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Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation (Review)

Hansel J, Rogers AM, Lewis SR, Cook TM, Smith AF

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[Intervention Review]

Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation

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ABSTRACT

Background

Tracheal intubation is a common procedure performed to secure the airway in adults undergoing surgery or those who are critically ill. Intubation is sometimes associated with difficulties and complications that may result in patient harm. While it is traditionally achieved by performing direct laryngoscopy, the past three decades have seen the advent of rigid indirect videolaryngoscopes (VLs). A mounting body of evidence comparing the two approaches to tracheal intubation has been acquired over this period of time. This is an update of a Cochrane Review first published in 2016.

Objectives

To assess whether use of different designs of VLs in adults requiring tracheal intubation reduces the failure rate compared with direct laryngoscopy, and assess the benefits and risks of these devices in selected population groups, users and settings.

Search methods

We searched MEDLINE, Embase, CENTRAL and Web of Science on 27 February 2021. We also searched clinical trials databases, conference proceedings and conducted forward and backward citation searches.

Selection criteria

We included randomized controlled trials (RCTs) and quasi-RCTs with adults undergoing laryngoscopy performed with either a VL or a Macintosh direct laryngoscope (DL) in any clinical setting. We included parallel and cross-over study designs.

Data collection and analysis

We used standard methodological procedures expected by Cochrane. We collected data for the following outcomes: failed intubation, hypoxaemia, successful first attempt at tracheal intubation, oesophageal intubation, dental trauma, Cormack-Lehane grade, and time for tracheal intubation.

Main results

We included 222 studies (219 RCTs, three quasi-RCTs) with 26,149 participants undergoing tracheal intubation. Most studies recruited adults undergoing elective surgery requiring tracheal intubation. Twenty-one studies recruited participants with a known or predicted difficult airway, and an additional 25 studies simulated a difficult airway. Twenty-one studies were conducted outside the operating theatre environment; of these, six were in the prehospital setting, seven in the emergency department and eight in the intensive care unit.

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We report here the findings of the three main comparisons according to videolaryngoscopy device type.

We downgraded the certainty of the outcomes for imprecision, study limitations (e.g. high or unclear risks of bias), inconsistency when we noted substantial levels of statistical heterogeneity and publication bias.

Macintosh-style videolaryngoscopy versus direct laryngoscopy (61 studies, 9883 participants)

We found moderate-certainty evidence that a Macintosh-style VL probably reduces rates of failed intubation (risk ratio (RR) 0.41, 95% confidence interval (CI) 0.26 to 0.65; 41 studies, 4615 participants) and hypoxaemia (RR 0.72, 95% CI 0.52 to 0.99; 16 studies, 2127 participants). These devices may also increase rates of success on the first intubation attempt (RR 1.05, 95% CI 1.02 to 1.09; 42 studies, 7311 participants; low-certainty evidence) and probably improve glottic view when assessed as Cormack-Lehane grade 3 and 4 (RR 0.38, 95% CI 0.29 to 0.48; 38 studies, 4368 participants; moderate-certainty evidence). We found little or no clear difference in rates of oesophageal intubation (RR 0.51, 95% CI 0.22 to 1.21; 14 studies, 2404 participants) but this finding was supported by low-certainty evidence. We were unsure of the findings for dental trauma because the certainty of this evidence was very low (RR 0.68, 95% CI 0.16 to 2.89; 18 studies, 2297 participants). We were not able to pool data for time required for tracheal intubation owing to considerable heterogeneity (I^2 = 96%).

Hyperangulated videolaryngoscopy versus direct laryngoscopy (96 studies, 11,438 participants)

We found moderate-certainty evidence that hyperangulated VLs probably reduce rates of failed intubation (RR 0.51, 95% CI 0.34 to 0.76; 63 studies, 7146 participants) and oesophageal intubation (RR 0.39, 95% CI 0.18 to 0.81; 14 studies, 1968 participants). In subgroup analysis, we noted that hyperangulated VLs were more likely to reduce failed intubation when used on known or predicted difficult airways (RR 0.29, 95% CI 0.17 to 0.48; P = 0.03 for subgroup differences; 15 studies, 1520 participants). We also found that these devices may increase rates of success on the first intubation attempt (RR 1.03, 95% CI 1.00 to 1.05; 66 studies, 8086 participants; low-certainty evidence) and the glottic view is probably also improved (RR 0.15, 95% CI 0.10 to 0.24; 54 studies, 6058 participants; data for Cormack-Lehane grade 3/4 views; moderate-certainty evidence). However, we found low-certainty evidence of little or no clear difference in rates of hypoxaemia (RR 0.49, 95% CI 0.22 to 1.11; 15 studies, 1691 participants), and the findings for dental trauma were unclear because the certainty of this evidence was very low (RR 0.51, 95% CI 0.16 to 1.59; 30 studies, 3497 participants). We were not able to pool data for time required for tracheal intubation owing to considerable heterogeneity (I^2 = 99%).

Channelled videolaryngoscopy versus direct laryngoscopy (73 studies, 7165 participants)

We found moderate-certainty evidence that channelled VLs probably reduce rates of failed intubation (RR 0.43, 95% CI 0.30 to 0.61; 53 studies, 5367 participants) and hypoxaemia (RR 0.25, 95% CI 0.12 to 0.50; 15 studies, 1966 participants). They may also increase rates of success on the first intubation attempt (RR 1.10, 95% CI 1.05 to 1.15; 47 studies, 5210 participants; very low-certainty evidence) and probably improve glottic view (RR 0.14, 95% CI 0.09 to 0.21; 40 studies, 3955 participants; data for Cormack-Lehane grade 3/4 views; moderate-certainty evidence). We found little or no clear difference in rates of oesophageal intubation (RR 0.54, 95% CI 0.17 to 1.75; 16 studies, 1756 participants) but this was supported by low-certainty evidence. We were unsure of the findings for dental trauma because the certainty of the evidence was very low (RR 0.52, 95% CI 0.13 to 2.12; 29 studies, 2375 participants). We were not able to pool data for time required for tracheal intubation owing to considerable heterogeneity (I^2 = 98%).

Authors' conclusions

VLs of all designs likely reduce rates of failed intubation and result in higher rates of successful intubation on the first attempt with improved glottic views. Macintosh-style and channelled VLs likely reduce rates of hypoxaemic events, while hyperangulated VLs probably reduce rates of oesophageal intubation. We conclude that videolaryngoscopy likely provides a safer risk profile compared to direct laryngoscopy for all adults undergoing tracheal intubation.

PLAIN LANGUAGE SUMMARY

Do video-assisted instruments for inserting breathing tubes in adults work better than direct-view instruments and do they cause unwanted effects?

Key messages

Devices called laryngoscopes are used to help medical staff to insert a plastic breathing tube into someone's windpipe because they need help with their breathing. A video camera can be attached to the device. We found that videolaryngoscopes generally improve the success of inserting a breathing tube compared with conventional laryngoscopes.

What is intubation?

People who are very ill or having surgery under general anaesthesia may need help to breathe. Trained medical staff may need to place a flexible plastic tube into a person's windpipe. This is called intubation. It will keep the airway open so that the person can be given help to breathe.

What are laryngoscopes?

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During intubation, the medical staff need to move the tongue and soft tissues of the mouth so that they can see the vocal cords before inserting the tube. To achieve this they use a laryngoscope. However, seeing the vocal cords may be difficult, for example when the person has restricted neck movement. Difficulties in intubation may lead to complications, including low oxygen levels and in extreme cases death.

In this review, we looked at two types of laryngoscopes: Macintosh direct laryngoscopes and videolaryngoscopes. A Macintosh direct laryngoscope is a curved piece of metal or plastic with a handle designed to hold down the tongue and soft tissues. A videolaryngoscope uses video technology and allows medical staff to see the position of the tube on a video screen while it is being inserted. There are three main designs of videolaryngoscopes: Macintosh-style (with a similar shape to the traditional laryngoscope), hyperangulated (more curved than other laryngoscopes), and channelled (with a groove to guide the breathing tube).

What is laryngoscopy?

Laryngoscopy is a medical procedure in which a device called a laryngoscope is used to examine the voice box and help with insertion of a breathing tube into the windpipe to protect the airways during anaesthesia or when patients have breathing difficulties. 'Direct laryngoscopes' rely on a direct line of sight to the voice box to achieve this. A 'videolaryngoscope' incorporates video technology that allows the voice box to be viewed on a screen during the procedure.

What did we want to find out?

We wanted to find out which type of laryngoscope works best for intubation for medical staff and patients. Which type of laryngoscope works best for certain groups of patients: for example, those with neck restrictions or obesity, different medical staff (experienced or less experienced) and in different settings (in or out of hospital). We also wanted to find out if any of the laryngoscopes cause unwanted effects.

What did we do?

We searched for studies that compared Macintosh laryngoscopes against each of the three different types of videolaryngoscopes. We compared and summarized their results, and rated our confidence in the evidence, based on factors such as study design, methods and numbers of participants.

What did we find?

We found 222 studies with 26,149 adults who were intubated using a laryngoscope. Most people were undergoing surgery and the intubation was planned or expected, but some intubations happened in emergency situations. Most studies included a mix of people. Some studies were in selected groups, such as people who were obese or when medical staff expected that intubation may be difficult. The studies were conducted in countries from around the world. Manufacturers of laryngoscopes were involved in 14 of the studies.

Main results

Compared to the traditional Macintosh laryngoscope, all three types of videolaryngoscope probably reduce the number of failed intubations. Hyperangulated videolaryngoscopes may lead to fewer failed intubations particularly in people with an airway that is difficult to intubate (or an expected difficult airway). All videolaryngoscopes may also increase the chances of being successfully intubated on the first attempt and improve the view of the vocal cords.

Macintosh-style and channelled videolaryngoscopes probably reduce the risk of the person experiencing a low oxygen level, but there may be little or no difference when a hyperangulated videolaryngoscope is used. Using a hyperangulated videolaryngoscope may reduce the risk of the breathing tube being accidentally inserted into the food pipe instead of the windpipe. The other videolaryngoscopes may or may not reduce this risk.

No type of laryngoscope increased or reduced accidental damage to the teeth, but we are very uncertain about this finding. We were unable to tell if any of the laryngoscopes reduced the time taken for intubation.

What are the limitations of the evidence?

We were moderately confident that videolaryngoscopes reduce failed intubations. We had moderate to very low confidence in our other findings. It was not possible for researchers to conceal what type of laryngoscope the medical staff used and this might have affected how they carried out intubations. The studies included different types of people, and some findings included the possibility of benefits or harms for both types of laryngoscope.

How up to date is this evidence?

This review updates our previous review. The evidence is up-to-date to March 2021.

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SUMMARY OF FINDINGS

Summary of findings 1. Macintosh-style videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Macintosh-style videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Patient or population: adults undergoing tracheal intubation
Setting: hospital and out-of-hospital; international
Intervention: Macintosh-style videolaryngoscopy
Comparison: direct laryngoscopy

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with direct laryngoscopy	Risk with Macintosh-style video-laryngoscopy				
Failed intubation	Study population		RR 0.41 (0.26 to 0.65)	4615 (41 RCTs)	⊕⊕⊕⊖ Moderate[a]	
	65 per 1000	27 per 1000 (17 to 42)				
Hypoxaemia	Study population		RR 0.72 (0.52 to 0.99)	2127 (16 RCTs)	⊕⊕⊕⊖ Moderate[a]	
	106 per 1000	76 per 1000 (55 to 105)				
Successful first attempt	Study population		RR 1.05 (1.02 to 1.09)	7311 (42 RCTs)	⊕⊕⊖⊖ Low[a,b]	
	813 per 1000	854 per 1000 (830 to 887)				
Oesophageal intubation	Study population		RR 0.51 (0.22 to 1.21)	2404 (14 RCTs)	⊕⊕⊖⊖ Low[a,c]	
	29 per 1000	15 per 1000 (6 to 36)				
Dental trauma	Study population		RR 0.68 (0.16 to 2.89)	2297 (18 RCTs)	⊕⊖⊖⊖ Very low[a,d]	
	4 per 1000	2 per 1000 (1 to 10)				
Cormack-Lehane grade	Study population		RR 0.38 (0.29 to 0.48)	4368 (38 RCTs)	⊕⊕⊕⊖ Moderate[a,b]	Data presented for frequency of Corma-
	196 per 1000	75 per 1000				

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		(57 to 94)				ck-Lehane grade 3 and 4 views
Time for tracheal intubation	See comment	See comment	-	4061 (35 RCTs)	⊕⊝⊝⊝ Very low[a,e]	High level of statistical heterogeneity between studies; therefore meta-analysis not completed

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **RCT:** randomized controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]We downgraded by one level for risk of performance bias due to the lack of blinding.
[b]We downgraded by one level for inconsistency because we noted considerable statistical heterogeneity.
[c]We downgraded by one level for imprecision because the confidence intervals indicated possible benefits as well as harms.
[d]We downgraded by two levels for imprecision because the frequency of events was small and the confidence intervals indicated possible benefits as well as harms.
[e]We downgraded by two levels for inconsistency because we noted extremely high statistical heterogeneity (I^2 = 96%).

Summary of findings 2. Hyperangulated videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Hyperangulated videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Patient or population: adults undergoing tracheal intubation
Setting: hospital and out-of-hospital; international
Intervention: hyperangulated videolaryngoscopy
Comparison: direct laryngoscopy

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with direct laryngoscopy	Risk with hyperangulated videolaryngoscopy				
Failed intubation	Study population		RR 0.51 (0.34 to 0.76)	7146 (63 RCTs)	⊕⊕⊕⊝ Moderate[a]	

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	56 per 1000	29 per 1000 (19 to 43)				
Hypoxaemia	Study population		RR 0.49 (0.22 to 1.11)	1691 (15 RCTs)	⊕⊕⊝⊝ Low[a,b]	
	44 per 1000	22 per 1000 (10 to 49)				
Successful first attempt	Study population		RR 1.03 (1.00 to 1.05)	8086 (66 RCTs)	⊕⊕⊝⊝ Low[a,c]	
	854 per 1000	879 per 1000 (854 to 896)				
Oesophageal intubation	Study population		RR 0.39 (0.18 to 0.81)	1968 (14 RCTs)	⊕⊕⊕⊝ Moderate[a]	
	26 per 1000	10 per 1000 (5 to 21)				
Dental trauma	Study population		RR 0.51 (0.16 to 1.59)	3497 (30 RCTs)	⊕⊝⊝⊝ Very low[a,d]	
	4 per 1000	2 per 1000 (1 to 7)				
Cormack-Lehane grade	Study population		RR 0.15 (0.10 to 0.24)	6058 (54 RCTs)	⊕⊕⊕⊝ Moderate[a,c]	Data presented for frequency of Cormack-Lehane grade 3 and 4 views
	189 per 1000	28 per 1000 (19 to 45)				
Time for tracheal intubation	see comment	see comment	-	6644 (59 RCTs)	⊕⊝⊝⊝ Very low[a,e]	High level of statistical heterogeneity between studies; therefore meta-analysis not completed

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **RCT:** randomized controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.

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Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

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[b]We downgraded by one level for imprecision because the confidence intervals indicated possible benefits as well as harms.
[c]We downgraded by one level for inconsistency because we noted considerable statistical heterogeneity.
[d]We downgraded by two levels for imprecision because the frequency of events was small and the confidence intervals indicated possible benefits as well as harms.
[e]We downgraded by two levels for inconsistency because we noted extremely high statistical heterogeneity (I^2 = 99%).

Summary of findings 3. Channelled videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Channelled videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

Patient or population: adults undergoing tracheal intubation
Setting: hospital and out-of-hospital; international
Intervention: channelled videolaryngoscopy
Comparison: direct laryngoscopy

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with direct laryngoscopy	Risk with channelled video-laryngoscopy				
Failed intubation	Study population		RR 0.43 (0.30 to 0.61)	5367 (53 RCTs)	⊕⊕⊕⊖ Moderate[a]	
	44 per 1000	19 per 1000 (13 to 27)				
Hypoxia	Study population		RR 0.25 (0.12 to 0.50)	1966 (15 RCTs)	⊕⊕⊕⊖ Moderate[a]	
	42 per 1000	10 per 1000 (5 to 21)				
Successful first attempt	Study population		RR 1.10 (1.05 to 1.15)	5210 (47 RCTs)	⊕⊕⊖⊖ Very low[a,b,c]	
	826 per 1000	909 per 1000 (868 to 950)				
Oesophageal intubation	Study population		RR 0.54 (0.17 to 1.75)	1756 (16 RCTs)	⊕⊕⊖⊖ Low[a,d]	
	34 per 1000	19 per 1000 (6 to 60)				

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Dental trauma	Study population		RR 0.52 (0.13 to 2.12)	2375 (29 RCTs)	⊕⊝⊝⊝ Very low[a,e]	
	3 per 1000	2 per 1000 (0 to 7)				
Cormack-Lehane grade	Study population		RR 0.14 (0.09 to 0.21)	3955 (40 RCTs)	⊕⊕⊕⊝ Moderate[a,b]	Data presented for frequency of Cormack-Lehane grade 3 and 4 views
	194 per 1000	27 per 1000 (17 to 41)				
Time for tracheal intubation	see comment	see comment	-	5676 (57 RCTs)	⊕⊝⊝⊝ Very low[a,f]	High level of statistical heterogeneity between studies; therefore meta-analysis not completed

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **RCT:** randomized controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]We downgraded by one level for risk of performance bias due to the lack of blinding.
[b]We downgraded by one level for inconsistency because we noted considerable statistical heterogeneity.
[c]We downgraded by one level for suspicion of publication bias.
[d]We downgraded by one level for imprecision because the confidence intervals indicated possible benefits as well as harms.
[e]We downgraded by two levels for imprecision because the frequency of events was small and the confidence intervals indicated possible benefits as well as harms.
[f]We downgraded by two levels for inconsistency because we noted extremely high statistical heterogeneity (I^2 = 98%).

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BACKGROUND

Description of the condition

Tracheal intubation, or simply intubation, is a procedure in which a tracheal tube is passed through the mouth or nose into the trachea via the larynx. It is performed for airway protection during general anaesthesia, for the provision of controlled ventilation in critically ill individuals and to provide a patent and secure airway during cardiopulmonary resuscitation. A correctly sited tracheal tube should enable controlled lung ventilation and prevent the aspiration of gastric contents into the lungs.

During direct laryngoscopy, a laryngoscope is introduced through the mouth and the blade of the device is used to retract the tongue and soft tissues in the floor of the mouth to provide a direct line of sight between the intubator's eye and the glottis. Additional manoeuvres such as flexing the lower cervical spine, extending the upper cervical spine and external laryngeal manipulation may be required to align the oral, pharyngeal and laryngeal axes. Once an adequate view of the glottis is obtained, the individual is intubated with a cuffed tracheal tube to secure the airway.

Tracheal intubation is a common procedure, performed for almost 40% of general anaesthetics in the UK and as an emergency procedure in the pre-hospital, emergency department and intensive care unit (ICU) setting (Woodall 2011). Failed or difficult intubation or unrecognized oesophageal intubation can have catastrophic consequences for individuals and may result in complications, including hypoxaemia, pulmonary aspiration, arrhythmias, cardiac arrest and death (Cook 2011a; Cook 2011b). Various factors influence the probability of failed intubation and complications arising from intubation. These include the location in which a person undergoes intubation, factors such as obesity or difficult airway predictors and the experience of the intubator.

Individuals who are intubated in ICU, emergency department or pre-hospital setting often differ from those scheduled for elective surgery. A comprehensive airway assessment may not be possible and critical care teams may need to provide airway management at very short notice without the presence of an anaesthetist (Cook 2011a). Vomit, secretions or blood may obscure the view of the glottis. Cervical spine immobilization and distorted airway anatomy from swelling or trauma can make it challenging to obtain a direct view of the glottis. Furthermore, disordered cardiorespiratory physiology from infection, trauma and hypermetabolism reduces the time available before complications such as hypoxaemia arise. Intubators tasked with securing the airway outside the theatre environment additionally face logistical challenges, such as limited availability of equipment or skilled assistance. Finally, educational issues and lack of regular exposure to airway management by intubators in non-theatre environments can present a contributing factor to observed difficulties in airway management.

Airway management difficulties are increased when individuals are obese (Juvin 2003; Lundstrom 2009). In the UK, the fourth National Audit Project (NAP4) showed that obese individuals accounted for 42% of those who experienced a major airway complication during anaesthesia (Cook 2011a). Functional residual capacity, which is the volume of air left in the lungs at the end of normal expiration, is reduced in obese individuals; this, along with other factors, reduces respiratory reserve and makes these individuals vulnerable to hypoxaemia if an airway is lost, making airway management more time critical (Adams 2000; Malhotra 2008; Marley 2005).

In addition to obesity, intubation may prove difficult for other reasons, for example restrictions in neck flexion, a narrow jaw opening, an enlarged tongue, poor tissue mobility and cervical instability. Predictive tests such as the Mallampati score, upper lip bite test or MACOCHA score are used before individuals are anaesthetized, yet a recent Cochrane systematic review advises caution when interpreting clinical airway examination tests owing to poor sensitivity (De Jong 2013; Mallampati 1985; Roth 2018). The modified Mallampati score, which is a four-grade score based on the view of the uvula when the individual opens their mouth, is the most widely used predictor of difficult intubation, but this and other prediction tests have been shown to have low positive predictive value for difficult intubation (Samsoon 1987; Shiga 2005).

There is a learning curve for the acquisition of skills in laryngoscopy and intubation (Bakshi 2015; Kim 2018; Marco 2011). Novice intubators are more likely to encounter failed intubation and take longer to undertake the procedure than expert intubators (Bakshi 2015). Inexperience in airway management was cited as an important factor contributing to fatal outcomes in several cases in NAP4, including examples of failed intubation and unrecognized oesophageal intubation (Cook 2011a).

Description of the intervention

Videolaryngoscopes (VLs) rely on video technology to transmit an image from the distal portion of the laryngoscope to an eyepiece or monitor where it is viewed by the intubator. These devices may be flexible or rigid in design for the purpose of assisting in difficult intubations and reducing failure, trauma and other complications. For this review we are interested in rigid VLs, which use a blade to retract the soft tissues and transmit an image to an eyepiece, a screen attached to the handle or to a stand-alone monitor. This design enables glottic visualization without requiring a direct line of sight.

A range of VLs are available in the marketplace with considerable heterogeneity in blade design. Some designs are broadly based on the original Macintosh blade shape, others have a more acutely curved blade or blade tip, allowing better visualization of anterior structures at the time of laryngoscopy. Another subset of VLs have a working channel incorporated into the blade. In this review, we refer to these three categories as Macintosh-style, hyperangulated and channelled blade designs, respectively. For examples of devices belonging to each category see Appendix 1.

How the intervention might work

In theory, VLs may assist intubation when difficulty is encountered unexpectedly or predicted with direct laryngoscopy. Furthermore, it could aid in sharing the view with other members of the team, enhancing situational awareness, teaching and teamwork, thereby potentially increasing safety.

Why it is important to do this review

The original version of this meta-analysis with 64 studies and 7044 participants provided evidence that VLs collectively improve glottic visualization and may reduce the incidence of failed intubation compared with direct laryngoscopy (Lewis 2016). Furthermore, the

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review indicated that laryngeal and airway trauma, and intubation difficulty (based on the Intubation Difficulty Scale, Adnet 1997), may be reduced with VLs. However, there was insufficient evidence to show that VLs reduce the incidence of hypoxaemia at the time of intubation.

A criticism of the original review and many of the meta-analyses in this area is that VLs are considered as a composite group, combining data for differing blade designs, rather than differentiating between blade types when reporting outcomes (Downey 2021). The technique required for successfully intubating an adult with a Macintosh-style VL is broadly similar to that when using a Macintosh direct laryngoscope. In contrast, the technique when using a hyperangulated device de-emphasizes displacement of the tongue and soft tissues, using the shape of the blade to clearly see the anteriorly situated glottis. A preformed stylet is normally used when intubating with a hyperangulated device. Channelled devices often have a bulkier blade than the Macintosh. The channel of the device guides the tracheal tube but does not permit manipulation of the tip in space, requiring an optimally positioned blade to ensure successful intubation.

It is plausible that some blade designs may be more advantageous in certain situations, such as when intubating individuals with obesity or predicted difficult airway, intubating in particular settings such as the emergency department or when intubation is performed by a novice.

Since the time of the original review many further randomized controlled trials (RCTs) have been published, adding to the evidence available in this area. Some hospitals and anaesthetic departments have adopted the universal use of VLs for all intubations and many have a range of different devices routinely available in various areas where intubation is likely to be performed (Cook 2018; Cortellazzi 2007).

This updated systematic review and meta-analysis seeks to update and build on the original review, by differentiating outcomes for Macintosh-style, hyperangulated and channelled blade designs versus direct laryngoscopy with a Macintosh blade (Lewis 2016). We hope the data will provide sufficient resolution to guide VL choice when intubating individuals in specific situations such as those outlined above. Oesophageal intubation was introduced as a critical outcome for this review owing to the renewed focus on unrecognized oesophageal intubation following recent examples of adult deaths in the UK, and noted high rates of oesophageal intubation in a large international observational study of ICU intubations (Cook 2019; Russotto 2021). This review does not focus on videolaryngoscopy in children, as this topic is the focus of another Cochrane Review (Abdelgadir 2017).

OBJECTIVES

To assess whether use of different designs of VLs in adults requiring tracheal intubation reduces the failure rate compared with direct laryngoscopy, and assess the benefits and risks of these devices in selected population groups, users and settings.

METHODS

Criteria for considering studies for this review

Types of studies

We included RCTs of both parallel and cross-over design. We included studies published as conference abstracts if they provided sufficient data on the methods and outcomes of interest. We aimed to include unpublished data if identified in the searches.

Types of participants

We included studies of participants aged 16 years and older who underwent tracheal intubation. We included adults scheduled for elective or emergency surgery, as well as those undergoing tracheal intubation in the ICU, the emergency department, prehospital or elsewhere outside the operating theatre. We included studies of adults in cardiac arrest who underwent tracheal intubation.

We included studies with unselected populations, those restricted to participants with known or predicted difficult laryngoscopy (e.g. Mallampati score 3 or 4 (Samsoon 1987) or previous Cormack-Lehane grade 3 or 4 (Cormack 1984) with direct laryngoscopy) and those restricted to participants with a body mass index (BMI) > 30 kg/m^2.

We excluded studies looking at awake tracheal intubation. We did not include manikin or cadaver studies.

Types of interventions

We included studies that compared the use of a VL of any model versus direct laryngoscopy with a Macintosh blade.

We categorized VL designs into the following groups: Macintosh-style, hyperangulated and channelled. We provide a list of example models and manufacturers categorized by VL device type in Appendix 1.

We excluded optical stylets, flexible fibreoptic intubating devices and tracheal tubes with an integrated camera. We excluded studies using a McCoy or Miller DL blade. We excluded simulation studies that did not involve human participants. We also excluded the Bullard VL.

Comparisons

We compared groups of interventions to DL with a Macintosh blade. Thus, we considered the following separate comparison groups:

- Macintosh-style videolaryngoscopy versus direct laryngoscopy;
- hyperangulated videolaryngoscopy versus direct laryngoscopy;
- channelled videolaryngoscopy versus direct laryngoscopy.

Types of outcome measures

We categorized outcomes as critical or important in accordance with the GRADE recommendations (GRADE Handbook). We identified outcomes that are patient-centred and arise from difficulties with intubation as critical. We also identified important outcomes, such as surrogate markers of airway problems. We did not categorize mortality as a critical outcome as it is reported very infrequently, and it is therefore unlikely that an RCT will identify the potential difference in frequencies of its occurrence (Duggan 2021).

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Critical outcomes

We extracted information on the following four 'critical' outcomes.

- Failed intubation – defined as more than three attempts or change of device or intubator required
- Hypoxaemia – defined as oxygen saturation less than 94% between start of induction and recovery from anaesthesia
- Successful first attempt at tracheal intubation – assessed at time of intubation
- Oesophageal intubation – assessed at time of intubation by the intubator

Failed intubation was seen to be an important indicator of the success of a given intubation technique. While failed intubation may not always result in an adverse consequence for the individual, it increases the risk of serious complications (Cook 2012). Hypoxaemia is an undesirable event at the time of intubation and is the commonest cause of airway-related deaths. Successful first attempt at intubation is associated with fewer adverse events in individuals undergoing emergency intubation (Sakles 2013). Oesophageal intubations, especially when unrecognized, remain an ongoing cause of preventable morbidity and mortality (Cook 2019; Higgs 2017).

Important outcomes

We also reported the following eight 'important' outcomes.

- Dental trauma – assessed at time of intubation
- The Cormack-Lehane grade (Cormack 1984) – assessed by intubator at time of intubation
- Time for tracheal intubation – defined as total time required for tracheal intubation at time of intubation
- Patient-reported sore throat – within the first 24 hours of anaesthesia or closest to six hours postoperatively
- Number of attempts at tracheal intubation – assessed at time of intubation
- Intubation Difficulty Scale (IDS) (Adnet 1997) – assessed by intubator at time of intubation
- Percentage of Glottic Opening (POGO) (Levitan 1998) – assessed by intubator at time of intubation
- Mortality – within 30 days of intubation

Search methods for identification of studies

Electronic searches

We identified RCTs through literature searching with systematic and sensitive search strategies, as outlined in Chapter 4 of the *Cochrane Handbook of Systematic Reviews of Interventions* (Lefebvre 2021a). We applied no restrictions on language or publication status.

We searched the following databases for relevant studies on 27 February 2021:

- Cochrane Central Register of Controlled Trials (CENTRAL; 2021, Issue 2) in the Cochrane Library;
- MEDLINE via Ovid (January 2015 to 27 February 2021);
- Embase via Ovid (January 2015 to 27 February 2021);
- Web of Science (January 2015 to 27 February 2021).

We limited the searches from January 2015 to 27 February 2021. We applied the Cochrane highly sensitive filter for RCTs in MEDLINE and Embase (Lefebvre 2021b). We updated the previous search strategies to include some of the newly identified device models that have come to market since the previous review.

We searched the trial registerClinicalTrials.gov and the World Health Organization International Clinical Trials Registry Portal(ICTRP) for ongoing studies on 10 June 2021.

We have presented our search strategies for MEDLINE, Embase, CENTRAL, Web of Science and trial registers in Appendix 2. We searched using only free text, as using broader medical subject headings (MeSH) would have resulted in too much noise in the search. We performed a separate search to identify previously unidentified records with the updated search strategy for records prior to 2015, which did not identify any additional records. We included publications that reported study data, including abstracts.

We searched for retractions of included studies in Retraction Watch Database.

We also included into the screening stage 33 references that were excluded from the original review due to uncertainty regarding the type of Airtraq device under study.

The searches were developed and run by the authors and peer reviewed by the Cochrane Anaesthesia Information Specialist.

Searching other resources

We undertook forward and backward citation tracking for key review articles and eligible articles identified through the electronic resources using Google Scholar on 27 February 2021. We also considered studies identified in other systematic reviews on the topic (Downey 2021). Conference proceedings were searched electronically.

Data collection and analysis

In order to reduce bias, we ensured that any review author who is a co-applicant, study author, or has had an advisory role on any potentially relevant study, remained independent of study selection decisions, risk of bias assessment and data extraction for their study.

Selection of studies

We collated results of the searches and removed duplicates using EndNote 20. Two review authors (JH and AR) screened all titles and abstracts to remove studies that were ineligible using Covidence. If no abstract was available, but the title was possibly relevant, we obtained the full text of the article. We reviewed the full texts of potentially relevant titles. Each review author used Covidence to record decisions and reach consensus at each stage. We resolved disagreements by discussion or adjudication by a third review author. We prepared a PRISMA flow-diagram to outline the study selection process, numbers of records at each stage of selection, and reasons for exclusions of full-text articles (Page 2021). We reported in the review details of key excluded studies, rather than all studies that were excluded from consideration of full-text articles.

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Data extraction and management

All review authors conferred on the essential data for extraction, and a form was structured to align with default headings in the Characteristics of included studies. Three review authors piloted the template on 10 studies and compared results. We then made further changes as necessary. For the remaining data extraction, one review author independently extracted data and a second review author checked all the data for accuracy. We extracted the following data.

- Study methodology: publication type; sponsorship/funding/notable conflicts of interest of study authors; study design; number of centres and locations; study inclusion and exclusion criteria; randomization method; number of randomized participants, losses (and reasons for losses), and number analysed for each outcome
- Population: baseline characteristics of the participants by group and overall (age, gender, weight, height, BMI, American Society of Anesthesiologists (ASA) status, Mallampati grade, other features such as pregnancy and urgency of intubation)
- Interventions: details of each intervention (device names, blade sizes, adjuncts used); general intubator details (number of intubators and their skills and experience, use of additional equipment, use of specific drugs, use of tools to simulate difficulty, such as a cervical collar or manual in-line stabilization)
- Outcomes: outcomes relevant to the review; we extracted outcome data into data and analysis tables or additional tables in RevMan Web 2021

We successfully contacted the authors of Ahmad 2015, Cordovani 2019, Gupta 2020, Hamp 2015, Janz 2016, Kriege 2020, Loughnan 2019, Silverberg 2015 and Suzuki 2008 for additional information.

Assessment of risk of bias in included studies

We assessed the risk of bias in the studies using RoB 1 (Higgins 2011). We assessed the following domains.

- Sequence generation (selection bias)
- Allocation concealment (selection bias)
- Blinding of participants, personnel (performance bias)
- Blinding of outcome assessors (detection bias)
- Incomplete outcome data (attrition bias)
- Selective reporting (reporting bias)
- Other risks of bias

For each domain, two review authors judged whether study authors made sufficient attempts to minimize bias in their design. For each domain, we made judgements using three measures - high, low, or unclear risk of bias - and we recorded these judgements in risk of bias tables. We reviewed the original protocol of the studies, where available, to identify any changes to procedure or missing outcome data that may indicate reporting bias.

It was not possible for the intubator to be blinded to the intervention for this research question and, similarly, it was difficult for assessors of outcomes during intubation to be unaware of the allocation of the participant. Outcomes assessed during or after the operation, such as airway trauma or respiratory complications, could be assessed by staff other than the intubator who were unaware of the laryngoscopy device. It is likely that participants who were asleep may not know the device used, which may be important for patient-reported outcomes, such as sore throat.

We considered the expertise and prior experience of the intubator, which has the potential to be an important confounder for this review.

This review also includes cluster-RCTs. In addition to the standard domains above, we also evaluated the following domains:

- bias arising from the randomization process;
- bias arising from the timing of identification and recruitment of participants;
- bias due to deviations from intended interventions;
- bias due to missing outcome data;
- bias in measurement of the outcome;
- bias in selection of the reported result.

Measures of treatment effect

We calculated risk ratios (RRs) for dichotomous data outcomes with 95% confidence intervals (CIs). We expressed treatment effects for continuous data outcomes as mean differences (MD) with 95% CI. We did not combine outcomes measured using different scales.

In the event that studies reported dichotomous data using more than one category, we selected the following cut-off points in the distribution of categories as follows.

- For sore throat: we reported data for those with moderate or severe sore throat; where sore throat was reported across a range of times following extubation, we reported data for the data point closest to six hours following the procedure;
- For Cormack-Lehane scores: we reported data for Cormack-Lehane grades 1 and 2 separately, and combined the events for grades 3 and 4 into one category;
- For IDS: we reported data for 0 (easy), 1 to 5 (some difficulty), > 5 (moderate-to-major difficulty) as described by Adnet 1997

Where continuous measures were reported as median and interquartile range (IQR), we did not extract them where we judged this to be due to a non-normal distribution of data.

Unit of analysis issues

We encountered a number of potential unit of analysis issues.

Firstly, a number of studies looked at multiple VLs, sometimes of various designs (e.g. hyperangulated and Macintosh-style). We designed this updated review to conduct separate comparisons for the three different VL categories. We extracted data for each type of VL into separate analyses, whereby we categorized them as either Macintosh-style, hyperangulated or channelled. This categorization and the devices assigned to each group by type are presented in Appendix 1.

We therefore extracted data into three separate comparisons, being mindful that the denominator data for DLs would be inflated if these data were to be combined thereafter. When we performed the sensitivity analyses to approximate the original review for failed intubation and hypoxaemia, that is combining all three designs, we compared the combined VL data only to the originally reported events and denominator figures for DL.

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Furthermore, we were not able to ascertain with certainty the possibility of reporting of overlapping outcomes for certain complications, such as airway trauma. This could range from lip lacerations, airway injuries, reports of blood on laryngoscope blades or dental trauma. These were reported separately in some studies, and combined in others. Where they were reported separately, it was often not clear whether multiple complications had occurred in the same individual. Therefore, combining these separately reported events would have potentially introduced unit of analysis issues. We avoided this by only extracting data for what we considered the most patient-centred outcome within the category, that is, dental trauma.

Finally, where cross-over studies reported data for Cormack-Lehane grade views, we only extracted the data when it was possible to ascertain which device was used in which order and what the reported event rates were for the given device.

We included cluster-RCTs in this review. The unit of analysis was the cluster rather than the individual in these studies.

Dealing with missing data

For each included study, we recorded the number of participant losses. We did not impute missing data. We prioritized intention-to-treat (ITT) data where these data were available. We used the risk of bias tool to judge attrition bias. We judged studies to be at high risk of attrition bias if we noted large amounts of unexplained missing data, loss that could not be easily justified in the study population, or losses were not sufficiently balanced between intervention groups. If we included a study with high attrition bias, we explored the effect during sensitivity analysis. We completed sensitivity analysis only for the critical outcome of failed intubation and removed studies with high or unclear attrition bias.

We attempted contact with study authors of more recently published studies when we noted that data for critical outcomes appeared to have been measured but not reported or if any discrepancies were noted in the reported data. We noted in the Characteristics of included studies when we could not use outcome data because they were insufficiently reported or because numbers of losses in each group were not clearly specified. We did not include results reported in abstracts in which denominator figures were not explicitly stated and for which we were unable to reach study authors.

Assessment of heterogeneity

We used the I^2 statistic (Higgins 2003), as automatically calculated in RevMan Web 2021, to quantify the possible degree of statistical heterogeneity of treatment effects between studies. We assumed moderate heterogeneity when the I^2 statistic was between 30% and 60%; substantial heterogeneity when it was between 50% and 90%; and considerable heterogeneity when it was between 75% and 100% (Deeks 2021). We noted the importance of the I^2 statistic depending on magnitude and direction of effects and strength of evidence for heterogeneity.

We assessed clinical and methodological diversity in terms of participants, interventions, outcomes, effect modifiers, and study characteristics for the included studies to determine whether a meta-analysis was appropriate; we used the information collected during data extraction to make these assessments. This diversity may have been due to:

- anticipated degree of airway difficulty (predicted, known or simulated);
- expertise of intubator (novice or expert);
- VL device used (device category or specific brand);
- degree of obesity;
- pregnancy;
- urgency of intubation (emergency or elective);
- setting (operating theatre, ICU, emergency department, prehospital).

We visually inspected forest plots to look at the consistency of intervention effects across included studies, and if necessary, we used sensitivity analyses to explore this.

Assessment of reporting biases

For the critical outcome of failed intubation in all three comparisons, we constructed a funnel plot and interpreted the plot using a visual inspection and the Harbord modified test in RStudio using the regtest function in the metafor package (version 3.0-2); we reported P values for the Harbord modified test, using the mixed-effects meta-regression model and standard error as the predictor. We incorporated this judgement into the assessment of publication bias within the GRADE assessment.

To assess outcome reporting bias, we screened clinical trials registers for protocols and registration documents of included studies that were prospectively published, and we sourced all clinical trials register documents that were reported in the study reports of included studies. We used evidence of prospective registration to judge whether studies were at risk of selective reporting bias.

Data synthesis

We conducted meta-analyses only when meaningful, that is, when the treatments, participants, and the underlying clinical question were similar enough for pooling to make sense. We pooled results of comparable groups of studies using random-effects models. This choice of the model was chosen after careful consideration of the extent to which any underlying effect could truly be thought to be fixed given the complexity of the interventions and populations included in this review. We presented 95% CIs throughout.

We found that some studies reported outcome data at more than one time point. For sore throat, we reported the data closest to the six-hour mark following intervention, as reported. For studies that reported outcome data using more than one measurement tool, we selected the tool that was used most commonly by other studies in the comparison group, or that reported data for the most number of participants.

We considered the appropriateness of pooling data where there was considerable heterogeneity (I^2 statistic value of greater than 80%) that could not be explained by the diversity of methodological or clinical features among studies. We presented data from these studies in the analyses and clearly reported these observations in the text for the critical outcomes in the review.

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Subgroup analysis and investigation of heterogeneity

We performed the following prespecified subgroup analyses for each comparison separately for the critical outcome of failed intubation only.

- Setting: theatre versus non-theatre intubations (ICU, emergency department, prehospital)
- Obesity: obese versus non-obese participants
- Airway difficulty: participants with predicted, known or simulated difficulty versus those with no such features
- Intubator experience: inexperienced versus experienced intubators

We defined experienced intubators as those who had equivalent experience in the clinical setting of at least 20 uses with each device, and inexperienced intubators as those with fewer than 20 uses of a VL device.

We did not perform subgroup analyses if fewer than 10 studies reported data for a given subgroup.

Given that we found too few studies to conduct subgroup analyses for a number of the prespecified categories for each comparison, we made the post hoc decision to conduct the four subgroup analyses for all VL designs combined. This was similar in design to the subgroup analyses performed in the original review (Lewis 2016).

Sensitivity analysis

We used sensitivity analysis to explore the effects of risks of bias on the review for critical outcomes. We excluded studies that were:

- at high or unclear risk of selection bias for sequence generation (this included studies that were described as quasi-randomized, or that did not adequately describe methods used to randomize participants to intervention groups); or
- at high or unclear risk of attrition bias (because studies reported a large number of losses that were unexplained, or that were unbalanced between groups, and that we expected could influence outcome data).

We compared the effect estimates in the sensitivity analysis with the effect estimates in the primary analysis; we reported the effect estimates from sensitivity analyses only if we noted a difference in our interpretation of the effect. We conducted a prespecified sensitivity analysis combining all three VL design types looking at the two primary outcomes reported in the previous version of this review (failed intubation and hypoxaemia). We separately performed a sensitivity analysis of the decision to include the Truview as a hyperangulated device.

We noted some extreme outliers in our data for 'hyperangulated VL versus DL' and 'channelled VL versus DL', which may have been the result of clinical diversity (Assessment of heterogeneity). We used sensitivity analysis to explore this by removing outlying data from the analysis of our critical outcome 'failed intubation'.

Given the high number of studies with zero events in both arms for certain outcomes, we conducted a post hoc sensitivity analysis for the critical outcomes of failed intubation, hypoxaemia, and oesophageal intubation where we included studies with no events. We used the Trial Sequential Analysis Software (version 0.9.5.10 Beta) with the reciprocal zero event handling method set at 0.5 to replicate the analysis in RevMan Web 2021.

Summary of findings and assessment of the certainty of the evidence

We used the GRADE system to assess the certainty of the body of evidence associated with seven critical outcomes in the review (Guyatt 2008).

- Failed intubation
- Hypoxaemia
- Successful first attempt
- Oesophageal intubation
- Dental trauma
- Cormack-Lehane grade
- Time for tracheal intubation

The GRADE approach assesses the certainty of a body of evidence based on the extent to which we can be confident that an estimate of effect or association reflects the item being assessed. Evaluation of the certainty of a body of evidence considers within-study risk of bias (study limitations), directness of the evidence (indirectness), heterogeneity of the data (inconsistency) precision of the effect estimates (imprecision), and risk of publication bias. The certainty of the evidence could be high, moderate, low or very low, being downgraded by one or two levels depending on the presence and extent of concerns in each of the five GRADE domains. We used footnotes to describe reasons for downgrading the certainty of the evidence for each outcome, and we used these judgements when drawing conclusions in the review.

We constructed summary of findings tables using the GRADE profiler software for the following comparisons in this review (GRADEpro GDT).

- Macintosh-style VL versus DL
- Hyperangulated VL versus DL
- Channelled VL versus DL

JH created the tables for each outcome and reached agreement on assessment decisions through discussion with SL and AR. For the outcome of Cormack-Lehane grades we reported data for Cormack-Lehane grades 3/4 in the summary of findings tables.

RESULTS

Description of studies

See Characteristics of included studies, Characteristics of excluded studies, Characteristics of ongoing studies, and Characteristics of studies awaiting classification.

Results of the search

After removal of duplicates from the results of the 1 January 2015 to 27 February 2021 search we screened 2344 titles and abstracts, which included backward citation searches and clinical trials register searches. We assessed 227 full-text records and identified 158 new studies for inclusion in this review update. We also included the 64 studies identified in the original review. We excluded 69 records, retaining 11 key records (see Excluded

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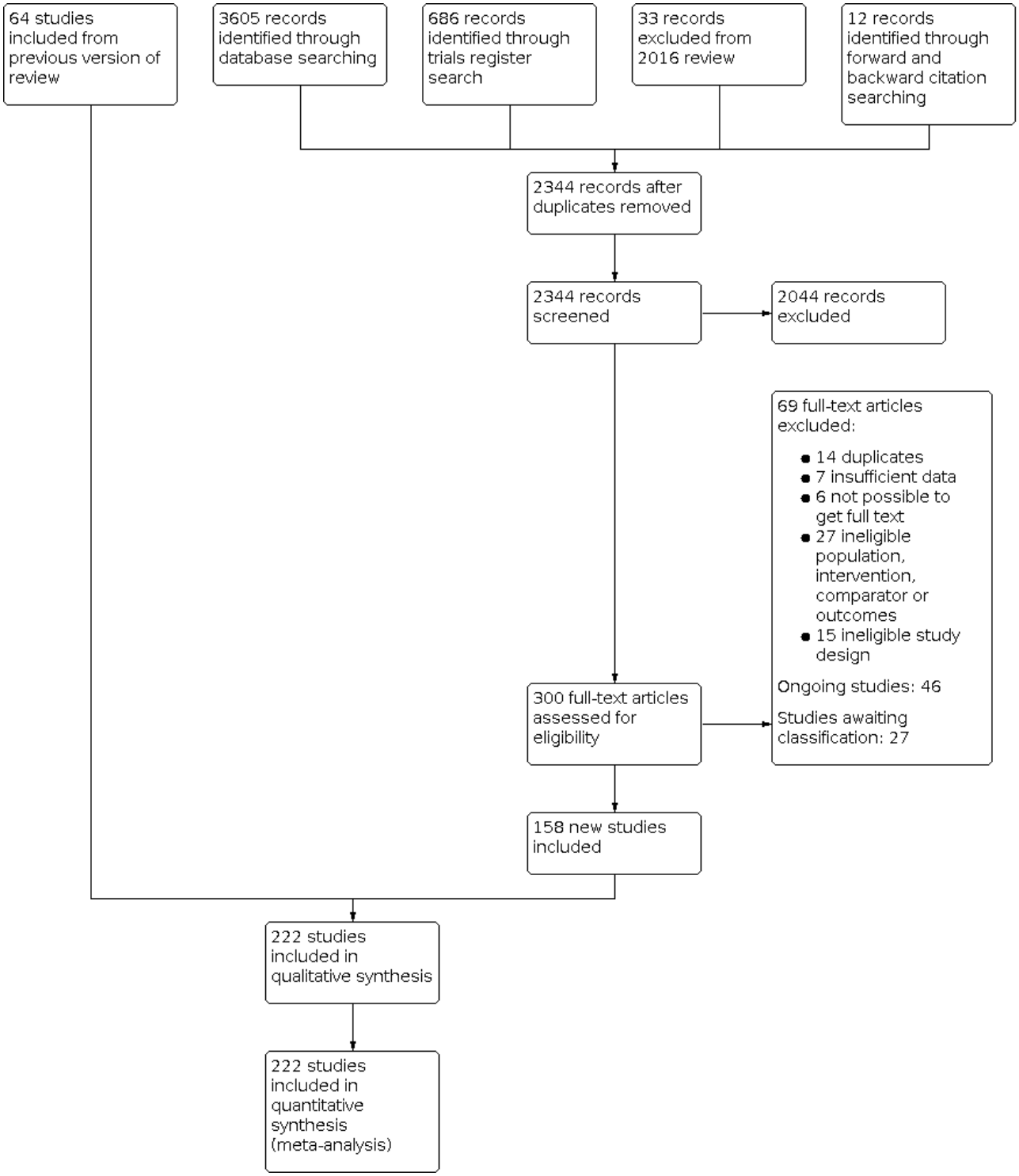
studies). We identified 46 ongoing studies and 27 studies awaiting classification. See Figure 1.

Figure 1. Flow diagram



Included studies

See Characteristics of included studies.

Seventeen studies were reported as abstracts only with no or limited baseline characteristics data (Dharanindra 2020; Echeverri 2020; Foulds 2016a; Frohlich 2011; Hostic 2016; Koennecke 2014; Kriege 2020; Lopez 2017; Nakayama 2010; Peck 2009; Rabbani 2020;

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Rewari 2017; Rovsing 2010; Sandhu 2014; Sansone 2012; Shippey 2013; Suzuki 2008). We noted that one study (Ducharme 2017) was terminated early due to slow enrolment.

Types of studies and setting

We included 222 studies (see Included studies).

All identified studies, except three, were RCTs. We identified two cluster-RCTs (Ducharme 2017; Kim 2016), and three quasi-randomized trials (Ahmadi 2015; Sarkilar 2015; Silverberg 2015), which we included.

Thirty-two studies employed a cross-over design (Arora 2013; Avula 2019; Bag 2014; Carassiti 2013; Cattano 2013; Cavus 2011; Cordovani 2019; Ducharme 2017; El-Tahan 2017a; Enomoto 2008; Erdivanli 2018; Ferrando 2011; Foulds 2016b; Gandhi 2019; Hindman 2014; Hirabayashi 2008; Ilyas 2014; Lee 2009; Lee 2012; Maassen 2012; Marrel 2007; Maruyama 2008a; Paik 2020; Peck 2009; Robitaille 2008; Russell 2013; Sbeghen 2021; Serocki 2010; Serocki 2013; Taylor 2013; Turkstra 2005; Turkstra 2009). The remaining studies were conducted using a parallel design. Studies described by authors as cross-over designs employed one type of laryngoscope initially to assess the glottic view, followed by the other type of laryngoscope to assess the glottic view and perform intubation.

Twenty-one studies were conducted outside the operating theatre setting. Six studies were conducted in the prehospital environment (Arima 2014; Ducharme 2017; Kreutziger 2019; Macke 2020; Trimmel 2011; Trimmel 2016), seven in the emergency department (Ahmadi 2015; Driver 2016; Goksu 2016; Kim 2016; Sanguanwit 2021; Sulser 2016; Yeatts 2013), and eight in the ICU (Abdelgalel 2018; Dey 2020; Dharanindra 2020; Gao 2018; Griesdale 2012a; Janz 2016; Lascarrou 2017; Silverberg 2015). The remaining studies were conducted in the operating theatre.

Types of participants

A total of 26,149 participants were included in the 222 studies.

Most studies recruited adult consenting participants undergoing elective surgical procedures. Eight studies included adults in cardiac arrest (Arima 2014; Dey 2020; Driver 2016; Ducharme 2017; Goksu 2016; Kim 2016; Kreutziger 2019; Silverberg 2015).

Sixteen studies specifically included only obese or morbidly obese individuals (Abdallah 2011; Akbarzadeh 2017; Ander 2017; Andersen 2011; Cakir 2020; Castillo-Monzon 2017; Marrel 2007; Nandakumar 2018; Ndoko 2008; Postaci 2015; Ranieri 2012; Rovsing 2010; Ruetzler 2020; Wasinwong 2017; Yousef 2012; Yumul 2016). A further eight studies included a mix of obese and non-obese participants (Ducharme 2017; Erdivanli 2018; Gao 2018; Golboyu 2016; Kreutziger 2019; Lascarrou 2017; Loughnan 2019; Malik 2009b).

Five studies included only pregnant participants undergoing caesarean section (Amini 2015; Arici 2014; Blajic 2019; Inal 2016; Toker 2019).

Twenty-one studies recruited participants with a known or predicted difficult airway (Ahmadi 2015; Ali 2017; Aziz 2012; Cordovani 2019; Gupta 2013; Gupta 2020; Hu 2017; Jungbauer 2009; Kumar 2019; Maharaj 2008; Malik 2009b; Ninan 2016; Pappu 2020; Sansone 2012; Serocki 2010; Serocki 2013; Tolon 2012; Turkstra 2009; Vijayakumar 2016; Woo 2012; Yoo 2018). A difficult airway was simulated by means of applying a cervical collar or manual in-line stabilization in 25 studies (Agrawal 2020; Akbar 2015; Aleksandrowicz 2018; Amor 2013; Aoi 2010; Chandrashekaraiah 2017; Enomoto 2008; Foulds 2016a; Ilyas 2014; Kleine-Brueggeney 2017; Koennecke 2014; Koh 2010; Laosuwan 2015; Lim 2005; Maharaj 2007; Malik 2008; Malik 2009a; Maruyama 2008a; Mathew 2018; McElwain 2011; Paik 2020; Peck 2009; Robitaille 2008; Shippey 2013; Taylor 2013). To simulate difficulty, participants were intubated on the floor in one study (Komatsu 2010) and in the lateral position in three studies (Bhat 2015; Rabbani 2020; Takenaka 2011). Eighteen studies did not specify difficult airway features in the inclusion or exclusion criteria (Abdallah 2011; Abdelgalel 2018; Arima 2014; Dey 2020; Dharanindra 2020; Foulds 2016a; Frohlich 2011; Gao 2018; Hostic 2016; Kim 2016; Kriege 2020; Lee 2009; Macke 2020; Masoumifar 2020; Sandhu 2014; Sanguanwit 2021; Suzuki 2008; Yeatts 2013).

Types of interventions

We present a table with the various VL types by category and the studies that included each device (see Appendix 1). The comparison was a Macintosh direct laryngoscope (DL).

Macintosh-style videolaryngoscope

Sixty-three studies with 10,222 participants included a Macintosh-style VL as one of the comparisons. Of these:

- 30 studies used a C-MAC;
- 25 studies used a McGrath Mac;
- three studies used a V-MAC;
- three studies used an X-lite; and
- one study used a CEL-100;
- one study did not report the specific device used.

Hyperangulated videolaryngoscope

One hundred and two studies with 11,857 participants included a hyperangulated VL as one of the comparisons. Of these:

- 63 studies used a GlideScope;
- 15 studies used a McGrath Series 5;
- 11 studies used a C-MAC D-BLADE;
- 11 studies used a Truview;
- three studies used a UEScope;
- two studies used an AP Advance;
- two studies used a King Vision without a guiding channel;
- one study used a McGrath Series 3; and
- one study used a Tosight.

The Truview VL design cannot readily be classified as either a Macintosh-style or a hyperangulated VL. We therefore made a discretionary decision on the category. Given the more acute angulation of the tip as compared to Macintosh blade, we decided to categorize it as a hyperangulated VL.

Channelled videolaryngoscope

Seventy-seven studies with 7385 participants included a channelled VL as one of the comparisons. Of these:

- 44 studies used an Airtraq;

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- 22 studies used a Pentax AWS; and
- 13 studies used a King Vision.

One study reported the use of a Storz VL, but the study authors did not specify which device this was. We included the study in the Macintosh-style comparisons (Lee 2009).

Three studies compared a Macintosh-style VL used as an indirect VL (with video screen used for intubation) versus the same device used as a DL, disallowing the intubator to view the video screen (Cattano 2013; Driver 2016; Marrel 2007). Where the device was explicitly reported as a Macintosh-style VL and no DL Macintosh laryngoscope data were reported, we included the outcome data from these studies.

One study changed the type of laryngoscope during the recruitment phase, switching from the channelled version of the King Vision laryngoscope to the unchannelled King Vision (Ducharme 2017).

Two studies allowed intubators to choose the exact VL device used for intubation (Janz 2016; Loughnan 2019). The most commonly used VL in Janz 2016 was the McGrath MAC (98.6%), with only one participant (1.4%) intubated with GlideScope. Loughnan 2019 provided us with raw data tables allowing device-specific extraction of data for the relevant reported outcomes.

We included 16 studies that used double-lumen tracheal tubes for intubation (Bakshi 2019; Bensghir 2010; El-Tahan 2017b; Hamp 2015; Hsu 2012; Huang 2020; Kido 2015; Lin 2012; Nakayama 2010; Risse 2020; Russell 2013; Shah 2016; Wasem 2013; Wei 2016; Yao 2015; Yoo 2018). All remaining studies used single-lumen tracheal tubes.

Most studies utilized a two-arm design, comparing one type of VL to a classic Macintosh laryngoscope. However, 30 studies reported multi-arm comparisons with two or three types of VL compared to a Macintosh blade (Abdelgalel 2018; Al-Ghamdi 2016; Altun 2018; Arslan 2017; Bakshi 2015; Bensghir 2013; Blajic 2019; Cavus 2011; Colak 2015; El-Tahan 2017b; Foulds 2016a; Gupta 2013; Hostic 2016; Huang 2020; Kaur 2020; Kleine-Brueggeney 2017; Koennecke 2014; Lee 2012; Malik 2008; Malik 2009b; McElwain 2011; Nakayama 2010; Pappu 2020; Rabbani 2020; Serocki 2010; Serocki 2013; Tempe 2016; Teoh 2010; Wallace 2015; Yumul 2016). Four of the multi-arm studies used a cross-over design (Cavus 2011; Lee 2012; Serocki 2010; Serocki 2013) . One study changed from a three-arm to a four-arm design part way through enrolment (Cavus 2011).

Experience of intubator

In twelve studies the intubators were described as novices or were trained on manikins, but had no or limited clinical experience (Ferrando 2011; Griesdale 2012a; Hirabayashi 2009; Janz 2016; Kapadia 2021; Kim 2018; Liu 2016; Marco 2011; Park 2010; Silverberg 2015; Walker 2009; Zhao 2014). Thirteen studies included intubators who were experienced in the use of DL, but were inexperienced with VL (Abdallah 2011; Al-Ghamdi 2016; Barak 2007; Chalkeidis 2010; Ducharme 2017; Frohlich 2011; Kill 2013; Lim 2005; Parasa 2016; Taylor 2013; Trimmel 2011; Trimmel 2016; Wasinwong 2017). One study included intubators who were experienced with both devices, but were inexperienced with double-lumen tube insertion (Bakshi 2019). Eleven studies included a combination of novice and experienced intubators (Arima 2014; Aziz 2012; Bakshi 2015; Bensghir 2010; Dey 2020; El-Tahan 2017b; Goksu 2016; Lascarrou 2017; Macke 2020; Russell 2012; Sanguanwit 2021).

Twenty-five percent of the studies did not specify intubator experience explicitly, and we were not able to infer it from the manuscript. The remaining studies used experienced intubators performing laryngoscopy and intubation.

Types of outcome measures

Twelve studies reported no outcomes of interest to the review (Buhari 2016; Cengiz 2019; Das 2016; Gavrilovska-Brzanov 2015; Hirabayashi 2008; Karaman 2016; Marsaban 2017; Misirlioglu 2016; Rewari 2017; Sbeghen 2021; Suzuki 2008; Wei 2016). The remaining studies reported at least one outcome of interest. Of the primary outcomes, 65% of studies reported data for failed intubation and 18% for hypoxaemia.

We did not include data for Ducharme 2017 and Kim 2016, which are cluster-RCTs, because they did not account for the effect of clustering in the manuscript.

Sources of funding and declarations of interest

Twenty-four study authors reported that they had received one or more of the intervention devices from the manufacturers for the purpose of the study (Abdallah 2011; Abdelgawad 2015; Al-Ghamdi 2016; Blajic 2019; Cavus 2011; El-Tahan 2017a; El-Tahan 2017b; Enomoto 2008; Frohlich 2011; Komatsu 2010; Malik 2008; Malik 2009a; Malik 2009b; Maruyama 2008a; Maruyama 2008b; McElwain 2011; Sbeghen 2021; Serocki 2010; Serocki 2013; Taylor 2013; Trimmel 2011; Trimmel 2016; Wallace 2015; Wasem 2013).

Fourteen study authors declared that one of their study team had received funding or had an interest in the company that manufactured the devices or received fees or other forms of external funding (Storz: Aziz 2012; Cattano 2013; Cavus 2011; Serocki 2013; Pentax: Enomoto 2008; McGrath: Taylor 2013; Verathon: Cordovani 2019; Kill 2013; Russell 2012; other: Blajic 2019; Janz 2016; Lascarrou 2017; Ruetzler 2020; Sbeghen 2021). One study used charity funding to purchase devices (Walker 2009).

Twenty-seven studies received government, departmental or institutional funding only (Andersen 2011; Bakshi 2019; Carassiti 2013; Colak 2019; Goksu 2016; Griesdale 2012a; Hirabayashi 2009; Ing 2017; Jungbauer 2009; Kido 2015; Kim 2016; Kreutziger 2019; Loughnan 2019; Najafi 2014; Ndoko 2008; Pournajafian 2014; Sulser 2016; Suzuki 2008; Takenaka 2011; Tempe 2016; Thion 2018; Tsan 2020; Wasinwong 2017; Yao 2015; Yeatts 2013; Yumul 2016; Zhao 2014). Other studies did not report on this.

Excluded studies

We excluded 69 studies at the full-text review stage. Studies excluded in the previous version of the review, that have not been included in this update because of a change to criteria, are in Lewis 2016.

We report in the review details of 11 key excluded studies (Characteristics of excluded studies). Of these:

- three studies used a Miller blade as a comparison (Cirilla 2015; Stoll 2019; Valencia 2016);
- in one study it was unclear what comparison was used (Benhocine 2020);

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- one study only compared various types of VL without a DL comparison (Dorges 2016);
- two studies were manikin studies (Aleksandrowicz 2016; Gawlowski 2017);
- one study reported no outcome data for the DL group (Thomas 2019);
- one study used a non-randomized study design (Pieters 2018);
- one study included a mix of adult and paediatric participants with data not reported separately for each group (Scholtis 2017);
- one study had intubators perform only laryngoscopy without intubation (Raimann 2019).

Studies awaiting classification

We identified 27 studies that required further assessment for inclusion (see Characteristics of studies awaiting classification).

All studies were potentially eligible and were listed as complete in clinical trials registers. Study results were not published on the clinical trials registers, and we were unable to establish whether these studies had been published.

Ongoing studies

We identified 46 ongoing studies through a clinical trials register search conducted on 10 June 2021 (see Characteristics of ongoing studies).

For this review, we found:

- 15 studies with an estimated 2494 participants assessing Macintosh-style VLs (CTRI/2015/02/005589; CTRI/2017/09/009810; CTRI/2018/02/012236; CTRI/2018/05/013771; CTRI/2019/06/019526; CTRI/2019/12/022303; CTRI/2020/02/023154; CTRI/2020/04/024885; CTRI/2020/05/024960; CTRI/2020/08/027190; NCT03516539; NCT03710096; NCT04433884; NCT04794764; PACTR202010891239155);
- eight studies with an estimated 16,299 participants assessing hyperangulated VLs (ChiCTR1900025718; ChiCTR2000030232; ChiCTR-IOR-15007535; CTRI/2017/09/009656; CTRI/2018/04/012941; CTRI/2020/11/029369; NCT03613103; NCT04701762);
- 11 studies with an estimated 2408 participants assessing channelled VLs (CTRI/2017/02/007809; CTRI/2017/03/008092; CTRI/2018/01/011446; CTRI/2018/04/013212; CTRI/2019/11/021953; CTRI/2020/04/024897; CTRI/2020/06/025642; NCT03271008; NCT03887897; NCT04386356; PACTR201802003065126).

Five studies with an estimated 753 participants are using more than one type of VL as a comparison (Macintosh-style and channelled: CTRI/2018/10/015874; CTRI/2018/10/016006; Macintosh-style and hyperangulated: CTRI/2018/05/014150; CTRI/2020/09/028011; hyperangulated and channelled: CTRI/2019/05/019391).

Seven studies with an estimated 912 participants do not report the type of VL used in the registration document (ChiCTR1900025553; CTRI/2021/01/030476; IRCT2016062728668N1; IRCT2016102718063N4; IRCT20190614043888N1; NCT04185675; RBR-92PM68).

The estimated total number of participants in these ongoing studies is 22,875.

All studies were potentially eligible and were listed as at the stage of recruiting participants.

Risk of bias in included studies

We only completed assessments of the risk of bias if we included any outcome measures in the review. Twelve studies did not report any outcomes that we were able to extract (Buhari 2016; Cengiz 2019; Das 2016; Gavrilovska-Brzanov 2015; Hirabayashi 2008; Karaman 2016; Marsaban 2017; Misirlioglu 2016; Rewari 2017; Sbeghen 2021; Suzuki 2008; Wei 2016). We did not perform a risk of bias assessment for a further two studies where we did not extract any outcomes (Ducharme 2017; Kim 2016). Blank spaces in the risk of bias figure indicate that risk of bias assessment was not completed for the particular domain. See Figure 2 and Figure 3.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

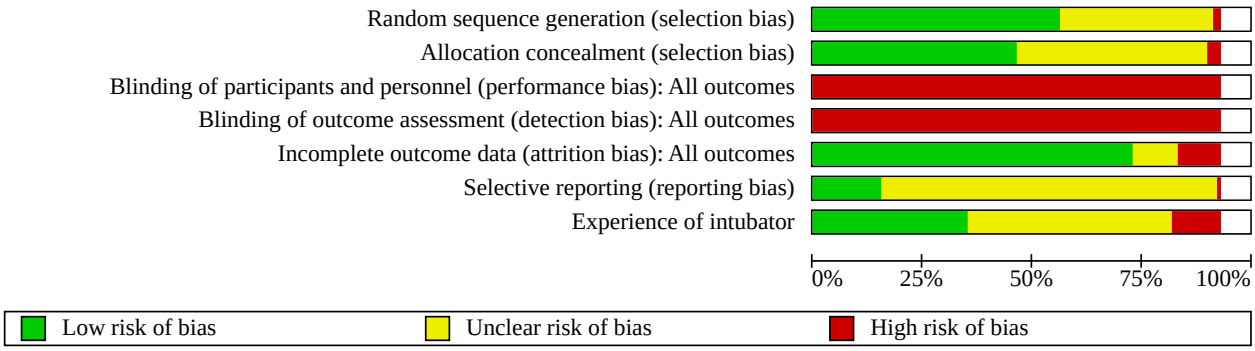

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Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study. Blank spaces indicate we did not complete a risk of bias assessment because we were not able to extract any relevant data for our chosen outcomes.

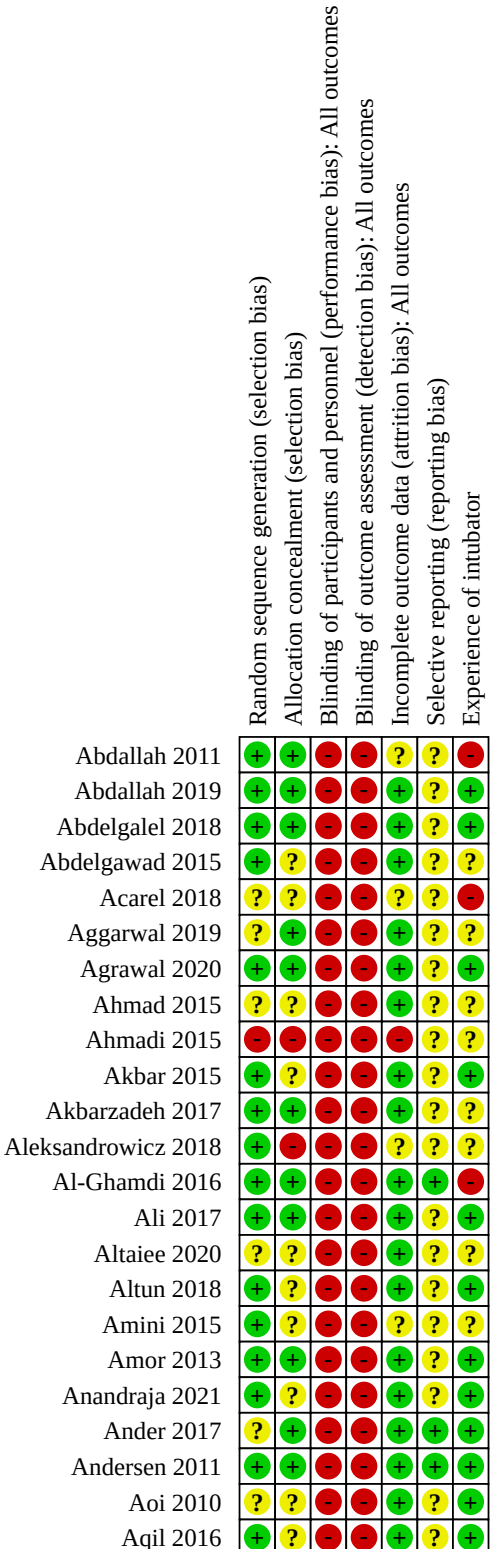

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Figure 3. (Continued)

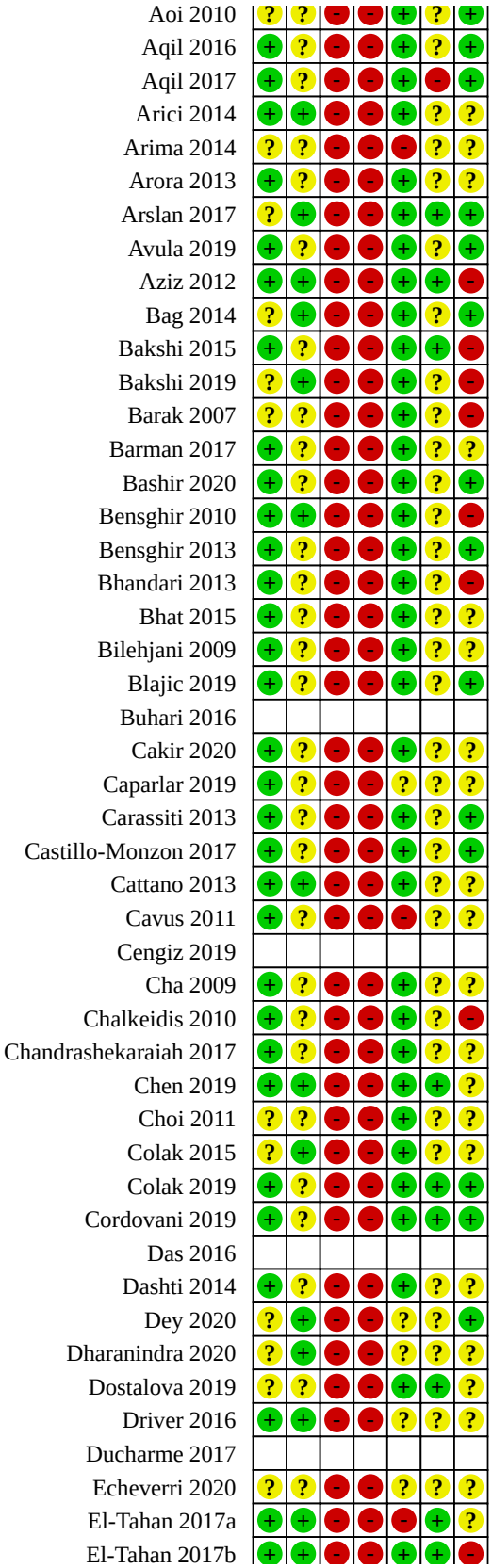

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Figure 3. (Continued)

El-Tahan 2017a	+	+	-	-	-	+	?
El-Tahan 2017b	+	+	-	-	+	+	-
Enomoto 2008	+	?	-	-	+	?	?
Erden 2010	+	-	-	-	+	?	?
Erdivanli 2018	+	?	-	-	+	?	?
Erturk 2015	?	+	-	-	+	?	?
Ferrando 2011	+	?	-	-	+	?	-
Foulds 2016a	?	?	-	-	?	?	?
Foulds 2016b	+	?	-	-	+	?	?
Frohlich 2011	?	?	-	-	+	?	?
Gandhi 2019	?	?	-	-	+	?	?
Gao 2018	?	?	-	-	+	?	?
Gavrilovska-Brzanov 2015							
Goksu 2016	?	+	-	-	+	?	-
Golboyu 2016	?	+	-	-	-	?	?
Griesdale 2012a	+	+	-	-	+	?	+
Gunes 2020	?	+	-	-	+	?	?
Gupta 2013	+	?	-	-	+	?	+
Gupta 2020	+	+	-	-	+	?	+
Hamp 2015	+	+	-	-	?	?	?
Hindman 2014	+	+	-	-	+	+	+
Hirabayashi 2008							
Hirabayashi 2009	?	?	-	-	+	?	-
Hosalli 2017	+	+	-	-	+	?	?
Hostic 2016	?	?	-	-	?	?	?
Hsu 2012	?	+	-	-	+	+	+
Hu 2017	+	+	-	-	-	+	+
Huang 2020	+	+	-	-	+	+	?
Ilyas 2014	+	+	-	-	+	?	?
Inal 2016	?	?	-	-	+	?	+
Inangil 2018	+	+	-	-	+	?	?
Ing 2017	+	+	-	-	?	+	?
Ithnin 2009	+	+	-	-	-	?	?
Jafra 2018	+	+	-	-	-	?	+
Janz 2016	+	+	-	-	+	+	-
Jungbauer 2009	+	?	-	-	+	?	?
Kanchi 2011	+	?	-	-	+	?	+
Kapadia 2021	+	+	-	-	+	?	?
Karaman 2016							
Kaur 2020	?	?	-	-	+	?	+
Kido 2015	?	+	-	-	+	+	?
Kill 2013	?	+	-	-	+	?	-
Kim 2013	?	+	-	-	+	+	+
Kim 2016							
Kim 2018	+	+	-	-	+	?	+
Kleine-Brueggeney 2017	+	+	-	-	+	?	?
Koennecke 2014	?	?	-	-	-	?	?

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Figure 3. (Continued)

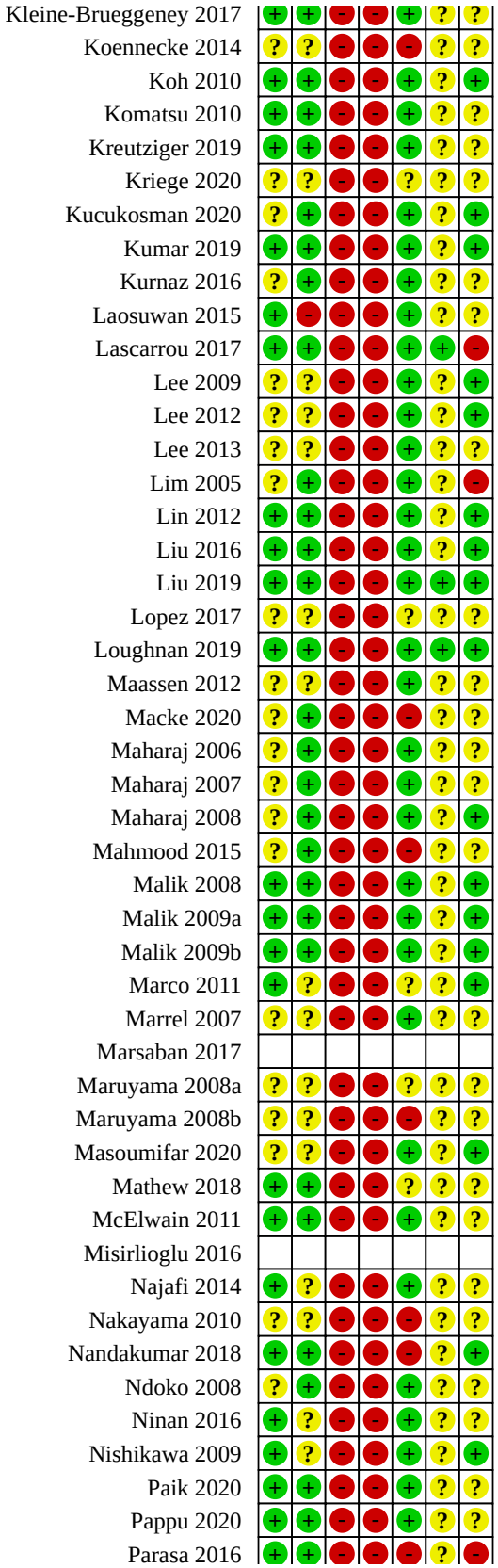

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Figure 3. (Continued)

Pappu 2020	+	+	-	-	+	?	?
Parasa 2016	+	+	-	-	-	?	-
Park 2010	+	-	-	-	+	?	+
Pazur 2016	?	?	-	-	+	?	?
Peck 2009	?	?	-	-	?	?	?
Postaci 2015	?	+	-	-	?	?	?
Pournajafian 2014	+	+	-	-	+	?	+
Rabbani 2020	?	?	-	-	-	?	?
Rajasekhar 2020	?	?	-	-	-	?	?
Ranieri 2012	?	+	-	-	+	?	+
Reena 2019	+	+	-	-	+	?	+
Rewari 2017							
Risse 2020	?	+	-	-	+	?	?
Robitaille 2008	+	?	-	-	+	?	+
Rovsing 2010	?	?	-	-	-	?	?
Ruetzler 2020	+	?	-	-	+	+	+
Russell 2012	+	?	-	-	+	?	+
Russell 2013	+	?	-	-	+	?	-
Sandhu 2014	?	?	-	-	?	?	?
Sanguanwit 2021	+	+	-	-	+	?	?
Sansone 2012	?	?	-	-	?	?	?
Saracoglu 2014	+	?	-	-	+	?	?
Sargin 2016	+	?	-	-	+	?	+
Sarkilar 2015	-	-	-	-	+	?	?
Sbeghen 2021							
Serocki 2010	?	+	-	-	+	?	+
Serocki 2013	?	+	-	-	+	?	+
Shah 2016	+	+	-	-	+	?	?
Shimazaki 2018	?	+	-	-	+	+	?
Shippey 2013	?	?	-	-	+	?	?
Shukla 2017	+	?	-	-	+	?	?
Siddiqui 2009	+	?	-	-	+	?	+
Silverberg 2015	-	-	-	-	+	+	?
Sulser 2016	+	+	-	-	+	+	?
Sun 2005	+	?	-	-	+	?	+
Suzuki 2008							
Takenaka 2011	?	+	-	-	+	?	+
Taylor 2013	?	+	-	-	+	?	-
Tempe 2016	+	+	-	-	+	+	+
Teoh 2010	+	+	-	-	+	?	+
Thion 2018	+	?	-	-	-	-	?
Toker 2019	?	+	-	-	+	+	+
Tolon 2012	?	?	-	-	+	?	?
Tosh 2018	+	?	-	-	+	?	?
Trimmel 2011	+	+	-	-	+	?	-
Trimmel 2016	+	+	-	-	+	?	-
Tsan 2020	+	+	-	-	+	+	+

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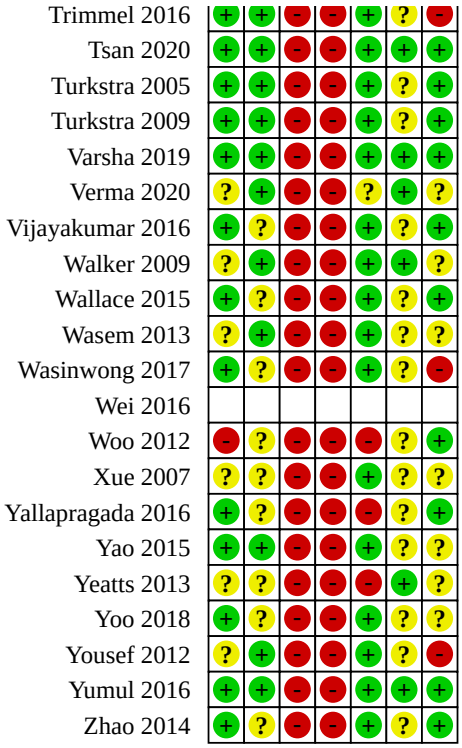
Figure 3. (Continued)



Allocation

All studies were described as RCTs. Approximately half (57%) of the included studies described adequate methods to randomize participants to treatment groups and we judged these studies to be at low risk of selection bias for sequence generation. We judged three quasi-randomized studies to be at high risk of bias for selection bias (sequence generation and allocation concealment) owing to the methods used to allocate participants to treatment groups (Ahmadi 2015; Sarkilar 2015; Silverberg 2015). We judged a further study as being at high risk of selection bias regarding methods of randomization (Woo 2012). The remaining studies did not provide sufficient information on methods used for randomization. We therefore judged the risk of bias as unclear for these.

Sufficient detail about methods used to conceal allocation was provided in 40% of the studies, and we judged those studies to be at low risk of bias in this domain. We judged seven studies as being at high risk of bias with regard to allocation concealment (Ahmadi 2015; Aleksandrowicz 2018; Erden 2010; Laosuwan 2015; Park 2010; Sarkilar 2015; Silverberg 2015). The remaining studies did not report sufficient detail, and we judged the risk of bias as unclear for these.

Blinding

It is not possible to blind intubators and outcome assessors to the intervention in these types of studies. We therefore judged all studies to be at high risk of performance bias.

Seven studies reported that researchers had made attempts to blind assessors to particular outcomes such as assessment of patient-reported sore throat (Abdallah 2011; Kill 2013; Lee 2013; Lin 2012; Najafi 2014; Nishikawa 2009; Siddiqui 2009). Additionally, a proportion of studies described outcome assessors as 'independent' for some outcomes such as IDS scores and haemodynamic outcomes; however, this does not equate to being blinded to group allocation.

Incomplete outcome data

For attrition bias, we considered whether study authors clearly reported participant losses, whether losses were balanced between study groups, and whether the reasons for losses seemed acceptable. Most studies reported no participant losses during the study or only a small number of losses that were unlikely to affect results. We obtained insufficient data to make an assessment in 23 studies (Abdallah 2011; Acarel 2018; Aleksandrowicz 2018; Amini 2015; Caparlar 2019; Dey 2020; Dharanindra 2020; Driver 2016; Echeverri 2020; Foulds 2016a; Hamp 2015; Hostic 2016; Ing 2017; Kriege 2020; Lopez 2017; Marco 2011; Maruyama 2008a; Mathew 2018; Peck 2009; Postaci 2015; Sandhu 2014; Sansone 2012; Verma 2020) so we judged them to be at unclear risk of bias. We judged 22 studies to be at high risk of bias because they reported large numbers of losses, used exclusion criteria that introduced bias to the results, terminated early, or made changes to the protocol during the study (Ahmadi 2015; Arima 2014; Cavus 2011; El-Tahan 2017a; Golboyu 2016; Hu 2017; Ithnin 2009; Jafra 2018; Koennecke 2014; Macke 2020; Mahmood 2015; Maruyama 2008b; Nakayama 2010; Nandakumar 2018; Parasa 2016; Rabbani 2020; Rajasekhar

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2020; Rovsing 2010; Thion 2018; Woo 2012; Yallapragada 2016; Yeatts 2013).

Selective reporting

We were able to source the protocol for 35 studies and judged them to be at low risk of reporting bias (Al-Ghamdi 2016; Ander 2017; Andersen 2011; Arslan 2017; Aziz 2012; Bakshi 2015; Chen 2019; Colak 2019; Cordovani 2019; Dostalova 2019; El-Tahan 2017a; El-Tahan 2017b; Hindman 2014; Hsu 2012; Hu 2017; Huang 2020; Ing 2017; Janz 2016; Kido 2015; Kim 2013; Lascarrou 2017; Liu 2019; Loughnan 2019; Ruetzler 2020; Shimazaki 2018; Silverberg 2015; Sulser 2016; Tempe 2016; Toker 2019; Tsan 2020; Varsha 2019; Verma 2020; Walker 2009; Yeatts 2013; Yumul 2016). We judged two studies to be at high risk of reporting bias. In Aqil 2017 there was a large mismatch between the number of participants enrolled as reported on the study registration data compared to the final participants included in the published manuscript. Thion 2018 did not report multiple prespecified outcomes.

Because the remaining studies did not report clinical trials registration or a prepublished protocol, it was not feasible to effectively assess risk of selective reporting bias, and we therefore judged risk of selective reporting bias in remaining studies to be unclear.

Other potential sources of bias

We considered the experience of the intubator to be a potential source of bias in this review, in particular whether there was a mismatch between the intubator's VL and DL experience. We were often not able to judge from the information presented by study authors whether bias had been introduced by intubators' experience.

We judged studies to be at low risk of bias in this domain if intubators had carried out more than 20 intubations with the VL device in the clinical setting, or had spent a considerable length of time clinically using the device, matched by the time of experience using a Macintosh DL. We identified 45% of included studies as being at low risk of bias. In the 25 studies in which intubators had carried out fewer than 20 intubations with VL prior to the start of the study period, we assumed, unless otherwise stated, that the balance of experience would favour the DL group and therefore judged these studies to be at high risk of bias (Abdallah 2011; Acarel 2018; Al-Ghamdi 2016; Aziz 2012; Bakshi 2015; Bakshi 2019; Barak 2007; Bensghir 2010; Bhandari 2013; Chalkeidis 2010; El-Tahan 2017b; Ferrando 2011; Goksu 2016; Hirabayashi 2009; Janz 2016; Kill 2013; Lascarrou 2017; Lim 2005; Parasa 2016; Russell 2013; Taylor 2013; Trimmel 2011; Trimmel 2016; Wasinwong 2017; Yousef 2012). The remaining studies did not specify the experience of intubators at all, or provided an otherwise insufficient level of detail for us to judge the risk of bias as either high or low, and we judged those studies to be at unclear risk of bias.

Eight studies included both novice and experienced intubators; where the balance of experience was not described as equivalent between groups, we judged these studies to be at high risk of bias (Aziz 2012; Bakshi 2015; Bensghir 2010; El-Tahan 2017b; Goksu 2016; Kill 2013; Lascarrou 2017; Lim 2005).

Twelve studies included only novice intubators (Ferrando 2011; Griesdale 2012a; Hirabayashi 2009; Janz 2016; Kapadia 2021; Kim 2018; Liu 2016; Marco 2011; Park 2010; Silverberg 2015; Walker 2009; Zhao 2014). Only Griesdale 2012a reported the level of experience between all intubators to be equivalent, and we judged it as being at low risk of bias.

In three studies intubators had equivalent experience with the devices but not with use of a double-lumen tube; therefore, we determined that a higher level of bias had been introduced (Bakshi 2019; Bensghir 2010; Russell 2013).

Effects of interventions

See: **Summary of findings 1** Macintosh-style videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation; **Summary of findings 2** Hyperangulated videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation; **Summary of findings 3** Channelled videolaryngoscopy compared to direct laryngoscopy for adults undergoing tracheal intubation

See Summary of findings 1; Summary of findings 2; Summary of findings 3.

1. Macintosh-stlye videolaryngoscopy versus direct laryngoscopy

This comparison includes data from 61 studies with 9883 participants. Here we report the effects for primary and secondary outcomes for Macintosh-style VL compared to DL.

We used GRADE to assess the certainty of the evidence for all critical and a subset of important outcomes. See Summary of findings 1.

Critical outcomes

Failed intubation

Forty-one studies reported the number of failed intubations (Aggarwal 2019; Akbar 2015; Altaiee 2020; Anandraja 2021; Ander 2017; Aziz 2012; Bakshi 2019; Bensghir 2010; Bensghir 2013; Bhat 2015; Blajic 2019; Cakir 2020; Cavus 2011; Dey 2020; Driver 2016; Frohlich 2011; Gupta 2013; Hostic 2016; Jungbauer 2009; Kaur 2020; Kido 2015; Kleine-Brueggeney 2017; Kucukosman 2020; Lascarrou 2017; Lee 2009; Lee 2012; Lin 2012; Maassen 2012; Macke 2020; McElwain 2011; Ninan 2016; Peck 2009; Ruetzler 2020; Sarkilar 2015; Serocki 2010; Shimazaki 2018; Shippey 2013; Teoh 2010; Wallace 2015; Yoo 2018; Yumul 2016). Of these, 13 were multi-arm studies that presented data for more than one comparison arm (Bensghir 2013; Blajic 2019; Cavus 2011; Gupta 2013; Hostic 2016; Kaur 2020; Kleine-Brueggeney 2017; Lee 2012; McElwain 2011; Serocki 2010; Teoh 2010; Wallace 2015; Yumul 2016). We extracted data for the Macintosh-style VLs separately. Where different types of Macintosh-style VLs were compared, we combined the data from those studies (Cavus 2011; Gupta 2013). We did not extract data for one arm in Wallace 2015 where the VL was used for direct laryngoscopy.

Analysis demonstrated fewer failed intubations when a Macintosh-style VL was used (risk ratio (RR) 0.41, 95% confidence interval (CI) 0.26 to 0.65; I^2 = 28%; favours videolaryngoscopy; 41 studies, 4615 participants; moderate-certainty evidence; Analysis 1.1). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot (see Figure 4), which demonstrated possible asymmetry on visual assessment, but we found no statistical evidence of small-study effects (Harbord modified test,

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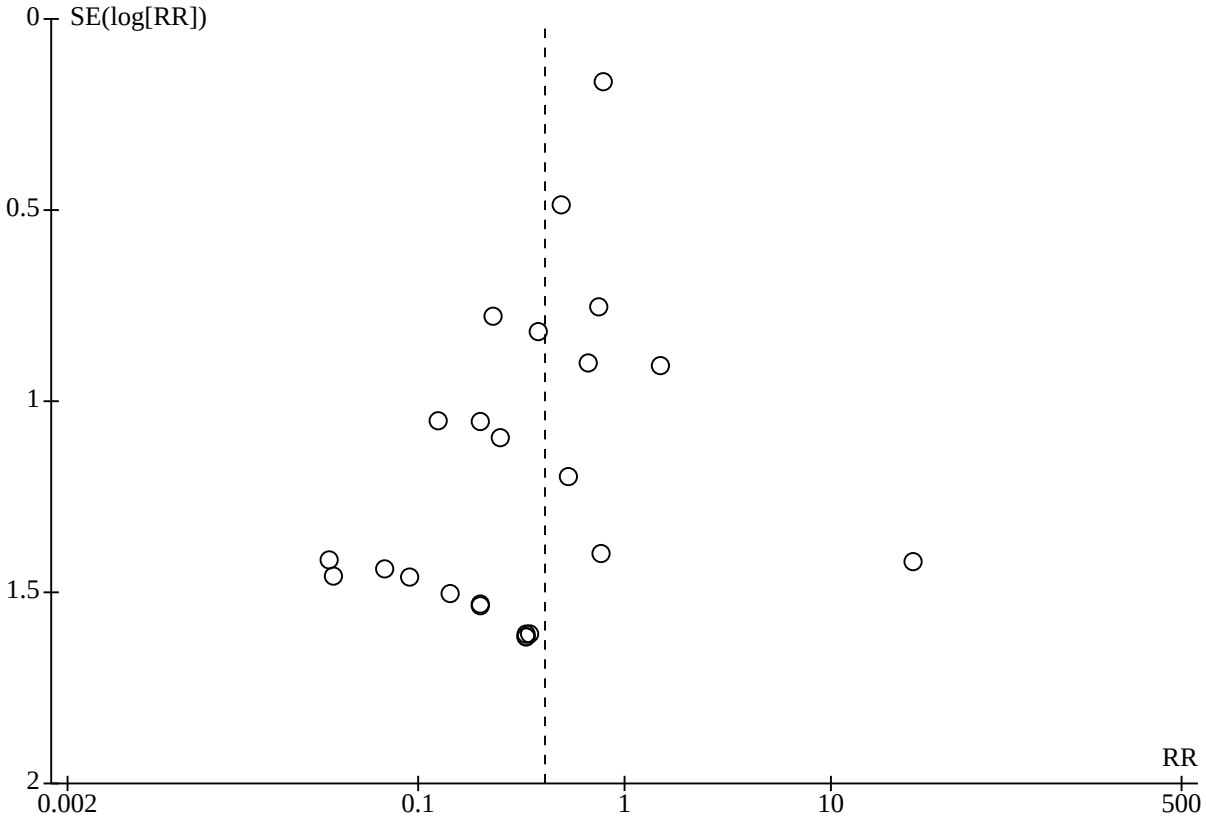
P = 0.202). A further analysis using weighted regression with multiplicative dispersion was done due to visual suggestion of asymmetry, which did not demonstrate statistical significance (P = 0.076).

Figure 4. Funnel plot of comparison: Macintosh-style videolaryngoscopy versus direct laryngoscopy, outcome 1.1, failed intubation



Hypoxaemia

Sixteen studies reported the number of hypoxaemic events (Akbar 2015; Aziz 2012; Bensghir 2010; Bensghir 2013; Bhat 2015; Driver 2016; Goksu 2016; Gupta 2013; Ing 2017; Kido 2015; Lascarrou 2017; Lin 2012; Serocki 2010; Teoh 2010; Thion 2018; Yoo 2018). Nine studies reported no events (Akbar 2015; Bhat 2015; Gupta 2013; Ing 2017; Kido 2015; Lin 2012; Serocki 2010; Teoh 2010; Yoo 2018). Of the remaining seven studies that reported events, three were conducted outside of the theatre setting (Driver 2016; Goksu 2016; Lascarrou 2017), and one included only participants with features of airway difficulty (Aziz 2012).

Analysis demonstrated fewer hypoxaemic events when a Macintosh-style VL was used (RR 0.72, 95% CI 0.52 to 0.99; I^2 = 26%; favours videolaryngoscopy; 16 studies, 2127 participants; moderate-certainty evidence; Analysis 1.2). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.8514).

Successful first attempt

Forty-two studies reported rates of successful intubation on the first attempt (Akbar 2015; Altaiee 2020; Altun 2018; Ander 2017; Aziz 2012; Bakshi 2019; Bensghir 2010; Bensghir 2013; Bhat 2015; Blajic 2019; Cakir 2020; Cattano 2013; Cavus 2011; Colak 2019; Dey 2020; Driver 2016; Frohlich 2011; Goksu 2016; Gupta 2013; Ing 2017; Janz 2016; Kapadia 2021; Kaur 2020; Kido 2015; Kleine-Brueggeney 2017; Kreutziger 2019; Kriege 2020; Kucukosman 2020; Lascarrou 2017; Lee 2012; Lin 2012; Loughnan 2019; Macke 2020; McElwain 2011; Ruetzler 2020; Sarkilar 2015; Serocki 2010; Shimazaki 2018; Shippey 2013; Sulser 2016; Teoh 2010; Yumul 2016). Of these, 12 were multi-arm studies that presented data for more than one comparison arm (Altun 2018; Bensghir 2013; Blajic 2019; Cavus 2011; Gupta 2013; Kaur 2020; Kleine-Brueggeney 2017; Lee 2012; McElwain 2011; Serocki 2010; Teoh 2010; Yumul 2016). We extracted data for the Macintosh-style VLs separately. Where different types of Macintosh-style VLs were compared, we combined the data from those studies (Cavus 2011; Gupta 2013).

Analysis demonstrated higher rates of success on the first attempt at intubation when a Macintosh-style VL was used (RR 1.05, 95% CI 1.02 to 1.09; I^2 = 77%; favours videolaryngoscopy; 42 studies, 7311 participants; low-certainty evidence; Analysis 1.3). We downgraded the evidence by one level for the risk of performance

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bias introduced by lack of blinding, and by one level because we noted considerable statistical heterogeneity.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.4639).

Oesophageal intubation

Fourteen studies reported rates of oesophageal intubation (Akbar 2015; Bhat 2015; Colak 2019; Goksu 2016; Ing 2017; Janz 2016; Kleine-Brueggeney 2017; Kreutziger 2019; Lascarrou 2017; Lin 2012; Sulser 2016; Teoh 2010; Thion 2018; Yoo 2018). Of these, two were multi-arm studies that presented data for more than one comparison arm (Kleine-Brueggeney 2017; Teoh 2010). We extracted data for the Macintosh-style VLs separately. Five studies were conducted outside the theatre setting (Goksu 2016; Janz 2016; Kreutziger 2019; Lascarrou 2017; Sulser 2016).

We found little or no difference in the rate of oesophageal intubation when a Macintosh-style VL was used (RR 0.51, 95% CI 0.22 to 1.21; I^2 = 39%; favours videolaryngoscopy; 14 studies, 2404 participants; low-certainty evidence; Analysis 1.4). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for imprecision because the confidence interval includes the possibility of benefit as well as harms for both devices.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.2123).

Important outcomes

Dental trauma

Eighteen studies reported data for dental trauma (Akbar 2015; Aziz 2012; Bensghir 2010; Bensghir 2013; Bhat 2015; Cakir 2020; Cavus 2011; Frohlich 2011; Gupta 2013; Ing 2017; Kleine-Brueggeney 2017; Lascarrou 2017; Lee 2009; Loughnan 2019; Maassen 2012; McElwain 2011; Sulser 2016; Teoh 2010). Of these, only four studies reported events (Aziz 2012; Frohlich 2011; Lascarrou 2017; Loughnan 2019). The remaining studies reported no events in either comparison group.

We found little or no difference in the rate of dental trauma when a Macintosh-style VL was used (RR 0.68, 95% CI 0.16 to 2.89; I^2 = 0%; favours videolaryngoscopy; 18 studies, 2297 participants; very low-certainty evidence; Analysis 1.5). We downgraded the evidence by two levels for imprecision due to few reported events from a small number of studies and the confidence intervals indicating possible benefits as well as harms, and by one level for the risk of performance bias introduced by lack of blinding.

Cormack-Lehane grade

Thirty-eight studies reported data for Cormack-Lehane grades in a format that we were able to extract (Aggarwal 2019; Akbar 2015; Altun 2018; Aziz 2012; Bakshi 2019; Bensghir 2010; Bensghir 2013; Bhat 2015; Blajic 2019; Caparlar 2019; Cattano 2013; Chandrashekaraiah 2017; Colak 2019; Dey 2020; Frohlich 2011; Gupta 2013; Janz 2016; Jungbauer 2009; Kapadia 2021; Kaur 2020; Kido 2015; Kleine-Brueggeney 2017; Lascarrou 2017; Lee 2012; Lin 2012; McElwain 2011; Ninan 2016; Rajasekhar 2020; Ruetzler 2020; Sarkilar 2015; Sulser 2016; Teoh 2010; Thion 2018; Toker 2019; Verma 2020; Wallace 2015; Yoo 2018; Yumul 2016). Five studies used a cross-over design and recorded the Cormack-Lehane grade for all participants for each laryngoscope (Cattano 2013; Lee 2012; Marrel 2007; Peck 2009; Serocki 2010). Of these, we were unable to extract data from Marrel 2007, Peck 2009 and Serocki 2010 as it was not clear which laryngoscopy was performed in which order. The remaining studies reported data for Cormack-Lehane grade individually for each device. We extracted data for Cormack-Lehane grades 1 and 2 separately, and combined data for Cormack-Lehane grades 3 and 4.

Analysis showed a higher proportion of grade 1 Cormack-Lehane views when a Macintosh-style VL was used (RR 1.50, 95% CI 1.39 to 1.63; I^2 = 57%; favours videolaryngoscopy; 38 studies, 4368 participants; moderate-certainty evidence; Analysis 1.6). Grade 2 Cormack-Lehane views were more common when a DL was used (RR 0.62, 95% CI 0.51 to 0.76; I^2 = 82%; favours videolaryngoscopy; 38 studies, 4368 participants; moderate-certainty evidence; Analysis 1.6). The effect estimate increased further for grade 3 and 4 Cormack-Lehane views combined (RR 0.38, 95% CI 0.29 to 0.48; I^2 = 37%; favours videolaryngoscopy; 38 studies, 4368 participants; moderate-certainty evidence; Analysis 1.6). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for inconsistency because we noted considerable heterogeneity, and upgraded by one level for large effect size.

Time for tracheal intubation

Thirty five studies with 4061 participants reported data on time required for tracheal intubation for Macintosh-style VL (Aggarwal 2019; Akbar 2015; Altaiee 2020; Altun 2018; Ander 2017; Aziz 2012; Bakshi 2019; Bensghir 2010; Bensghir 2013; Bhat 2015; Blajic 2019; Cakir 2020; Caparlar 2019; Cavus 2011; Colak 2019; Driver 2016; Foulds 2016a; Goksu 2016; Hostic 2016; Jungbauer 2009; Kido 2015; Kreutziger 2019; Kucukosman 2020; Loughnan 2019; Maassen 2012; Marrel 2007; Peck 2009; Rabbani 2020; Sarkilar 2015; Shippey 2013; Sulser 2016; Teoh 2010; Toker 2019; Verma 2020; Yumul 2016). Nine of these were multi-arm studies that reported data for each device type separately (Altun 2018; Bensghir 2013; Blajic 2019; Cavus 2011; Foulds 2016a; Hostic 2016; Rabbani 2020; Teoh 2010; Yumul 2016). We did not include studies that reported time for tracheal intubation as median (IQR).

When we combined these studies, we noted considerable statistical heterogeneity (I^2 = 96%), which could likely be explained by the variation in the definitions of time for intubation used in the included studies. We did not report a pooled effect estimate (Analysis 1.7). We assessed this outcome to be of very low certainty. We downgraded by one level for risk of performance bias due to lack of blinding, and by two levels for inconsistency because we noted considerable heterogeneity.

Patient-reported sore throat

Seventeen studies reported data for patient-reported sore throat (Altun 2018; Ander 2017; Aziz 2012; Bakshi 2019; Blajic 2019; Caparlar 2019; Ing 2017; Kapadia 2021; Kido 2015; Kleine-Brueggeney 2017; Lin 2012; Peck 2009; Ruetzler 2020; Shimazaki 2018; Teoh 2010; Thion 2018; Yumul 2016). Of these, five were multi-arm studies that presented data for more than one comparison arm (Altun 2018; Blajic 2019; Kleine-Brueggeney 2017; Teoh 2010; Yumul 2016). We extracted data for the Macintosh-style VLs separately.

We found little or no difference in the rate of patient-reported sore throat when a Macintosh-style VL was used (RR 0.85, 95%

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CI 0.68 to 1.07; I^2 = 65%; favours videolaryngoscopy; 1960 participants; Analysis 1.8).

Number of attempts at tracheal intubation

Thirty-one studies reported the number of attempts required for successful intubation for Macintosh-style VLs (Akbar 2015; Altaiee 2020; Altun 2018; Bakshi 2019; Bensghir 2010; Bensghir 2013; Bhat 2015; Blajic 2019; Cakir 2020; Cavus 2011; Colak 2019; Dey 2020; Frohlich 2011; Gupta 2013; Ing 2017; Kapadia 2021; Kaur 2020; Kido 2015; Kucukosman 2020; Lascarrou 2017; Lee 2012; Lin 2012; Macke 2020; McElwain 2011; Ruetzler 2020; Sarkilar 2015; Serocki 2010; Shimazaki 2018; Shippey 2013; Teoh 2010; Yumul 2016). Eleven of these were multi-arm studies that reported data for each device separately (Altun 2018; Bensghir 2013; Blajic 2019; Cavus 2011; Gupta 2013; Kaur 2020; Lee 2012; McElwain 2011; Serocki 2010; Teoh 2010; Yumul 2016). Where multiple types of Macintosh-style designs were used we combined the outcome data (Altun 2018; Cavus 2011).

Analysis demonstrated a higher proportion of successful single attempts at intubation when a Macintosh-style VL was used (RR 1.05, 95% CI 1.01 to 1.10; I^2 = 74%; favours videolaryngoscopy; 31 studies, 3240 participants). We found no difference between Macintosh-style VL and DL when more than one attempt was required (RR 0.68, 95% CI 0.46 to 1.01; I^2 = 63%; favours videolaryngoscopy; 31 studies, 3240 participants; Analysis 1.9).

Intubation Difficulty Scale (IDS)

Four studies reported IDS scores in a way to allow data extraction for Macintosh-style VLs (Bensghir 2013; Chandrashekaraiah 2017; Loughnan 2019; McElwain 2011). We did not extract data for studies that reported IDS scores as median and IQR or mean and SD or used non-standard difficulty scales.

We found little or no difference between Macintosh-style VL and DL for easy intubations, where IDS = 0 (RR 1.22, 95% CI 0.87 to 1.72; I^2 = 0%; favours videolaryngoscopy; 4 studies, 267 participants), IDS 1 to 5 (RR 1.04, 95% CI 0.84 to 1.28; I^2 = 0%; favours videolaryngoscopy; 4 studies, 267 participants), or for difficult intubations, with IDS above 5 (RR 0.60, 95% CI 0.25 to 1.45; I^2 = 21%; favours videolaryngoscopy; 4 studies, 267 participants). See Analysis 1.10.

Percentage of glottic opening (POGO) score

Five studies reported POGO scores for this comparison (Dey 2020; Hostic 2016; Kido 2015; Peck 2009; Yumul 2016). We noted considerable statistical heterogeneity (I^2 = 94%) and did therefore not report a pooled effect estimate (see Analysis 1.11).

Mortality

Three studies with 719 participants reported mortality rates when a Macintosh-style VL was used (Driver 2016; Janz 2016; Lascarrou 2017). All three were conducted outside the operating theatre environment, either in the ICU or emergency department. Driver 2016 and Janz 2016 reported mortality as survival to hospital discharge, whereas Lascarrou 2017 reported mortality at 28 days.

We found little or no difference in mortality rates when a Macintosh-style VL was used (RR 1.01, 95% CI 0.82 to 1.24; I^2 = 0%; favours direct laryngoscopy; 3 studies, 719 participants; Analysis 1.12).

Subgroup analyses

We performed subgroup analyses for the critical outcome of failed intubation.

Setting

Four studies with 969 participants reported data for intubations occurring outside the theatre setting (ICU: Dey 2020; Lascarrou 2017; emergency department: Driver 2016; prehospital: Macke 2020). We could therefore not conduct a meaningful subgroup analysis for this comparison.

Obesity

Four studies reported data for failed intubation for obese participants exclusively (Ander 2017; Cakir 2020; Ruetzler 2020; Yumul 2016). Lascarrou 2017 reported data for a mixed cohort. Two studies (Anandraja 2021; Macke 2020) did not report sufficiently detailed participant data to allow assessment. We could therefore not conduct a meaningful subgroup analysis for this comparison.

Difficult airway

Six studies reported data for failed intubation in participants with either a known or predicted difficult airway (Aziz 2012; Gupta 2013; Jungbauer 2009; Ninan 2016; Serocki 2010; Yoo 2018). A further six studies reported data for participants with a simulated difficult airway (Akbar 2015; Bhat 2015; Kleine-Brueggeney 2017; McElwain 2011; Peck 2009; Shippey 2013). We considered the above two groups as possessing features of a difficult airway for the purposes of this subgroup analysis. Twenty-three studies excluded participants with features of airway difficulty or reported the absence of said features. Five studies provided insufficient detail to assess whether participants had features of airway difficulty (Dey 2020; Frohlich 2011; Hostic 2016; Lee 2009; Macke 2020). Driver 2016 reported a mixed cohort of participants. We excluded the latter two groups from our analysis.

Analysis demonstrated fewer failed intubations when a Macintosh-style VL was used for participants with predicted, known or simulated difficult airway (RR 0.37, 95% CI 0.19 to 0.74, I^2 = 40%; favours videolaryngoscopy; 12 studies, 1393 participants; Analysis 1.13). We found no difference on subgroup analysis of between group differences (P = 0.85, I^2 = 0%).

Intubator experience

Seventeen studies reported intubators as being experienced in the use of both devices with quantification of experience (Akbar 2015; Ander 2017; Bensghir 2013; Blajic 2019; Driver 2016; Gupta 2013; Kaur 2020; Kleine-Brueggeney 2017; Kucukosman 2020; Lee 2009; Lee 2012; Lin 2012; Ruetzler 2020; Serocki 2010; Teoh 2010; Wallace 2015; Yumul 2016). Ten studies reported intubators as being experienced, but this was not quantified further (Aggarwal 2019; Anandraja 2021; Bakshi 2019; Bhat 2015; Cakir 2020; Jungbauer 2009; McElwain 2011; Sarkilar 2015; Shimazaki 2018; Yoo 2018). We considered these two groups as expert for the purposes of this analysis. No studies reported using completely novice intubators, and only one study reported using intubators experienced with DL, but not with channelled VLs (Frohlich 2011). Five studies used intubators with a mixed level of experience, not reporting data in a way to allow separate extraction (Aziz 2012; Bensghir 2010; Dey 2020; Lascarrou 2017; Macke 2020). Eight studies did not report sufficient detail to allow assessment of experience (Altaiee 2020;

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Cavus 2011; Hostic 2016; Kido 2015; Maassen 2012; Ninan 2016; Peck 2009; Shippey 2013).

As only one study with 60 participants reported rates of failed intubation for non-expert intubators using Macintosh-style VLs, we could not conduct a meaningful subgroup analysis.

Sensitivity analyses

Given the high number of studies with zero events in both arms for certain outcomes, we conducted a post hoc sensitivity analysis for the critical outcomes of failed intubation, hypoxaemia, and oesophageal intubation where we included studies with no events. For the Macintosh-style VL versus DL comparison we found the following estimates: failed intubation (RR 0.63, 95% CI 0.48 to 0.81; P = 0.0004), hypoxaemia (RR 0.74, 95% CI 0.57 to 0.94; P = 0.0152), and oesophageal intubation (RR 0.79, 05% CI 0.44 to 1.43; P = 0.4348). This did not alter our interpretation of the primary findings.

Risk of bias

For sensitivity analysis of our risk of bias assessments, we considered only our primary outcome of failed intubation.

We removed studies with unclear or high risk of selection bias for sequence generation (Aggarwal 2019; Altaiee 2020; Ander 2017; Bakshi 2019; Dey 2020; Frohlich 2011; Hostic 2016; Kaur 2020; Kido 2015; Kucukosman 2020; Lee 2009; Lee 2012; Maassen 2012; Macke 2020; Peck 2009; Sarkilar 2015; Serocki 2010; Shimazaki 2018; Shippey 2013). This resulted in no change to our interpretation of the effect, with fewer failed intubations when a Macintosh-style VL was used (RR 0.42, 95% CI 0.25 to 0.70; I^2 = 28%; 22 studies, 2973 participants). Similarly, we noted no differences in results when we removed studies with an unclear or high level of attrition bias (RR 0.51, 95% CI 0.33 to 0.80; I^2 = 16%; 35 studies, 3721 participants; excluded studies: Cavus 2011; Dey 2020; Driver 2016; Hostic 2016; Macke 2020; Peck 2009).

2. Hyperangulated videolaryngoscopy versus direct laryngoscopy

This comparison includes data from 96 studies with 11,438 participants. Here we report the effects for primary and secondary outcomes for hyperangulated VL compared to DL.

We used GRADE to assess the certainty of the evidence for all critical and a subset of important outcomes. See Summary of findings 2.

Critical outcomes

Failed intubation

Sixty-five studies reported the number of failed intubations (Abdelgalel 2018; Abdelgawad 2015; Agrawal 2020; Ahmadi 2015; Al-Ghamdi 2016; Andersen 2011; Aqil 2016; Aqil 2017; Arici 2014; Arora 2013; Arslan 2017; Bakshi 2015; Barak 2007; Bashir 2020; Bilehjani 2009; Carassiti 2013; Chen 2019; Colak 2015; Cordovani 2019; Ducharme 2017; El-Tahan 2017b; Foulds 2016b; Gao 2018; Gunes 2020; Hostic 2016; Hu 2017; Ilyas 2014; Inal 2016; Jafra 2018; Kaur 2020; Kill 2013; Kim 2016; Kleine-Brueggeney 2017; Koennecke 2014; Lee 2012; Lim 2005; Liu 2016; Liu 2019; Malik 2008; Malik 2009b; Nakayama 2010; Nandakumar 2018; Paik 2020; Pournajafian 2014; Rovsing 2010; Russell 2013; Sanguanwit 2021; Sargin 2016; Serocki 2010; Serocki 2013; Shah 2016; Siddiqui 2009; Silverberg 2015; Sun 2005; Taylor 2013; Tempe 2016; Teoh 2010; Tosh 2018; Tsan 2020; Walker 2009; Wasinwong 2017; Xue 2007; Yao 2015; Yousef 2012; Yumul 2016). Of these, 19 were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Al-Ghamdi 2016; Arslan 2017; Bakshi 2015; Colak 2015; El-Tahan 2017b; Hostic 2016; Kaur 2020; Kleine-Brueggeney 2017; Koennecke 2014; Lee 2012; Malik 2008; Malik 2009b; Nakayama 2010; Serocki 2010; Serocki 2013; Tempe 2016; Teoh 2010; Yumul 2016). We extracted data for hyperangulated VLs separately. Where different types of hyperangulated VLs were compared, we combined data from those studies (Arslan 2017; Bakshi 2015; Koennecke 2014; Lee 2012; Malik 2008; Serocki 2013; Tempe 2016; Yumul 2016). We did not include Trimmel 2016 in the meta-analysis as the number of failed intubations in the VL group was disproportionately large, rendering the study an outlier (see sensitivity analysis below). We did not extract data for Ducharme 2017 and Kim 2016 due to a lack of accounting for clustering.

Analysis demonstrated fewer failed intubations when a hyperangulated VL was used (RR 0.51, 95% CI 0.34 to 0.76; I^2 = 41%; favours videolaryngoscopy; 63 studies, 7146 participants; moderate-certainty evidence; Analysis 2.1). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P value = 0.7249).

Hypoxaemia

Fifteen studies reported the number of hypoxaemic events (Abdelgalel 2018; Andersen 2011; Barak 2007; Gao 2018; Gunes 2020; Inal 2016; Risse 2020; Serocki 2010; Shah 2016; Silverberg 2015; Tempe 2016; Teoh 2010; Tsan 2020; Walker 2009; Yousef 2012). Nine studies reported no events (Andersen 2011; Barak 2007; Gunes 2020; Inal 2016; Serocki 2010; Tempe 2016; Teoh 2010; Tsan 2020; Walker 2009). Of the remaining six studies that reported events, three were conducted outside of the theatre setting (Abdelgalel 2018; Gao 2018; Silverberg 2015).

We found little or no difference in the rate of hypoxaemic events when a hyperangulated VL was used (RR 0.49, 95% CI 0.22 to 1.11; I^2 = 39%; favours videolaryngoscopy; 15 studies, 1691 participants; low-certainty evidence; Analysis 2.2). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for imprecision because the confidence interval includes the possibility of benefit as well as harms for both devices.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.9604).

Successful first attempt

Sixty-eight studies reported rates of successful intubation on the first attempt (Abdelgalel 2018; Abdelgawad 2015; Agrawal 2020; Ahmad 2015; Ahmadi 2015; Al-Ghamdi 2016; Andersen 2011; Aqil 2016; Aqil 2017; Arici 2014; Arora 2013; Arslan 2017; Barak 2007; Bashir 2020; Bilehjani 2009; Chen 2019; Ducharme 2017; El-Tahan 2017b; Gao 2018; Golboyu 2016; Griesdale 2012a; Gunes 2020; Hsu 2012; Hu 2017; Huang 2020; Inal 2016; Jafra 2018; Kaur 2020; Kim 2016; Kleine-Brueggeney 2017; Koennecke 2014; Kurnaz 2016; Lee 2012; Lim 2005; Liu 2016; Liu 2019; Loughnan 2019; Malik 2008; Malik 2009b; Masoumifar 2020; Nakayama 2010; Nandakumar 2018; Paik 2020; Pappu 2020; Parasa 2016; Pournajafian 2014; Risse 2020; Russell 2013; Sanguanwit 2021; Sargin 2016; Serocki 2010; Serocki

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2013; Shah 2016; Silverberg 2015; Sun 2005; Taylor 2013; Tempe 2016; Teoh 2010; Tosh 2018; Trimmel 2016; Tsan 2020; Walker 2009; Wasinwong 2017; Xue 2007; Yao 2015; Yeatts 2013; Yousef 2012; Yumul 2016). Of these, 18 were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Al-Ghamdi 2016; Arslan 2017; El-Tahan 2017b; Huang 2020; Kaur 2020; Kleine-Brueggeney 2017; Koennecke 2014; Lee 2012; Malik 2008; Malik 2009b; Nakayama 2010; Pappu 2020; Serocki 2010; Serocki 2013; Tempe 2016; Teoh 2010; Yumul 2016). We extracted data for hyperangulated VLs separately. Where different types of hyperangulated VLs were compared, we combined the data from those studies (Arslan 2017; Huang 2020; Koennecke 2014; Lee 2012; Malik 2008; Pappu 2020; Serocki 2013; Tempe 2016; Yumul 2016). We did not extract data for Ducharme 2017 and Kim 2016 due to a lack of accounting for clustering.

Analysis demonstrated higher rates of success on the first attempt at intubation when a hyperangulated VL was used (RR 1.03, 95% CI 1.00 to 1.05; I^2 = 76%; favours videolaryngoscopy; 66 studies, 8086 participants; low-certainty evidence; Analysis 2.3). We downgraded the evidence by one level for inconsistency because we noted substantial heterogeneity and by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.0576).

Oesophageal intubation

Fifteen studies reported rates of oesophageal intubation (Abdelgalel 2018; Gao 2018; Inangil 2018; Ithnin 2009; Kim 2016; Kleine-Brueggeney 2017; Russell 2012; Russell 2013; Sanguanwit 2021; Shah 2016; Silverberg 2015; Teoh 2010; Trimmel 2016; Tsan 2020; Walker 2009). Of these, three were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Kleine-Brueggeney 2017; Teoh 2010). We extracted data for hyperangulated VLs separately. Six studies were conducted outside the theatre setting (Abdelgalel 2018; Gao 2018; Kim 2016; Sanguanwit 2021; Silverberg 2015; Trimmel 2016). We did not extract data for Kim 2016 due to a lack of accounting for clustering.

Analysis demonstrated fewer oesophageal intubations when a hyperangulated VL was used (RR 0.39, 95% CI 0.18 to 0.81; I^2 = 0%; favours videolaryngoscopy; 14 studies, 1968 participants; moderate-certainty evidence; Analysis 2.4). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.9188).

Important outcomes

Dental trauma

In all, 31 studies reported data for dental trauma when a hyperangulated VL was used (Abdelgalel 2018; Al-Ghamdi 2016; Andersen 2011; Arici 2014; Arora 2013; Arslan 2017; Bag 2014; Barak 2007; Carassiti 2013; Colak 2015; El-Tahan 2017b; Foulds 2016b; Gao 2018; Huang 2020; Ilyas 2014; Inal 2016; Jafra 2018; Kim 2016; Kleine-Brueggeney 2017; Laosuwan 2015; Liu 2016; Loughnan 2019; Malik 2008; Malik 2009b; Pappu 2020; Russell 2013; Silverberg 2015; Sun 2005; Taylor 2013; Tempe 2016; Teoh 2010). Of these, only eight studies reported events (Abdelgalel 2018; Arslan 2017; Barak 2007; Gao 2018; Kim 2016; Liu 2016; Loughnan 2019; Silverberg 2015). The remaining studies reported no events in either comparison group. We did not extract data for Kim 2016 due to a lack of accounting for clustering.

We found little or no difference in the rate of dental trauma when a hyperangulated VL was used (RR 0.51, 95% CI 0.16 to 1.59; I^2 = 0%; favours videolaryngoscopy; 30 studies, 3497 participants; very low-certainty evidence; Analysis 2.5). We downgraded the evidence by two levels for imprecision due to few reported events from a small number of studies and the confidence intervals indicating possible benefits as well as harms, and by one level for the risk of performance bias introduced by lack of blinding.

Cormack-Lehane grade

Fifty-five studies reported data for Cormack-Lehane grades in a format that we were able to extract (Abdelgalel 2018; Abdelgawad 2015; Agrawal 2020; Al-Ghamdi 2016; Andersen 2011; Aqil 2016; Aqil 2017; Arici 2014; Arora 2013; Arslan 2017; Avula 2019; Bag 2014; Barak 2007; Bashir 2020; Bilehjani 2009; Chen 2019; Colak 2015; Ducharme 2017; El-Tahan 2017b; Foulds 2016b; Gao 2018; Golboyu 2016; Griesdale 2012a; Hu 2017; Huang 2020; Ilyas 2014; Inal 2016; Inangil 2018; Jafra 2018; Kaur 2020; Kleine-Brueggeney 2017; Laosuwan 2015; Lee 2012; Lim 2005; Liu 2016; Malik 2008; Malik 2009b; Nandakumar 2018; Pappu 2020; Parasa 2016; Pazur 2016; Postaci 2015; Risse 2020; Robitaille 2008; Rovsing 2010; Shah 2016; Sun 2005; Taylor 2013; Tempe 2016; Teoh 2010; Tsan 2020; Walker 2009; Yao 2015; Yousef 2012; Yumul 2016). Nine studies used a cross-over design (Arora 2013; Avula 2019; Bag 2014; Ducharme 2017; Foulds 2016b; Ilyas 2014; Lee 2012; Robitaille 2008; Taylor 2013). We did not extract data for this outcome from Serocki 2010 as it was not clear which device was used in what order from the reported tables. The remaining studies reported data that we were able to extract. We extracted data for Cormack-Lehane grades 1 and 2 separately, and combined data for Cormack-Lehane grades 3 and 4. We did not extract data for Ducharme 2017 due to a lack of accounting for clustering.

Analysis showed a higher proportion of grade 1 VL views when a hyperangulated VL was used (RR 1.77, 95% CI 1.56 to 2.01; I^2 = 87%; favours videolaryngoscopy; 54 studies, 6058 participants; moderate-certainty evidence; Analysis 2.6). Grade 2 Cormack-Lehane views were more common when a DL was used (RR 0.54, 95% CI 0.46 to 0.63; I^2 = 67%; favours videolaryngoscopy; 54 studies, 6058 participants; moderate-certainty evidence; Analysis 2.6). This effect increased further for grade 3 and 4 Cormack-Lehane views combined (RR 0.15, 95% CI 0.10 to 0.24; I^2 = 60%; favours videolaryngoscopy; 54 studies, 6058 participants; moderate-certainty evidence; Analysis 2.6). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for inconsistency because we noted considerable heterogeneity, and upgraded by one level for large effect size.

Time for tracheal intubation

A total of 59 studies with 6644 participants reported data on time required for tracheal intubation when a hyperangulated VL was used (Abdelgalel 2018; Abdelgawad 2015; Ahmad 2015; Ahmadi 2015; Akbarzadeh 2017; Amini 2015; Andersen 2011; Aqil 2016; Aqil 2017; Arici 2014; Arora 2013; Avula 2019; Barak 2007; Bilehjani 2009; Carassiti 2013; Chen 2019; Choi 2011; Colak 2015; Dashti

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2014; Dostalova 2019; Echeverri 2020; Foulds 2016b; Gunes 2020; Hostic 2016; Hsu 2012; Hu 2017; Ilyas 2014; Inal 2016; Inangil 2018; Jafra 2018; Koennecke 2014; Kurnaz 2016; Laosuwan 2015; Lim 2005; Liu 2016; Loughnan 2019; Malik 2008; Najafi 2014; Nakayama 2010; Nandakumar 2018; Parasa 2016; Pazur 2016; Postaci 2015; Pournajafian 2014; Rovsing 2010; Sandhu 2014; Serocki 2013; Shah 2016; Siddiqui 2009; Sun 2005; Taylor 2013; Tempe 2016; Teoh 2010; Tsan 2020; Turkstra 2005; Xue 2007; Yao 2015; Yeatts 2013; Yumul 2016). Of these, 10 were multi-arm studies that reported data for each device type separately (Abdelgalel 2018; Colak 2015; Hostic 2016; Koennecke 2014; Malik 2008; Nakayama 2010; Serocki 2013; Tempe 2016; Teoh 2010; Yumul 2016). We did not include studies that reported time for tracheal intubation as median (IQR).

On combining the above studies, we again noted considerable statistical heterogeneity (I^2 = 99%) and therefore we did not report a pooled effect estimate (see Analysis 2.7). We downgraded by one level for risk of performance bias due to lack of blinding, and by two levels for inconsistency because we noted considerable heterogeneity.

Patient-reported sore throat

Thirty-one studies reported data for patient-reported sore throat (Abdelgawad 2015; Al-Ghamdi 2016; Amini 2015; Andersen 2011; Aqil 2017; Arslan 2017; Barak 2007; Bilehjani 2009; Dostalova 2019; El-Tahan 2017b; Hsu 2012; Huang 2020; Ilyas 2014; Jafra 2018; Kleine-Brueggeney 2017; Laosuwan 2015; Liu 2016; Liu 2019; Masoumifar 2020; Najafi 2014; Pappu 2020; Parasa 2016; Russell 2013; Siddiqui 2009; Taylor 2013; Tempe 2016; Teoh 2010; Tosh 2018; Yao 2015; Yousef 2012; Yumul 2016). Of these, nine were multi-arm studies that presented data for more than one comparison arm (Al-Ghamdi 2016; Arslan 2017; El-Tahan 2017b; Huang 2020; Kleine-Brueggeney 2017; Pappu 2020; Tempe 2016; Teoh 2010; Yumul 2016). We extracted data for hyperangulated VLs separately.

Analysis showed a lower incidence of patient-reported sore throat when a hyperangulated VL was used (RR 0.81, 95% CI 0.66 to 1.00; I^2 = 60%; favours videolaryngoscopy; 31 studies, 3725 participants; Analysis 2.8).

Number of attempts at tracheal intubation

Fifty-one studies reported the number of attempts required for successful intubation when hyperangulated VLs were used (Abdelgalel 2018; Abdelgawad 2015; Agrawal 2020; Ahmad 2015; Al-Ghamdi 2016; Andersen 2011; Aqil 2016; Aqil 2017; Arici 2014; Arora 2013; Arslan 2017; Barak 2007; Bashir 2020; Bilehjani 2009; Chen 2019; Gao 2018; Golboyu 2016; Griesdale 2012a; Gunes 2020; Hsu 2012; Huang 2020; Inal 2016; Jafra 2018; Kaur 2020; Kim 2016; Kurnaz 2016; Lee 2012; Lim 2005; Liu 2016; Liu 2019; Malik 2008; Malik 2009b; Masoumifar 2020; Nandakumar 2018; Pappu 2020; Risse 2020; Sanguanwit 2021; Sargin 2016; Serocki 2010; Serocki 2013; Silverberg 2015; Sun 2005; Tempe 2016; Teoh 2010; Tosh 2018; Tsan 2020; Wasinwong 2017; Xue 2007; Yao 2015; Yousef 2012; Yumul 2016). Of these, 14 were multi-arm studies that reported data for each device separately (Abdelgalel 2018; Al-Ghamdi 2016; Arslan 2017; Huang 2020; Kaur 2020; Lee 2012; Malik 2008; Malik 2009b; Pappu 2020; Serocki 2010; Serocki 2013; Tempe 2016; Teoh 2010; Yumul 2016). Where multiple hyperangulated VLs were compared we combined the outcome data (Arslan 2017; Huang 2020; Lee 2012; Malik 2008; Pappu 2020; Serocki 2013; Tempe 2016; Yumul 2016). We did not extract data for Kim 2016 due to a lack of accounting for clustering.

Analysis demonstrated a higher proportion of successful single attempts at intubation when a hyperangulated VL was used (RR 1.02, 95% CI 1.00 to 1.05; I^2 = 60%; favours videolaryngoscopy; 50 studies, 5502 participants). Again, we found little or no difference between hyperangulated VL and DL when more than one attempt was required (RR 0.84, 95% CI 0.66 to 1.08; I^2 = 48%; favours videolaryngoscopy; 50 studies, 5502 participants). See Analysis 2.9.

Intubation Difficulty Scale (IDS)

Ten studies reported data for IDS scores for hyperangulated VLs (Agrawal 2020; Andersen 2011; Arora 2013; Loughnan 2019; Malik 2008; Malik 2009b; Nandakumar 2018; Pazur 2016; Postaci 2015; Yousef 2012). We did not extract data for studies that reported IDS scores as median and interquartile range (IQR) or mean and standard deviation (SD) or used non-standard difficulty scales.

We noted considerable statistical heterogeneity (I^2 = 93%) and did therefore not report a pooled effect estimate (see Analysis 2.10).

Percentage of glottic opening (POGO) score

Fourteen studies reported POGO scores for this comparison (Akbarzadeh 2017; Aqil 2016; Aqil 2017; Arici 2014; Choi 2011; Hostic 2016; Jafra 2018; Koennecke 2014; Sandhu 2014; Sargin 2016; Shah 2016; Taylor 2013; Tsan 2020; Yumul 2016). We noted considerable statistical heterogeneity (I^2 = 95%) and did therefore not report a pooled effect estimate (see Analysis 2.11).

Mortality

Three studies with 826 participants reported mortality rates when a hyperangulated VL was used (Gao 2018; Griesdale 2012a; Yeatts 2013). All three were conducted outside the operating theatre environment, either in the ICU or emergency department. Gao 2018 reported complications of airway management, including death, which we extracted as mortality. The timeframe of when this outcome was assessed was not reported. Griesdale 2012a reported data for hospital mortality without clear timeframes, whereas Yeatts 2013 reported 30-day mortality data.

We found little or no difference in mortality rates when a hyperangulated VL was used (RR 1.15, 95% CI 0.73 to 1.79; I^2 = 0%; favours direct laryngoscopy; 3 studies, 826 participants; Analysis 2.12).

Subgroup analyses

We performed subgroup analyses for the critical outcome of failed intubation.

Setting

Seven studies with 837 participants reported data for intubations occurring outside the theatre setting for hyperangulated VLs (ICU: Abdelgalel 2018; Gao 2018; Silverberg 2015; emergency department: Ahmadi 2015; Kim 2016; Sanguanwit 2021; prehospital: Ducharme 2017). We could not conduct a meaningful subgroup analysis.

Obesity

Seven studies with 477 participants reported data for obese participants (Andersen 2011; Malik 2009b; Nandakumar 2018; Rovsing 2010; Wasinwong 2017; Yousef 2012; Yumul 2016). We could therefore not conduct a meaningful subgroup analysis.

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Difficult airway

Six studies reported data for failed intubation in participants with either a known or predicted difficult airway (Ahmadi 2015; Cordovani 2019; Hu 2017; Malik 2009b; Serocki 2010; Serocki 2013). A further nine studies reported data for participants with a simulated difficult airway (Agrawal 2020; Foulds 2016b; Ilyas 2014; Kleine-Brueggeney 2017; Koennecke 2014; Lim 2005; Malik 2008; Paik 2020; Taylor 2013). We considered the above two groups as possessing features of a difficult airway for the purposes of this subgroup analysis. Forty-five studies specifically reported the absence of difficult airway features or excluded participants with such features. Five studies reported insufficient detail to assess for the presence or absence of difficult airway features (Abdelgalel 2018; Gao 2018; Hostic 2016; Kim 2016; Sanguanwit 2021). We did not include the above two groups in our analysis.

Analysis demonstrated fewer failed intubations when a hyperangulated VL was used for participants with predicted, known or simulated difficult airway (RR 0.29, 95% CI 0.17 to 0.48; I^2 = 27%; favours videolaryngoscopy; 15 studies, 1520 participants; Analysis 2.13). Subgroup analysis demonstrated a difference in favour of hyperangulated VLs when features of difficult airway were present (P = 0.03, I^2 = 78.2%). See Figure 5.

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Figure 5. Forest plot of comparison: hyperangulated videolaryngoscopy, subgroup analysis of failed intubation in participants with predicted, known or simulated features of airway difficulty

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
2.13.1 Predicted, known or simulated difficulty						
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015 (1)	1	24	3	23	2.7%	0.32 [0.04 , 2.85]
Cordovani 2019	3	24	5	20	5.4%	0.50 [0.14 , 1.84]
Foulds 2016b	0	24	7	25	1.8%	0.07 [0.00 , 1.15]
Hu 2017 (2)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	1.7%	11.00 [0.62 , 194.90]
Kleine-Brueggeney 2017 (3)	23	240	52	120	10.4%	0.22 [0.14 , 0.34]
Koennecke 2014 (3)	10	83	10	30	8.3%	0.36 [0.17 , 0.78]
Lim 2005	0	30	0	30		Not estimable
Malik 2008 (3)	2	60	2	30	3.3%	0.50 [0.07 , 3.38]
Malik 2009b	1	25	4	25	2.8%	0.25 [0.03 , 2.08]
Paik 2020	0	20	0	20		Not estimable
Serocki 2010	1	40	4	40	2.8%	0.25 [0.03 , 2.14]
Serocki 2013 (3)	0	63	4	32	1.7%	0.06 [0.00 , 1.03]
Taylor 2013	0	44	18	44	1.8%	0.03 [0.00 , 0.43]
Subtotal (95% CI)		**881**		**639**	**42.7%**	**0.29 [0.17 , 0.48]**
Total events:	46		109			
Heterogeneity: Tau² = 0.18; Chi² = 13.68, df = 10 (P = 0.19); I² = 27%						
Test for overall effect: Z = 4.66 (P < 0.00001)						
2.13.2 No difficulty						
Abdelgawad 2015	0	40	0	40		Not estimable
Al-Ghamdi 2016	0	21	0	22		Not estimable
Andersen 2011	0	50	2	50	1.6%	0.20 [0.01 , 4.06]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (4)	0	54	0	54		Not estimable
Arslan 2017 (3)	0	80	0	40		Not estimable
Bakshi 2015 (5)	12	84	2	42	4.7%	3.00 [0.70 , 12.79]
Barak 2007	1	80	2	90	2.4%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Chen 2019	1	220	3	220	2.6%	0.33 [0.03 , 3.18]
Colak 2015	2	50	1	50	2.4%	2.00 [0.19 , 21.36]
El-Tahan 2017b	0	66	0	32		Not estimable
Gunes 2020	0	90	0	90		Not estimable
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Kaur 2020	0	40	0	40		Not estimable
Kill 2013	0	30	3	30	1.7%	0.14 [0.01 , 2.65]
Lee 2012 (3)	3	50	1	25	2.6%	1.50 [0.16 , 13.70]
Liu 2016	2	90	1	90	2.3%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	1.8%	0.05 [0.00 , 0.82]
Nakayama 2010	0	80	3	80	1.6%	0.14 [0.01 , 2.72]
Nandakumar 2018	1	15	0	15	1.5%	3.00 [0.13 , 68.26]
Pournajafian 2014	6	52	3	52	5.2%	2.00 [0.53 , 7.57]
Rovsing 2010	0	50	2	50	1.6%	0.20 [0.01 , 4.06]
Russell 2013	3	35	0	35	1.7%	7.00 [0.37 , 130.69]
Sargin 2016	0	50	0	50		Not estimable
Shah 2016 (6)	0	30	1	30	1.5%	0.33 [0.01 , 7.87]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	7.3%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	1.4%	0.33 [0.01 , 8.09]
Tempe 2016	1	40	1	20	1.9%	0.50 [0.03 , 7.59]
Teoh 2010	0	100	0	100		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Walker 2009	1	60	0	60	1.4%	3.00 [0.12 , 72.20]
Wasinwong 2017	0	23	1	23	1.5%	0.33 [0.01 , 7.78]
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	1.8%	0.08 [0.00 , 1.31]

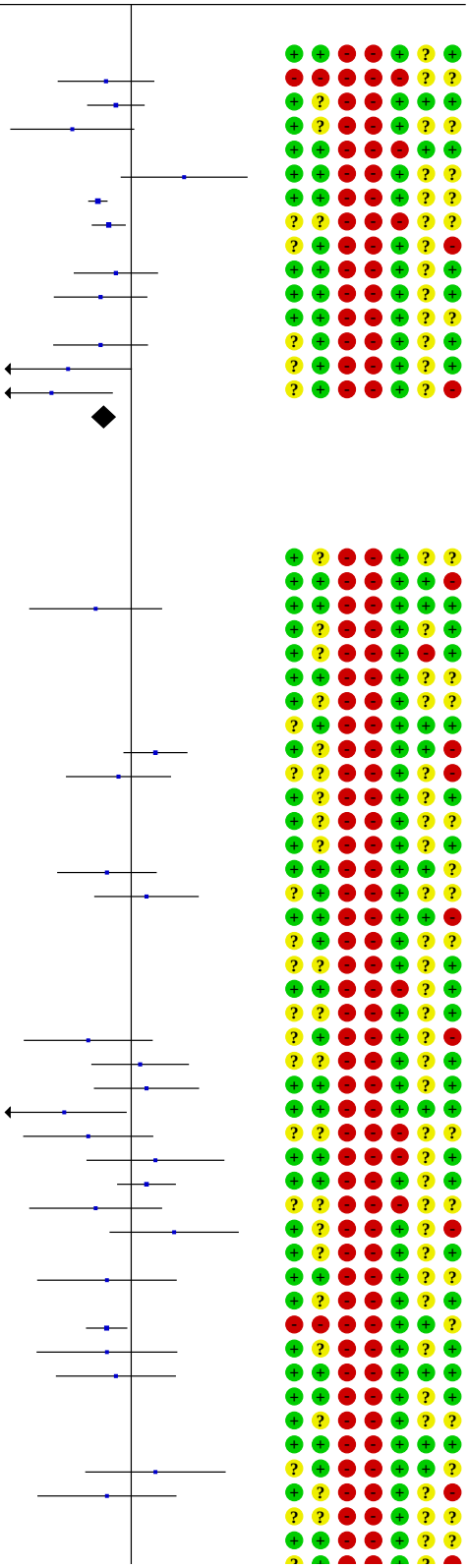

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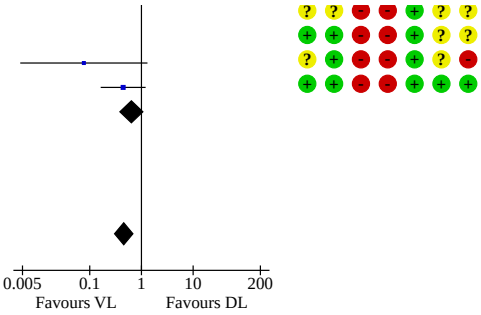
Figure 5. (Continued)

Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	1.8%	0.08 [0.00 , 1.31]
Yumul 2016	6	60	7	31	6.9%	0.44 [0.16 , 1.20]
Subtotal (95% CI)		**2633**		**2454**	**57.3%**	**0.64 [0.38 , 1.06]**
Total events:	44		66			
Heterogeneity: Tau² = 0.25; Chi² = 25.88, df = 21 (P = 0.21); I² = 19%						
Test for overall effect: Z = 1.72 (P = 0.09)						
Total (95% CI)		**3514**		**3093**	**100.0%**	**0.45 [0.30 , 0.68]**
Total events:	90		175			
Heterogeneity: Tau² = 0.37; Chi² = 49.09, df = 32 (P = 0.03); I² = 35%						
Test for overall effect: Z = 3.79 (P = 0.0002)						
Test for subgroup differences: Chi² = 4.60, df = 1 (P = 0.03), I² = 78.2%						



Footnotes

(1) For the purposes of this subgroup analysis we extracted data only for the predicted difficult airways for this study.
(2) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(3) Multi-arm study. Data combined for each VL group.
(4) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(5) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(6) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Intubator expertise

Thirty-two studies reported intubators as being experienced in the use of both devices with quantification of experience (Abdelgalel 2018; Agrawal 2020; Andersen 2011; Aqil 2016; Aqil 2017; Arslan 2017; Bashir 2020; Carassiti 2013; Chen 2019; Cordovani 2019; Hu 2017; Inal 2016; Jafra 2018; Kaur 2020; Kleine-Brueggeney 2017; Lee 2012; Liu 2019; Malik 2008; Malik 2009b; Nandakumar 2018; Pournajafian 2014; Russell 2013; Sargin 2016; Serocki 2010; Serocki 2013; Siddiqui 2009; Sun 2005; Tempe 2016; Teoh 2010; Tsan 2020; Yao 2015; Yumul 2016). Thirteen studies reported intubators as being experienced, but this experience was not quantified further (Abdelgawad 2015; Ahmadi 2015; Arici 2014; Arora 2013; Bilehjani 2009; Colak 2015; Foulds 2016b; Ilyas 2014; Koennecke 2014; Rovsing 2010; Shah 2016; Tosh 2018; Xue 2007). We considered the above two groups as expert for the purposes of this analysis. Three studies reported using novice intubators (Liu 2016; Silverberg 2015; Walker 2009). Six studies included intubators experienced with DL, but not with the studied VL devices (Al-Ghamdi 2016; Barak 2007; Kill 2013; Lim 2005; Taylor 2013; Wasinwong 2017). We considered these two groups as non-expert for the purposes of this analysis. Three studies used intubators with a mixed level of experience, not reporting data in a way to allow extraction (Bakshi 2015; El-Tahan 2017b; Sanguanwit 2021). Six studies did not report sufficient detail to allow assessment of experience (Gao 2018; Gunes 2020; Hostic 2016; Nakayama 2010; Paik 2020; Yousef 2012). We did not include these studies in the analysis. We also did not include Trimmel 2016 in this subgroup analysis as it was not included in the primary analysis.

We could not conduct a meaningful subgroup analysis due to insufficient data.

Sensitivity analyses

For the critical outcome of failed intubation, we performed a sensitivity analysis including Trimmel 2016 and this did not alter our interpretation of the effect for this outcome (RR 0.57, 95% CI 0.34 to 0.95; I^2 = 69%; favours videolaryngoscopy; 64 studies, 7472 participants).

Given the high number of studies with zero events in both arms for certain outcomes, we conducted a post hoc sensitivity analysis for the critical outcomes of failed intubation, hypoxaemia, and oesophageal intubation where we included studies with no events. For the hyperangulated VL versus DL comparison we found the following estimates: failed intubation (RR 0.43, 95% CI 0.34 to 0.56; P < 0.0001), hypoxaemia (RR 0.7, 95% CI 0.41 to 1.17; P = 0.1713), and oesophageal intubation (RR 0.41, 95% CI 0.19 to 0.91; P = 0.0280). This did not alter our interpretation of the primary findings.

Truview devices

We performed a sensitivity analysis for the primary outcome of failed intubation, excluding studies looking at Truview VL (Arora 2013; Bakshi 2015; Barak 2007; Colak 2015; Inal 2016; Kaur 2020; Malik 2008; Tempe 2016). This did not change our effect estimate for this outcome (RR 0.45, 95% CI 0.30 to 0.69; I^2 = 40%; favours videolaryngoscopy; 55 studies, 6312 participants).

Risk of bias

For sensitivity analysis of our risk of bias assessments, we considered only our primary outcome of failed intubation.

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We removed studies with unclear or high risk of selection bias for sequence generation (Ahmadi 2015; Arslan 2017; Barak 2007; Colak 2015; Gao 2018; Hostic 2016; Inal 2016; Kaur 2020; Kill 2013; Koennecke 2014; Lee 2012; Lim 2005; Liu 2019; Nakayama 2010; Rovsing 2010; Serocki 2010; Serocki 2013; Silverberg 2015; Taylor 2013; Walker 2009; Xue 2007; Yousef 2012). The confidence interval crossed the line of no effect while still favouring videolaryngoscopy when these studies were removed, altering the outcome estimate for this comparison (RR 0.73, 95% CI 0.39 to 1.36; I^2 = 58%; 41 studies, 4743 participants). We removed studies with an unknown or high level of attrition bias (Ahmadi 2015; Hostic 2016; Hu 2017; Jafra 2018; Koennecke 2014; Nakayama 2010; Nandakumar 2018; Rovsing 2010) and noted no change in our effect estimate (RR 0.54, 95% CI 0.34 to 0.86; I^2 = 49%; 55 studies, 6162 participants).

3. Channelled videolaryngoscopy versus direct laryngoscopy

This comparison includes data from 73 studies with 7165 participants. Here we report the effects for primary and secondary outcomes for channelled VL compared to DL.

We used GRADE to assess the certainty of the evidence for all critical and a subset of important outcomes. See Summary of findings 3.

Critical outcomes

Failed intubation

Fifty-three studies reported the number of failed intubations (Abdallah 2019; Abdelgalel 2018; Acarel 2018; Al-Ghamdi 2016; Aleksandrowicz 2018; Ali 2017; Amor 2013; Aoi 2010; Bensghir 2013; Bhandari 2013; Blajic 2019; Castillo-Monzon 2017; Chalkeidis 2010; Colak 2015; El-Tahan 2017a; El-Tahan 2017b; Enomoto 2008; Erden 2010; Erdivanli 2018; Erturk 2015; Ferrando 2011; Hirabayashi 2009; Hosalli 2017; Kim 2013; Kim 2018; Koh 2010; Komatsu 2010; Maharaj 2006; Maharaj 2007; Maharaj 2008; Malik 2008; Malik 2009a; Malik 2009b; Mathew 2018; McElwain 2011; Nakayama 2010; Ndoko 2008; Nishikawa 2009; Park 2010; Ranieri 2012; Reena 2019; Sansone 2012; Saracoglu 2014; Shukla 2017; Takenaka 2011; Teoh 2010; Tolon 2012; Turkstra 2009; Varsha 2019; Vijayakumar 2016; Wasem 2013; Woo 2012; Zhao 2014). Of these, 11 were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Al-Ghamdi 2016; Bensghir 2013; Blajic 2019; Colak 2015; El-Tahan 2017b; Malik 2008; Malik 2009b; McElwain 2011; Nakayama 2010; Teoh 2010). We extracted data for channelled VLs separately. Where different types of channelled VLs were compared, we combined data from those studies (Al-Ghamdi 2016; El-Tahan 2017b). We did not include Arima 2014 and Trimmel 2011 in the meta-analysis as the number of failed intubations in the VL groups were disproportionately large, rendering the studies outliers (see sensitivity analysis below). Of note, both studies were conducted in the prehospital setting.

Analysis demonstrated fewer failed intubations when a channelled VL was used (RR 0.43, 95% CI 0.30 to 0.61; I^2 = 0%; favours videolaryngoscopy; 53 studies, 5367 participants; moderate-certainty evidence; Analysis 3.1). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P value = 0.4167).

Hypoxaemia

Fifteen studies reported the number of hypoxaemic events (Abdelgalel 2018; Ali 2017; Bensghir 2013; Castillo-Monzon 2017; Erden 2010; Erdivanli 2018; Gupta 2020; Komatsu 2010; Maharaj 2008; Ndoko 2008; Park 2010; Ranieri 2012; Shukla 2017; Teoh 2010; Vijayakumar 2016). Eight studies reported no events (Ali 2017; Castillo-Monzon 2017; Erdivanli 2018; Gupta 2020; Komatsu 2010; Park 2010; Teoh 2010; Vijayakumar 2016). Of the remaining seven studies that reported events, one was conducted outside of the theatre setting (Abdelgalel 2018), two included only obese participants (Ndoko 2008; Ranieri 2012), and one included only participants with predicted features of airway difficulty (Maharaj 2008).

Analysis demonstrated fewer hypoxaemic events when a channelled VL was used (RR 0.25, 95% CI 0.12 to 0.50; I^2 = 0%; favours videolaryngoscopy; 15 studies, 1966 participants; moderate-certainty evidence; Analysis 3.2). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.1849).

Successful first attempt

Forty-seven studies reported rates of successful intubation on the first attempt (Abdallah 2011; Abdallah 2019; Abdelgalel 2018; Acarel 2018; Al-Ghamdi 2016; Ali 2017; Aoi 2010; Arima 2014; Bensghir 2013; Bhandari 2013; Blajic 2019; Castillo-Monzon 2017; Dharanindra 2020; El-Tahan 2017a; El-Tahan 2017b; Enomoto 2008; Erdivanli 2018; Erturk 2015; Ferrando 2011; Gupta 2020; Hirabayashi 2009; Hosalli 2017; Kim 2013; Kim 2018; Koh 2010; Komatsu 2010; Maharaj 2006; Maharaj 2007; Maharaj 2008; Malik 2008; Malik 2009a; Malik 2009b; Marco 2011; Mathew 2018; McElwain 2011; Nakayama 2010; Park 2010; Ranieri 2012; Reena 2019; Shukla 2017; Takenaka 2011; Teoh 2010; Varsha 2019; Vijayakumar 2016; Wasem 2013; Woo 2012; Zhao 2014). Of these, 10 were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Al-Ghamdi 2016; Bensghir 2013; Blajic 2019; El-Tahan 2017b; Malik 2008; Malik 2009b; McElwain 2011; Nakayama 2010; Teoh 2010). We extracted data for channelled VLs separately. Where different types of channelled VLs were compared, we combined the data from those studies (Al-Ghamdi 2016; El-Tahan 2017b).

Analysis demonstrated higher rates of success on the first attempt at intubation when a channelled VL was used (RR 1.10, 95% CI 1.05 to 1.15; I^2 = 84%; favours videolaryngoscopy; 47 studies, 5210 participants; very low-certainty evidence; Analysis 2.3). We downgraded the evidence by one level for inconsistency because we noted considerable heterogeneity, by one level for the risk of performance bias introduced by lack of blinding and by one level for suspicion of publication bias.

We generated a funnel plot (see Figure 6) and we found statistical evidence of possible presence of small-study effects (Harbord modified test, P = 0.0050).

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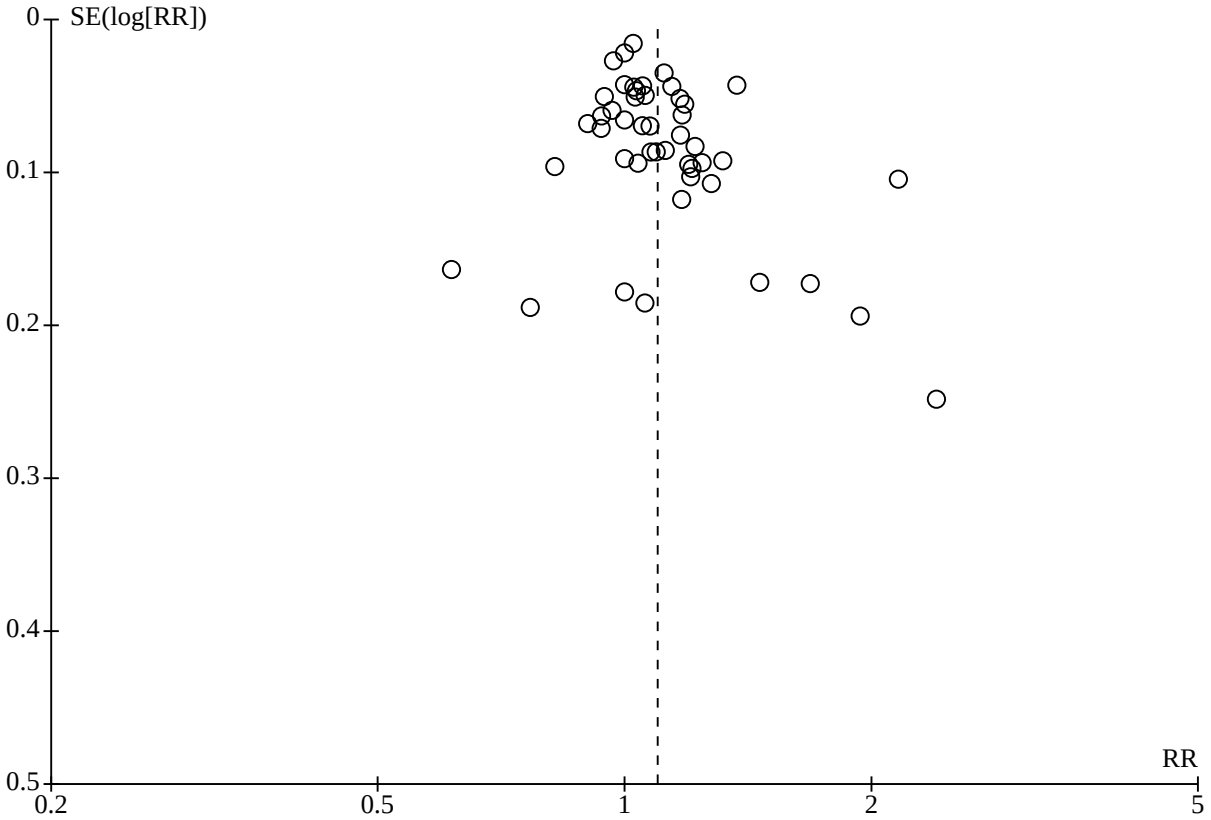
Figure 6. Funnel plot of comparison: channelled videolaryngoscopy versus direct laryngoscopy, outcome 3.3, successful first attempt



Oesophageal intubation

Sixteen studies reported rates of oesophageal intubation (Abdallah 2019; Abdelgalel 2018; Acarel 2018; Ali 2017; Aoi 2010; Castillo-Monzon 2017; Erden 2010; Ferrando 2011; Hindman 2014; Hirabayashi 2009; Komatsu 2010; Park 2010; Saracoglu 2014; Teoh 2010; Trimmel 2011; Wasem 2013). Of these, two were multi-arm studies that presented data for more than one comparison arm (Abdelgalel 2018; Teoh 2010). We extracted data for channelled VLs separately. Two studies were conducted outside the theatre setting (Abdelgalel 2018; Trimmel 2011).

We found little or no difference in the rate of oesophageal intubation when a channelled VL was used (RR 0.54, 95% CI 0.17 to 1.75; I^2 = 39%; favours videolaryngoscopy; 16 studies, 1756 participants; low-certainty evidence; Analysis 3.4). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for imprecision because the confidence interval includes the possibility of benefit as well as harms for both devices.

We generated a funnel plot and we found no statistical evidence of small-study effects (Harbord modified test, P = 0.2329).

Important outcomes

Dental trauma

Twenty-nine studies reported data for dental trauma for channelled VL (Abdelgalel 2018; Al-Ghamdi 2016; Ali 2017; Amor 2013; Aoi 2010; Bensghir 2013; Bhandari 2013; Castillo-Monzon 2017; Colak 2015; El-Tahan 2017b; Ferrando 2011; Hosalli 2017; Kim 2013; Kim 2018; Komatsu 2010; Kumar 2019; Maharaj 2006; Maharaj 2008; Malik 2008; Malik 2009a; Malik 2009b; Marco 2011; McElwain 2011; Park 2010; Saracoglu 2014; Teoh 2010; Tolon 2012; Vijayakumar 2016; Zhao 2014). Of these, only five studies reported events (Abdelgalel 2018; Aoi 2010; Castillo-Monzon 2017; Komatsu 2010; Tolon 2012). The remaining studies reported no events in either comparison group.

We found little or no difference in the rate of dental trauma when a channelled VL was used (RR 0.52, 95% CI 0.13 to 2.12; I^2 = 0%; favours videolaryngoscopy; 29 studies, 2375 participants; very low-certainty evidence; Analysis 3.5). We downgraded the evidence by two levels for imprecision due to few reported events from a small number of studies and the confidence intervals indicating possible benefits as well as harms, and by one level for the risk of performance bias introduced by lack of blinding.

Cormack-Lehane grade

Forty studies reported data for Cormack-Lehane grades in a format that we were able to extract (Abdelgalel 2018; Al-Ghamdi 2016; Ali 2017; Amor 2013; Aoi 2010; Bensghir 2013; Blajic 2019; Colak 2015; El-Tahan 2017a; El-Tahan 2017b; Enomoto 2008; Erden 2010; Erdivanli 2018; Erturk 2015; Ferrando 2011; Gupta 2020; Hamp 2015; Hosalli 2017; Kim 2013; Lopez 2017; Maharaj 2006; Maharaj 2007; Maharaj 2008; Mahmood 2015; Malik 2008; Malik 2009a; Malik 2009b; Maruyama 2008b; McElwain 2011; Ndoko 2008; Ranieri 2012;

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Reena 2019; Takenaka 2011; Teoh 2010; Tolon 2012; Turkstra 2009; Varsha 2019; Vijayakumar 2016; Wasem 2013; Zhao 2014). Five studies used a cross-over design and recorded the Cormack-Lehane grade for all participants for each laryngoscope (El-Tahan 2017a; Enomoto 2008; Erdivanli 2018; Ferrando 2011; Turkstra 2009). As for previous comparisons, we extracted data for Cormack-Lehane grades 1 and 2 separately, and combined data for Cormack-Lehane grades 3 and 4.

Analysis showed a higher proportion of grade 1 Cormack-Lehane views when a channelled VL was used (RR 2.01, 95% CI 1.75 to 2.31; I^2 = 85%; favours videolaryngoscopy; 40 studies, 3955 participants; moderate-certainty evidence; Analysis 3.6). Direct laryngoscopy was associated with a higher proportion of grade 2 Cormack-Lehane views (RR 0.24, 95% CI 0.17 to 0.35; I^2 = 75%; favours videolaryngoscopy; 40 studies, 3955 participants; moderate-certainty evidence; Analysis 3.6). This effect was further strengthened for grade 3 and 4 Cormack-Lehane views combined (RR 0.14, 95% CI 0.09 to 0.21; I^2 = 14%; favours videolaryngoscopy; 40 studies, 3955 participants; moderate-certainty evidence; Analysis 3.6). We downgraded the evidence by one level for the risk of performance bias introduced by lack of blinding, and by one level for inconsistency because we noted considerable heterogeneity, and upgraded by one level for large effect size.

Time for tracheal intubation

A total of 57 studies with 5676 participants reported data on time required for tracheal intubation when a channelled VL was used (Abdallah 2019; Abdelgalel 2018; Aleksandrowicz 2018; Ali 2017; Amor 2013; Aoi 2010; Barman 2017; Bensghir 2013; Bhandari 2013; Blajic 2019; Castillo-Monzon 2017; Cha 2009; Chalkeidis 2010; Colak 2015; Dharanindra 2020; El-Tahan 2017a; Enomoto 2008; Erden 2010; Erdivanli 2018; Gupta 2020; Hamp 2015; Hindman 2014; Hirabayashi 2009; Kanchi 2011; Kim 2013; Kim 2018; Koh 2010; Komatsu 2010; Kumar 2019; Lee 2013; Lopez 2017; Maharaj 2006; Maharaj 2007; Maharaj 2008; Mahmood 2015; Malik 2008; Marco 2011; Maruyama 2008a; Maruyama 2008b; Mathew 2018; Nakayama 2010; Ndoko 2008; Nishikawa 2009; Park 2010; Rabbani 2020; Ranieri 2012; Reena 2019; Sansone 2012; Saracoglu 2014; Shukla 2017; Teoh 2010; Tolon 2012; Trimmel 2011; Wasem 2013; Woo 2012; Yallapragada 2016; Zhao 2014). Of these, eight were multi-arm studies that reported data for each device type separately, allowing extraction (Abdelgalel 2018; Bensghir 2013; Blajic 2019; Colak 2015; Malik 2008; Nakayama 2010; Rabbani 2020; Teoh 2010). We did not include studies that reported time for tracheal intubation as median (IQR).

When we combined data for the above studies we noted considerable statistical heterogeneity (I^2 = 98%) and therefore did not report a pooled effect estimate (see Analysis 3.7). We downgraded by one level for risk of performance bias due to lack of blinding, and by two levels for inconsistency because we noted considerable heterogeneity.

Patient-reported sore throat

Eighteen studies reported data for patient-reported sore throat (Abdallah 2011; Abdallah 2019; Al-Ghamdi 2016; Aoi 2010; Bhandari 2013; Blajic 2019; Cha 2009; El-Tahan 2017b; Gandhi 2019; Kim 2018; Marco 2011; Mathew 2018; Nishikawa 2009; Saracoglu 2014; Teoh 2010; Wasem 2013; Woo 2012; Yallapragada 2016). Of these, four were multi-arm studies that presented data for more than one comparison arm (Al-Ghamdi 2016; Blajic 2019; El-Tahan 2017b; Teoh 2010). We extracted data for channelled VLs separately.

We found little or no difference in the rate of patient-reported sore throat when a channelled VL was used (RR 0.91, 95% CI 0.73 to 1.14; I^2 = 40%; favours videolaryngoscopy; 18 studies, 1666 participants; Analysis 3.8).

Number of attempts at tracheal intubation

Thirty-eight studies reported the number of attempts required for successful intubation when a channelled VL was used (Abdallah 2011; Abdallah 2019; Abdelgalel 2018; Acarel 2018; Al-Ghamdi 2016; Ali 2017; Aoi 2010; Bensghir 2013; Bhandari 2013; Blajic 2019; Castillo-Monzon 2017; Erdivanli 2018; Erturk 2015; Ferrando 2011; Gupta 2020; Hirabayashi 2009; Hosalli 2017; Kim 2013; Kim 2018; Koh 2010; Komatsu 2010; Maharaj 2006; Maharaj 2007; Maharaj 2008; Malik 2008; Malik 2009a; Malik 2009b; Mathew 2018; McElwain 2011; Park 2010; Ranieri 2012; Reena 2019; Shukla 2017; Takenaka 2011; Teoh 2010; Varsha 2019; Vijayakumar 2016; Wasem 2013). Of these, eight were multi-arm studies that reported data for each device separately (Abdelgalel 2018; Al-Ghamdi 2016; Bensghir 2013; Blajic 2019; Malik 2008; Malik 2009b; McElwain 2011; Teoh 2010).

Analysis demonstrated a higher proportion of successful single attempts at intubation when a channelled VL was used (RR 1.09, 95% CI 1.04 to 1.14; I^2 = 81%; favours videolaryngoscopy; 38 studies, 4157 participants). We noted considerable heterogeneity. When more than one attempt was required, this was less commonly observed for channelled VL as compared to DL (RR 0.47, 95% CI 0.33 to 0.68; I^2 = 56%; favours videolaryngoscopy; 38 studies, 4157 participants). See Analysis 3.9.

Intubation Difficulty Scale (IDS)

Sixteen studies reported data for IDS scores for channelled VLs (Ali 2017; Amor 2013; Aoi 2010; Bensghir 2013; Kumar 2019; Lopez 2017; Maharaj 2006; Maharaj 2007; Malik 2008; Malik 2009a; Malik 2009b; McElwain 2011; Ndoko 2008; Tolon 2012; Vijayakumar 2016; Wasem 2013). We did not extract data for studies that reported IDS scores as median and interquartile range (IQR) or mean and standard deviation (SD) or used non-standard difficulty scales.

Analysis demonstrated a higher proportion of easy intubations (IDS = 0) when channelled VLs were used (RR 3.34, 95% CI 2.43 to 4.60; I^2 = 66%; favours videolaryngoscopy; 16 studies, 1004 participants). Higher scores were less frequently observed when a channelled VL was used; IDS 1 to 5 (RR 0.38, 95% CI 0.27 to 0.53; I^2 = 73%; favours videolarynogoscopy; 16 studies, 1004 participants) and IDS above 5 (RR 0.21, 95% CI 0.12 to 0.37; I^2 = 0%; favours videolaryngoscopy; 16 studies, 1004 participants). This was associated with considerable heterogeneity for IDS scores of 1 to 5. See Analysis 3.10.

Percentage of glottic opening (POGO) score

Five studies reported POGO scores for this comparison (Abdallah 2019; Cha 2009; Hindman 2014; Kim 2018; Woo 2012). As with previous comparisons, we noted considerable statistical heterogeneity (I^2 = 99%) and did therefore not report a pooled effect estimate (see Analysis 3.11).

Mortality

No studies reported data for mortality rates in this comparison.

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Subgroup analyses

We performed subgroup analyses for the critical outcome of failed intubation.

Setting

There were insufficient data to conduct a meaningful subgroup analysis for failed intubation in this comparison. Following the exclusion of outliers (Arima 2014; Trimmel 2011), only one study reported data for this outcome in the non-theatre setting (Abdelgalel 2018). Therefore, we did not present data for this comparison.

Obesity

Four studies with 359 participants reported failed intubation for obese participants where channelled VLs were used (Castillo-Monzon 2017; Malik 2009b; Ndoko 2008; Ranieri 2012). Erdivanli 2018 recruited a combination of obese and non-obese participants, and the study population was insufficiently described in two studies (Aleksandrowicz 2018; Arima 2014). There was an insufficient number of studies to conduct a meaningful subgroup analysis.

Difficult airway

Nine studies reported data for failed intubation in participants with either a known or predicted difficult airway (Ali 2017; Komatsu 2010; Maharaj 2008; Malik 2009b; Sansone 2012; Tolon 2012; Turkstra 2009; Vijayakumar 2016; Woo 2012). Eleven studies reported data for participants with a simulated difficult airway (Aleksandrowicz 2018; Amor 2013; Aoi 2010; Enomoto 2008; Koh 2010; Maharaj 2007; Malik 2008; Malik 2009a; Mathew 2018; McElwain 2011; Takenaka 2011). We combined these two groups into a subgroup of participants with known, predicted or simulated difficult airway. We compared this to data from 32 studies that specifically excluded participants with difficult airway features. Two studies (Abdelgalel 2018 Arima 2014), did not report sufficient detail to allow classification, and we therefore excluded them from this subgroup analysis.

Analysis demonstrated fewer failed intubations when a channelled VL was used for participants with predicted, known or simulated difficult airway (RR 0.22, 95% CI 0.10 to 0.49; I^2 = 0%; favours videolaryngoscopy; 20 studies, 1433 participants; Analysis 3.12). We found no difference when testing for subgroup differences (P = 0.07, I^2 = 69.3%).

Intubator experience

Twenty-six studies reported intubators as being experienced in the use of both devices with quantification of experience (Abdallah 2019; Abdelgalel 2018; Acarel 2018; Ali 2017; Amor 2013; Bensghir 2013; Blajic 2019; Castillo-Monzon 2017; El-Tahan 2017a; Erdivanli 2018; Kim 2013; Koh 2010; Komatsu 2010; Maharaj 2008; Malik 2008; Malik 2009a; Malik 2009b; Nishikawa 2009; Ranieri 2012; Reena 2019; Takenaka 2011; Teoh 2010; Turkstra 2009; Varsha 2019; Vijayakumar 2016; Woo 2012). Thirteen studies reported intubators as being experienced, but this was not quantified further (Aleksandrowicz 2018; Aoi 2010; Colak 2015; Erden 2010; Hosalli 2017; Maharaj 2006; Maharaj 2007; Mathew 2018; McElwain 2011; Ndoko 2008; Saracoglu 2014; Shukla 2017; Wasem 2013). We considered these two groups as expert for the purposes of this analysis. Five studies reported using novice intubators (Ferrando 2011; Hirabayashi 2009; Kim 2018; Park 2010; Zhao 2014). Two studies used intubators experienced with DL, but not with channelled VL devices (Al-Ghamdi 2016; Chalkeidis 2010). We considered these two groups as non-expert for the purposes of this analysis. One study used intubators with a mixed level of experience, not reporting data in a way to allow extraction (El-Tahan 2017b). Six studies did not report sufficient detail to allow assessment of experience (Bhandari 2013; Enomoto 2008; Erturk 2015; Nakayama 2010; Sansone 2012; Tolon 2012). We did not include these studies in the analysis. We also did not include Arima 2014 and Trimmel 2011 in this analysis as they were not included in the primary analysis.

Given that only seven studies with 1152 participants reported rates of failed intubation for non-expert intubators using channelled VLs, we could not conduct a meaningful subgroup analysis.

Sensitivity analyses

For the critical outcome of failed intubation, we performed a sensitivity analysis including Arima 2014 and Trimmel 2011. The effect estimate with these studies is different to the primary analysis as it crosses the line of no effect with wider confidence intervals (RR 0.55, 95% CI 0.29 to 1.03; I^2 = 58%; favours videolaryngoscopy; 55 studies, 5685 participants).

Given the high number of studies with zero events in both arms for certain outcomes, we conducted a post hoc sensitivity analysis for the critical outcomes of failed intubation, hypoxaemia, and oesophageal intubation where we included studies with no events. For the channelled VL versus DL comparison we found the following estimates: failed intubation (RR 0.47, 95% CI 0.33 to 0.68; P < 0.0001), hypoxaemia (RR 0.28, 95% CI 0.14 to 0.56; P = 0.0003), and oesophageal intubation (RR 0.48, 95% CI 0.19 to 1.23; P = 0.1280). This did not alter our interpretation of the primary findings.

Risk of bias

For sensitivity analysis of our risk of bias assessments, we considered only our primary outcome of failed intubation.

We removed studies with unclear or high risk of selection bias for sequence generation (Acarel 2018; Aoi 2010; Colak 2015; Erturk 2015; Hirabayashi 2009; Kim 2013; Maharaj 2006; Maharaj 2007; Maharaj 2008; Nakayama 2010; Ndoko 2008; Ranieri 2012; Sansone 2012; Takenaka 2011; Tolon 2012; Wasem 2013; Woo 2012). This resulted in no change to our interpretation of the effect, with fewer failed intubations when a channelled VL was used (RR 0.46, 95% CI 0.31 to 0.67; I^2 = 0%; 36 studies, 3618 participants). Similarly, we noted no differences in our estimates when we removed studies with an unknown or high level of attrition bias (RR 0.46, 95% CI 0.31 to 0.66; I^2 = 1%; 46 studies, 4811 participants; excluded studies: Acarel 2018; Aleksandrowicz 2018; El-Tahan 2017a; Mathew 2018; Nakayama 2010; Sansone 2012; Woo 2012).

Other sensitivity and subgroup analyses

We performed a separate sensitivity analysis of all three device types combined, looking at the critical outcomes of failed intubation, hypoxaemia, successful first attempt and oesophageal intubation.

One hundred and thirty-nine studies reported the number of failed intubations. Analysis demonstrated fewer failed intubations with

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VLs of any design (RR 0.44, 95% CI 0.35 to 0.56; I^2 = 22%; favours videolaryngoscopy; 139 studies, 16,228 participants; Analysis 4.1).

Forty-one studies reported the number of hypoxaemic events. Analysis demonstrated fewer hypoxaemic events with VLs of any design (RR 0.61, 95% CI 0.44 to 0.85; I^2 = 34%; favours videolaryngoscopy; 41 studies, 5434 participants; Analysis 4.2).

138 studies reported rates of successful intubation on the first attempt. Analysis demonstrated increased rates of success on the first attempt at intubation with VL of any design (RR 1.05, 95% CI 1.03 to 1.07; I^2 = 81%; favours videolaryngoscopy; 138 studies, 19,797 participants; Analysis 4.3).

Forty studies reported rates of oesophageal intubation. Analysis demonstrated a lower rate of oesophageal intubations with VLs of any design (RR 0.47, 95% CI 0.29 to 0.77; I^2 = 16%; favours videolaryngoscopy; 40 studies, 5768 participants; Analysis 4.4).

Combined subgroup analyses

In light of the small numbers of studies that explored effects of the prespecified subgroups in each comparison, we made a post hoc decision to perform subgroup analyses of the combined VL designs, similar to the two sensitivity analyses above. We looked at setting, obesity, airway difficulty and intubator experience.

Eleven studies reported intubations outside the theatre setting when all VL designs were combined. Analysis demonstrated a stronger effect for reducing the rates of failed intubation in theatre (RR 0.41, 95% CI 0.32 to 0.54; I^2 = 19%; favours videolaryngoscopy; 130 studies, 14,604 participants; Analysis 4.5) as compared to outside of theatre (RR 0.68, 95% CI 0.42 to 1.09; I^2 = 39%; favours videolaryngoscopy; 11 studies, 1846 participants; Analysis 4.5). However, testing for subgroup differences did not reveal an important difference (P = 0.07, I^2 = 69.6%).

Looking at obesity, 13 studies reported data for obese participants when all VL designs were combined. We found no clear difference between the two groups here either (P = 0.07, I^2 = 68.5%), though there was a more pronounced trend of less frequent failed intubations in obese individuals when VL was used (obese: RR 0.25, 95% CI 0.13 to 0.46; I^2 = 0%; favours videolaryngoscopy; 13 studies, 1085 participants; non-obese: RR 0.47, 95% CI 0.35 to 0.62; I^2 = 42%; favours videolaryngoscopy; 120 studies, 13,796 participants; Analysis 4.6).

We found 42 studies looking at participants with predicted, known or simulated features of airway difficulty. Again, there was a strong trend towards a reduction in the rates of failed intubation when VL was used in participants with difficult airway features (predicted, known or simulated difficulty: RR 0.32, 95% CI 0.23 to 0.44; I^2 = 9%; favours videolaryngoscopy; 42 studies, 4100 participants; no difficulty: RR 0.54, 95% CI 0.38 to 0.78; I^2 = 23%; favours videolaryngoscopy; 90 studies, 10,899 participants; Analysis 4.7). Analysis demonstrated a difference between the two subgroups (P = 0.03; I^2 = 78.4%).

Finally, looking at intubator experience, we identified 17 studies looking at non-expert intubators. We found no reduction in the rates of failure when non-expert intubators used VL compared to DL (RR 0.62, 95% CI 0.32 to 1.18; I^2 = 60%; favours videolaryngoscopy; 17 studies, 2156 participants; Analysis 4.8). When expert intubators used VL devices, however, a distinct reduction in intubation failure was observed (RR 0.41, 95% CI 0.33 to 0.50; I^2 = 0%; favours videolaryngoscopy; 98 studies, 10,939 participants; Analysis 4.8). There was no difference between subgroups (P = 0.24, I^2 = 28.6%).

DISCUSSION

Summary of main results

We included 222 studies that compared videolaryngoscopy with direct laryngoscopy in adults requiring tracheal intubation. We also identified 27 studies awaiting classification and 46 ongoing studies.

We reported three main comparisons for this review. We categorized VLs as Macintosh-style, hyperangulated or channelled based on design features. We found a large number of studies reporting the critical outcomes of interest for all three comparisons, allowing meaningful meta-analysis for all critical outcomes.

Here we summarize the effects of the critical and important outcomes in these three comparison groups.

Macintosh-style videolaryngoscopy versus direct laryngoscopy

The evidence for this comparison, which included 61 studies with 9883 participants, is shown in Summary of findings 1. We found moderate-certainty evidence for decreased rates of failed intubation and hypoxaemia, with a higher proportion of successful intubation on the first attempt when a Macintosh-style VL was used. We found low-certainty evidence of little or no difference in oesophageal intubation rates when a Macintosh-style VL was used. We found very low-certainty evidence of little or no difference in rates of dental trauma. We found moderate-certainty evidence of considerable improvements in glottic views as assessed by Cormack-Lehane grade when a Macintosh-style VL was used. We were not able to pool data for time required for tracheal intubation due to considerable statistical heterogeneity.

We found little or no difference in patient-reported rates of sore throat between the two device types. The number of attempts required was reduced when a Macintosh-style VL was used. Only four studies reported IDS scores, and we found no difference in the frequencies of high or low scores. We did not pool data for percentage of glottic opening (POGO) scores due to high statistical heterogeneity. Only three studies reported mortality, and we found little or no difference between devices.

We were not able to conduct a subgroup analysis for intubation setting, the impact of obesity or intubator experience for this comparison due to the small number of studies. When features of a difficult airway were present, Macintosh-style VL resulted in a lower incidence of failed intubation, but we noted no clear difference between subgroups.

Hyperangulated videolaryngoscopy versus direct laryngoscopy

The evidence for this comparison, which included 96 studies with 11,438 participants, is shown in Summary of findings 2. We found moderate-certainty evidence for decreased rates of failed intubation and oesophageal intubation when a hyperangulated VL was used. We found low-certainty evidence of little or no difference in the rate of hypoxaemic events. We found low-certainty evidence of higher rates of successful intubation on the first attempt and

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moderate-certainty evidence of improved glottic views as assessed by Cormack-Lehane grade when a hyperangulated VL was used. We found very low-certainty evidence of little or no difference in rates of dental trauma. We were not able to pool data for time required for tracheal intubation due to considerable statistical heterogeneity.

We noted a lower incidence of patient-reported sore throat when a hyperangulated VL was used. We also noted a reduction in the number of attempts required with hyperangulated VLs. Hyperangulated VLs were associated with a higher proportion of easy and lower proportion of difficult intubations as assessed by IDS. We did not pool data for POGO scores due to high statistical heterogeneity. Mortality was reported in only three studies, and we found little or no difference between devices.

We were not able to conduct a meaningful subgroup analysis for intubation setting, the impact of obesity or intubator experience for this comparison due to a small number of studies. Looking at participants with features of a difficult airway, we noted an important subgroup difference in favour of hyperangulated VLs.

Channelled videolaryngoscopy versus direct laryngoscopy

The evidence for this comparison, which included 73 studies with 7165 participants, is shown in Summary of findings 3. We found moderate-certainty evidence for decreased rates of failed intubation and hypoxaemia when a channelled VL was used. We found low-certainty evidence of little or no difference in rates of oesophageal intubation and very low-certainty evidence of a higher proportion of successful intubation on the first attempt with a channelled VL. We found moderate-certainty evidence of improved glottic views as assessed by Cormack-Lehane grade when a channelled VL was used. We found very low-certainty evidence of little or no difference in rates of dental trauma. We were not able to pool data for time required for tracheal intubation due to considerable statistical heterogeneity.

We found little or no difference in rates of patient-reported sore throat with channelled VLs when compared to DL. The use of channelled devices resulted in fewer attempts than DL. When a channelled device was used, this was more commonly associated with lower IDS scores, suggestive of increased ease of intubation. We did not pool data for POGO scores due to considerable statistical heterogeneity. No studies for channelled VLs reported data for mortality.

We were not able to conduct a subgroup analysis for intubation setting, the impact of obesity or intubator experience for this comparison due to the small number of studies reporting the outcome of interest for these groups. When channelled VLs were used to intubate participants with known, predicted or simulated features of a difficult airway, this resulted in fewer failures, but we found no clear difference between the subgroups.

Overall completeness and applicability of evidence

We identified 222 studies reporting outcomes from 26,149 participants. The population is representative of a general adult population that would be expected to require either elective or emergency tracheal intubation. Most studies reported characteristics such as the ASA performance status and Mallampati scores. The included studies were conducted in several countries from across the world, with a number conducted in low- and middle-income countries. This increases the external validity of our review, but might have introduced a degree of heterogeneity as the conduct of airway management might vary regionally.

We included studies that enrolled participants who were anticipated to have a difficult intubation and participants who were not, participants with obesity and without. We did not exclude studies that enrolled participants in cardiac arrest undergoing tracheal intubation. We included studies with both expert and non-expert intubators performing tracheal intubation across an array of settings, such as the operating theatre, ICU, emergency department and the prehospital setting.

Of note, out of the six studies from the prehospital setting, three were marked outliers for the critical outcome of failed intubation and we did not extract data from them for our meta-analysis. There were, specifically, high rates of failed intubation with VLs in these studies, which could be accounted for by the more challenging environment the prehospital setting represents or different levels of expertise. In any case, further studies would be necessary to establish what the effects of videolaryngoscopy in the prehospital setting on patient outcomes are.

The review reported three prespecified between-group comparisons with the majority of included studies reporting our critical or important outcomes of interest. We were, however, unable to perform a number of our prespecified subgroup analyses due to insufficient studies reporting the critical outcome of interest within each comparison. Included studies were published between 2005 and 2021, with most published since 2015, likely reflecting an increasing popularity of VLs and more widespread introduction into general clinical practice.

A cost analysis of videolaryngoscopy compared with direct laryngoscopy is beyond the scope of this review, and it will depend on the practice setting and available resources and expertise in any given environment. An evidence summary by the National Institute for Health and Care Excellence (NICE) looking at the use of VL in individuals with features of airway difficulty acknowledged that purchase and ownership costs of videolaryngoscopy solutions are higher than that of direct laryngoscopy, but might be offset by a reduction in complications and time savings for staff involved in patient care (NICE 2018). This has also been demonstrated more recently in other high-income practice settings (Alsumali 2018; Zhang 2021). We are not sure how these findings translate to low- and middle-income settings, however, as data are sparse at present. Low-cost, custom-made VLs have emerged recently in response to the COVID-19 pandemic, and a recently published systematic review looking at these solutions in particular found that the evidence was of low certainty and further RCTs are required (Hamal 2022).

Quality of the evidence

We used GRADE to formally assess the certainty of the evidence for our main comparisons for the critical and some important outcomes in the review. The certainty of evidence ranged from very low to moderate. Owing to the limitations inherent to study design and the overall high risk of performance and detection bias introduced by lack of blinding intubators and outcome assessors to the allocated intervention, we were not able to describe any of the outcomes as high-certainty. We did not downgrade for indirectness as the study populations and types of interventions were consistent with our intended criteria. We evaluated the risk

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of publication bias for the critical outcome of failed intubation in all three comparisons, and found no reason to downgrade for this potential limitation following quantitative statistical analysis.

We downgraded for inconsistency when we noted substantial and considerable heterogeneity, which was particularly evident in measures of glottic view and time for tracheal intubation. The former is likely to be somewhat subjective as the outcome relies on an assessment by the intubator, while the latter included various timepoints in the definitions in different studies. We noted imprecision for the outcome of dental trauma, where event rates were very low, and we therefore downgraded our assessment of the certainty of evidence in this domain; this was evident across all three comparisons.

As previously pointed out by Downey 2021, there is considerable heterogeneity in the studies included in systematic reviews on airway management. The scope of this review, being inclusive but aiming to focus on higher-certainty evidence such as RCTs, does not do away with the above issue. We did, however, aim to decrease some observed heterogeneity by conducting separate comparisons for the three different VL designs.

Potential biases in the review process

The previous version of this review (Lewis 2016), did not include devices such as Airtraq and Truview EVO2/CPD because it was unclear whether these devices were used with video/camera attachment (Lewis 2016). Following post-publication feedback, we agreed to take a more inclusive approach to eligible devices in this update; we therefore included devices such as the Airtraq and Truview EVO2/CPD in this review. The exception to this is the Bullard VL, which we still excluded. The consensus in the review team was that the device was never part of routine clinical practice.

In order to address the differences between blade designs, we also presented data in the review according to three discrete categories of devices: Macintosh-style, hyperangulated, and channelled. We acknowledge that this represented an artificial construct and, at times, it was necessary for us to apply expert judgement to allocate a given design into a category. For example, we classified the Truview devices as hyperangulated. We recognized that these devices might not fit comfortably into this category, and we therefore performed a sensitivity analysis for the primary outcome; this did not alter our interpretation of the effect estimates. This categorization, however, would in theory improve the power of analysis for dichotomous outcomes, especially ones with low numbers of events. A drawback to our approach, as opposed to performing a network meta-analysis (NMA), is that this discards potential indirect evidence on which group of VLs might perform better than others.

We evaluated the decision to use three categories by performing an additional sensitivity analysis in which we grouped all studies together in a single analysis. We found reduced rates of failed intubation, hypoxaemia and oesophageal intubation and improved success on the first attempt at intubation with videolaryngoscopy. These sensitivity analyses seem to support the notion that videolaryngoscopy, in general, tends to have a more favourable risk and benefit profile for tracheal intubation. Specifically, we noted a robust effect estimate in favour of videolaryngoscopy for oesophageal intubation.

We also modified the definitions of some critical outcomes in this update, such as failed intubation and hypoxaemia. Previously, we adopted a study-centric approach and used the definitions presented by study author teams. In this update, we agreed a review-level definition of these outcomes and extracted data according to our definitions rather than study authors. Despite this change, we found that generally the extracted outcome data from studies was largely unchanged.

We found that establishing the experience of intubators was challenging. A number of studies reported intubators as experienced without quantifying the amount of experience. Others reported experience either in terms of years or number of prior uses of a given device. A study by Cortellazzi and colleagues showed that the number of intubations with a hyperangulated VL required for attaining a success rate of 90% by novice intubators was 75 (Cortellazzi 2015). We did not change the cut-off from the previous version of this review and kept it at 20 intubations prior to start of enrolment as it allowed to differentiate between complete novices and intubators with some expertise. We could not rule out the possibility that our thresholds for defining intubator experience introduced bias into this particular subgroup analysis; therefore, the results of the subgroup analyses presented in this review are applicable only according to our interpretation of experience as defined.

Agreements and disagreements with other studies or reviews

The systematic review of studies relevant to airway management published between 2006 and 2017 conducted by Ahmad and colleagues provides a convenient blueprint for comparisons of the landscape of airway management research (Ahmad 2019). We noted a generally similar distribution and frequency of reported outcomes in our review, with procedural success being the most commonly reported primary outcome. Ahmad 2019 noted that 90.8% of studies assessed airway management in the operating theatre environment, which is roughly in line with our finding of 21 studies (9.4%) conducted outside the theatre setting. A larger proportion of studies included non-expert intubators in the Ahmad 2019 review as compared to our review, but, to some extent, this can be explained by the inclusion of non-RCT studies and manikin studies, which are more likely to include non-expert intubators.

Since the advent of videolaryngoscopy at the turn of the century until the time of our updated review, 21 systematic reviews and meta-analyses have been published comparing videolaryngoscopy to direct laryngoscopy. These included a variety of study designs and VL designs, focusing on various different facets of the conduct of tracheal intubation. Downey 2021 provides the most recent summary of these reviews with a narrative summary of the findings. Downey and colleagues concluded that although most recently published meta-analyses suggest a superiority of VL to DL, many did not clearly offer meaningful information on which device design the findings pertain to. This, combined with a multitude of other sources of heterogeneity, in their view, limits the applicability of findings of meta-analyses to date. Our review addresses their concerns to some extent by conducting separate comparisons and analyses according to VL design.

In terms of findings, there is general agreement between the reviews to date that videolaryngoscopy improves intubation success rates across various settings, populations and users

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when compared to direct laryngoscopy (Arulkumaran 2018; Bhattacharjee 2018; De Jong 2014; Griesdale 2012b; Healy 2012; Hoshijima 2018a; Hoshijima 2018b; Liu 2018; Su 2011). Interestingly, in contrast to our findings, a number of systematic reviews noted no difference in their assessed primary outcomes, especially outside the operating theatre environment (Hoshijima 2014; Huang 2017; Jiang 2017; Zhao 2017). These were, however, limited by a small number of included studies or limited to one device type.

Our review is the largest systematic review of its kind to date, providing a comprehensive overview of relevant published RCTs along with an extensive summary of ongoing research in this domain. The findings of our meta-analyses are generally in keeping with the conclusions of previous reviews of similar design and add to the mounting evidence base on the improved safety and efficacy profile of videolaryngoscopy as compared to direct laryngoscopy across designs, populations, users and settings. It is worth noting, however, that our review design does not allow for comparisons between the various VLs, and it does not represent a head-to-head comparison of the three designs. We only present evidence for separate comparisons of the three designs to direct laryngoscopy.

AUTHORS' CONCLUSIONS

Implications for practice

This review examined the evidence from randomized controlled trials (RCTs) on the effects of three different types of videolaryngoscopes (VLs): Macintosh-style, hyperangulated and channelled, compared to direct laryngoscopy (DL) in adults undergoing tracheal intubation. We found evidence for all of our critical outcomes and most of our important outcomes.

We found moderate-certainty evidence that a Macintosh-style VL probably reduces rates of failed intubation and hypoxaemia. These devices may also increase rates of success on the first intubation attempt and probably improve glottic view. We found little or no difference in rates of oesophageal intubation but this finding was supported by low-certainty evidence.

We found moderate-certainty evidence that hyperangulated VLs probably reduce rates of failed intubation and oesophageal intubation. In subgroup analysis, we noted that hyperangulated VLs were more likely to reduce oesophageal intubation when used on known or predicted difficult airways. We also found that these devices may increase rates of success on the first intubation attempt, and the glottic view is probably also improved. However, we found low-certainty evidence of little or no difference in rates of hypoxaemia.

We found moderate-certainty evidence that channelled VLs probably reduce rates of failed intubation and hypoxaemia. They may also increase rates of success on the first intubation attempt and probably improve glottic view. We found little or no difference in rates of oesophageal intubation but this was supported by low-certainty evidence.

We were unsure of the findings for dental trauma because the certainty of the evidence was very low for all three VL designs. We were also not able to pool data for time required for tracheal intubation for any of the designs due to considerable heterogeneity.

We conclude that VLs of any of the three designs likely reduce rates of failed intubation with increased rates of successful intubation on the first attempt and better glottic views across patient groups and settings. Hyperangulated designs are likely favourable in terms of reducing the rate of oesophageal intubation, and result in improved rates of successful intubation in individuals presenting with difficult airway features.

Implications for research

There is ongoing interest in this topic in the field of airway device research, as evidenced by the 46 ongoing studies and 27 studies awaiting classification that may contribute data to future review updates. We encourage future investigators to address the limitations in the quality of evidence, focusing on high-quality study design with clear and complete reporting on methods of randomization, allocation concealment, and quantified intubator experience. If multi-arm studies are planned, a sensible approach would be to include representative devices from the three device categories as described in our review.

While our review addressed the issue of differential performance of the various VL designs, there is still considerable outstanding clinical heterogeneity when comparing the outlined interventions. This can be addressed with future reviews looking at specific groups of participants or settings. Specifically, more evidence on the relative effects of VLs in the intensive care unit, emergency department and prehospital setting would be helpful, and future studies in this domain should address the methodological drawbacks highlighted above. Furthermore, while not strictly within the scope of this review, studies looking at effective ways of teaching videolaryngoscopy and harmonising education across various skill groups of intubators would be encouraged.

We acknowledge the paucity of agreed core outcome sets in airway management research. This is reflected in the heterogeneity of outcomes reported across the various studies identified in the review process, and has been previously highlighted by Ahmad 2019. A set of core outcome measures developed through a validated process would be welcome to ensure appropriate selection of meaningful outcomes and allow for higher-quality summation of evidence. It is important to acknowledge that a number of the outcomes chosen in this review are surrogate markers of intubation success, without much direct bearing on patient outcomes.

We believe that our review presents a robust evidence base in favour of videolaryngoscopy across VL designs when compared to direct laryngoscopy. We expect that further expansions of this type of review design would not add much more to the certainty of evidence in this domain as most studies will have inherent design issues, notably the inability to blind intubators to the allocated device, disallowing us from reaching anything beyond moderate-certainty evidence for the main outcomes. Future systematic reviews will need to address new device designs entering the market and consider comparing various VL designs to each other, as opposed to direct laryngoscopy. A network meta-analysis comparing the three VL categories would present a further avenue of future research.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Abdallah 2011

Study characteristics

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Abdallah 2011 *(Continued)*

Methods	RCT; parallel design
Participants	**Total number of participants:** 99 **Country:** USA **Setting:** theatre; single centre **Inclusion criteria:** BMI between 30 and 50 kg/m^2; orotracheal intubation required for elective surgery **Exclusion criteria**: no details **Baseline characteristics:** **Pentax AWS** • Age, mean (SD): 50 (± 12) years • Gender M/F, n: 11/39 • BMI, mean (SD): 41.2 (± 4.4) kg/m^2 • ASA I/II/III/IV, n: 0/15/32/3 • Mallampati 1/2/3/4, n: 21/18/7/4 **Macintosh** • Age, mean (SD): 49 (± 14) years • Gender M/F, n: 10/39 • BMI, mean (SD): 42.5 (± 5.9) kg/m^2 • ASA I/II/III/IV, n: 0/7/40/2 • Mallampati 1/2/3/4, n: 14/21/13/0 Notes: more women than men in each group. More ASA II in Pentax group, more ASA III in Macintosh group. More Mallampati scores of 1 in Pentax group, more Mallampati scores of 2 in Macintosh group
Interventions	**General details:** study did not report experience of intubator or use of additional equipment **Pentax AWS:** • Analysed = 50 **Macintosh:** • Analysed = 49 • #4 blade **VL classification**: channelled Notes: 105 patients were randomized. A total of 6 participants were excluded from the study after randomization (4 due to cancellation of surgery or list delays and 2 in the Pentax group had missing primary outcomes). The number of excluded participants from each group was not specified.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Number of attempts: 1-3 • Patient-reported sore throat • CL grade: reported with CL 1 and 2: grouped as good; CL 3 and 4: grouped as poor. Data not extracted for this outcome. **Continuous outcomes**

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Abdallah 2011 *(Continued)*

- Time for tracheal intubation: defined as time from start of first attempt of insertion of laryngoscope until a capnogram signal was obtained. No evidence of a learning curve on time to intubation with the Pentax AWS based on analysis of sequence quartiles

Notes: ease of intubation on a scale of 0-100 (0 as easiest) was also recorded. This was not an outcome of interest to our review.

Notes	**Funding/sponsor/declarations of interest**: supported by internal funds; Pentax on loan from manufacturers for duration of the study **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was based on computer-generated, random-block codes"
Allocation concealment (selection bias)	Low risk	"Sequentially numbered opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"It was impossible to blind the operator to the device being used"
Blinding of outcome assessment (detection bias) All outcomes	High risk	Observers who looked at blood staining and postoperative sore throat were blinded to group allocation. However, it was not possible to blind outcome assessors to primary outcomes.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	"Of 105 randomized patients, 4 did not complete the study because of cancellation of surgery or because the laryngoscopist could not arrive to the operating room on time, and 2 patients in the Pentax group had missing primary outcomes"
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to make a judgement about selective reporting without these documents
Experience of intubator	High risk	"All patients' tracheas were intubated by 1 of 2 attending anesthesiologists, each of whom had previously used the Pentax AWS 5 to 10 times before the study began" It is likely that the balance of experience will favour the Macintosh group.

Abdallah 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** Egypt **Setting**: theatre; single centre

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Abdallah 2019 *(Continued)*

Inclusion criteria: age 18-60, ASA I or II, no criteria for suspected difficult intubation, scheduled for various types of non-ophthalmic elective surgery requiring orotracheal intubation

Exclusion criteria: raised IOP or ICP, need for RSI, aspiration risk, suspicion or history of difficult intubation, C-spine pathology, BMI ≥ 35 kg/m^2, cardiovascular, hyperreactive airway disease, and/or on β-blocker therapy

Baseline characteristics

Airtraq

- Age, mean (SD): 40.43 (± 9.93) years
- Gender M/F, n: 19/16
- Weight, mean (SD): 69.50 (± 13.18) kg
- Height, mean (SD): 1.64 (± 0.05) m
- ASA I/II/III/IV, n: 23/12/0/0

Macintosh

- Age, mean (SD): 41.62 (± 5.22) years
- Gender M/F, n: 22/13
- Weight, mean (SD): 68.15 (± 11.11) kg
- Height, mean (SD): 1.66 (± 0.04) m
- ASA I/II/III/IV, n: 22/13/0/0

Notes: no significant differences in group demographics

Interventions

General details: single intubator, > 8 years' clinical experience with both devices

Airtraq

- Randomized = 35; no losses; analysed = 35

Macintosh

- Randomized = 35; no losses; analysed = 35
- #3 or #4 blade, size used at discretion of intubator

VL classification: channelled

Notes: authors report the use of gum-elastic bougie

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: an intubation attempt was considered a failed one when it reached 60 s duration without correct placement of the tracheal tube.
- Number of attempts
- Successful first attempt: correct placement of the tracheal tube within the first 60 s
- Airway trauma: reported blood staining on laryngoscope blade only. Dental trauma not reported therefore no data extracted for this outcome
- Patient-reported sore throat
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: time from inserting the laryngoscope between the central incisors until confirmed vision of tracheal tube passage between the vocal cords
- POGO score: a 100% POGO score is a full view of the glottis from the anterior commissure to the interarytenoid notch. A POGO score of 0 means that even the interarytenoid notch is not seen.

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Abdallah 2019 *(Continued)*

	Notes: any need for assistance during laryngoscopy and intubation was recorded.
Notes	**Funding/sponsor/declarations of interest**: study authors received no funding, and declare no conflicts of interest. **Study dates:** September 2017–February 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Randomization codes were concealed in closed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unblinded, outcomes assessed by intubator performing intervention or ophthalmologist measuring IOP immediately after intubation
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (PACTR201708002460428). Trial registered prospectively and all prespecified outcomes reported
Experience of intubator	Low risk	> 8 years' experience with both devices. Single intubator

Abdelgalel 2018

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Egypt **Setting:** ICU; single centre **Inclusion criteria:** patients aged ≥ 18 years, ASA III and IV, requiring emergency intubation on ICU **Exclusion criteria**: cardiac arrest, severe oxygen desaturation (SpO_2 < 80%), patients with diagnosed or predicted C-spine injury **Baseline characteristics** **GlideScope** • Age, mean (SD): 44.34 (± 13.40) years • Gender M/F, n: 27/13

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Abdelgalel 2018 *(Continued)*

- BMI, mean (SD): 25.65 (± 5.34) kg/m^2

Airtraq

- Age, mean (SD): 41.96 (± 15.27) years
- Gender M/F, n: 25/15
- BMI, mean (SD): 24.82 (± 4.65) kg/m^2

Macintosh

- Age, mean (SD): 42.19 (± 13.52) years
- Gender M/F, n: 26/14
- BMI, mean (SD): 26.57 (± 4.86) kg/m^2

Notes: the authors also reported APACHE scores for all groups.

Interventions	**General details**: intubation was performed by an ICU physician with > 3 years of experience in anaesthesia and intensive care and who had performed > 30 intubations with Airtraq and GlideScope each. A stylet was used for all intubations. **GlideScope** • Randomized = 40; no losses; analysed = 40 **Airtraq** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated (GlideScope), channelled (Airtraq)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failed tracheal intubation is defined as failure to intubate the patient after 3 attempts using the same laryngoscope. • Hypoxia • Number of attempts • Airway trauma: dental injury • CL grade • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: the duration of intubation is defined as the time from when laryngoscope was first inserted into the patient's mouth until the appearance of the first capnography wave. Notes: • an attempt is defined as an introduction of the laryngoscope into the mouth and its removal regardless of whether a tracheal tube was inserted or not. If the oxygen saturation dropped below 90% the attempt was terminated and considered as a failed attempt • study authors also reported lip injury and oropharyngeal injury. We did not include these data in analyses to avoid a unit of analysis error
Notes	**Funding/sponsor/declarations of interest:** study authors report that they received no funding, and there were no conflicts of interest.

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Abdelgalel 2018 *(Continued)*

Study dates: April 2016–December 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer generated random numbers"
Allocation concealment (selection bias)	Low risk	"Sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Intubators had > 3 years' anaesthesia experience, with > 30 intubations with each device. The experience of the intubating physician was more with Macintosh laryngoscopy compared to Airtraq and GlideScope as it is more frequently used in routine practice, but this was the same for all the physicians that participated in the study.

Abdelgawad 2015

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** China **Setting:** theatre; single centre **Inclusion criteria**: normotensive and hypertensive patients, ASA Ⅰ or Ⅱ, aged 20–70 years, admitted to undergo elective surgery under GA requiring tracheal intubation **Exclusion criteria**: cardiac and thoracic operations, Mallampati class 3 or 4, mouth opening < 4 cm, thyromental distance < 6 cm, a history of documented difficult airway and restricted neck mobility, atrio-ventricular block more than first degree, HR < 50 beats/min, SBP < 80 mmHg on arrival to theatre, uncontrolled hypertension, history of drug allergy, asthma, chronic obstructive pulmonary disease, renal dysfunction, active liver disease and psychiatric illness **Baseline characteristics**

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Abdelgawad 2015 *(Continued)*

UEScope

- Age, mean (SD): 49 (± 19.97) years
- Gender M/F, n: 17/23
- ASA I/II/III/IV: 19/21/0/0

Macintosh

- Age, mean (SD): 52.4 (± 15.91) years
- Gender M/F, n: 21/91
- ASA I/II/III/IV: 5/35/0/0

Notes: the study authors performed a parallel-design RCT with 2 patient groups (hypertensive and normotensive), with 60 patients in each, and then randomized patients within these 2 groups into 3 intervention arms. For the purposes of this review we combined the respective intervention arm data from the hypertensive and the normotensive cohorts (Higgins 2021).

There were significantly more ASA II patients in the control arm. We include only 80 patients in this review, as the third intervention arm, assessing a video-stylet device, was not relevant to the review.

Interventions

General details: tracheal intubation was conducted by a single anaesthetist with sufficient experience in the use of all devices as per the authors. They do not define this experience further. A stylet was used for all intubations.

UEScope

- Randomized = 40; no losses; analysed = 40
- #3 blade

Macintosh

- Randomized = 40; no losses; analysed = 40
- #3 blade

VL classification: hyperangulated

Notes: the study included a third intervention arm - the UE video intubation stylet - which we did not include in the review because it is not classified as a VL.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: failed intubation was defined as an intubation time > 40 s, oesophageal intubation or > 2 attempts of intubation
- Number of attempts
- Airway trauma: detection of blood drops in the mouth, lip or the tube after removal. Dental trauma was not reported and therefore no data were extracted for this outcome
- Patient-reported sore throat: assessed by asking about sore throat and hoarseness 24 h after surgery using an established 4-point scale (none, mild, moderate, severe).
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: time from insertion of the intubation device into the mouth to capnographic confirmation.

Notes: the study authors also reported haemodynamic outcomes, such as change in HR, BP and cardiac output, which were not relevant to this review.

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Abdelgawad 2015 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** no external funding or competing interests were declared. The VLs used in this study were provided by Unremitting Efforts, Zhejiang UE Medical Corporation Xianju, Taizhou, China, with no charge. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The 120 patients were randomly divided into 6 groups (n=20 each) according to the used device for tracheal intubation by using random number tables"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to blind certain outcomes - e.g. CL grade, intubation attempts. No specific comments regarding blinding of outcome assessors for outcomes such as BP measurement or patient reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not feasible to make a judgement about selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single intubator performing all intubations, experience defined as sufficient, but not explicitly reported.

Acarel 2018

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Turkey **Setting:** theatre; single-centre **Inclusion criteria:** patients aged 18-65, Mallampati 1 and 2 **Exclusion criteria:** age < 18 or > 65, Mallampati classification 3 and 4, thyromental distance < 6 cm, BMI > 35 kg/m^2, deformity in face and neck tissues, coagulation disorders, significant heart, kidney, neurological and psychiatric diseases **Baseline characteristics** **Airtraq** • Age, mean (SD): 35.67 (± 12.55) years

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Acarel 2018 *(Continued)*

	• Gender M/F, n: 9/18 • Weight, mean (SD): 70.15 (± 16.55) kg • Height, mean (SD): 1.68 (± 0.10) m • BMI, mean (SD): 24.71 (± 4.91) kg/m^2 • Mallampati 1/2/3/4: 24/3/0/0 **Macintosh** • Age, mean (SD): 36.7 (± 12.02) years • Gender M/F, n: 14/14 • Weight, mean (SD): 73.29 (± 11.93) kg • Height, mean (SD): 1.69 (± 0.09) m • BMI, mean (SD): 25.69 (± 4.19) kg/m^2 • Mallampati 1/2/3/4: 23/5/0/0 Notes: more women in Airtraq group
Interventions	**General details:** all intubations performed by the same anaesthetist, having performed > 20 intubations with an Airtraq laryngoscope and > 1000 intubations with a DL **Airtraq** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 • #3 blade **VL classification**: channelled Notes: significant difference in experience with DL versus VL devices, but still above the threshold of 20 intubations to define as experienced
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts • Oesophageal intubation Notes: study authors report haemodynamic parameters such as changes in HR and BP, which were not relevant to this review. Failed intubation is not explicitly defined.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified
Allocation concealment (selection bias)	Unclear risk	Not specified

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Acarel 2018 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not reported
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	> 1000 intubations with Macintosh, 20 intubations with VL only. High risk of bias due to disparity in experience with each device.

Aggarwal 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 150 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** patients scheduled for elective surgery aged 25-60 years, ASA I and II **Exclusion criteria:** patients with thyromental distance < 6 cm, Mallampati Grade ≥ 3, BMI > 30 kg/m^2, ASA > III, pregnant women **Baseline characteristics** **C-MAC** • Age, mean (SD): 34.11 (± 4.22) years • Gender M/F, n: 23/27 • BMI, mean (SD): 23.31 (± 2.57) kg/m^2 • ASA I/II/III/IV, n: 26/24/0/0 • Mallampati 1/2/3/4, n: 23/27/0/0 **Macintosh** • Age, mean (SD): 33.05 (± 5.12) years • Gender M/F, n: 22/28 • BMI, mean (SD): 22.71 (± 2.73) kg/m^2 • ASA I/II/III/IV, n: 26/24/0/0 • Mallampati 1/2/3/4, n: 23/27/0/0 Notes: this was a 3-arm study with a McCoy laryngoscope as the third intervention. The McCoy laryngoscope is not eligible for this review and we have therefore not included it.

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Aggarwal 2019 *(Continued)*

Interventions	**General details:** laryngoscopy and intubations were performed by an anaesthetist who was familiar and trained with intubation using Macintosh, McCoy, and C-MAC laryngoscope. It is not clear how much experience the intubator had. **C-MAC** • Randomized = 50; no losses; analysed = 50 • #3 or #4 blade **Macintosh** • Randomized = 50; no losses, analysed = 50 • #3 or #4 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failure to intubation was defined as failure after 3 attempts. • Airway trauma: only local injury and bleeding reported. Dental trauma data not available therefore outcome not included in the meta-analysis. • CL grade **Continuous outcomes** • Time for tracheal intubation: time from the time the instrument is inserted in mouth to confirmation by capnography. It was noted using a stopwatch. Notes: the study authors also reported haemodynamic endpoints, such as change in HR and BP. These were not relevant to the review.
Notes	**Funding/sponsor/declarations of interest**: the study authors reported no funding and declared no conflicts of interest. **Study dates:** June 2015–October 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	"Sealed envelope technique was used for group allocation and persons recording observations was unconnected to the study"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident

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Aggarwal 2019 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	A prepublished protocol was not available for this study. It is not possible to make a judgement on selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Laryngoscopy and intubations were performed by an anesthesiologist who was familiar and trained with intubation using Macintosh, McCoy, and C-MAC laryngoscope." Unclear how much experience

Agrawal 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** patients aged 18-60 years, ASA I and II, scheduled for elective surgery under GA requiring tracheal intubation **Exclusion criteria:** patients with anticipated difficult airway; modified Mallampati class 3 and 4, thyromental distance < 6 cm, inter incisor distance < 3.5 cm, BMI > 35 kg/m^2, restricted subluxation of the mandible and with oropharyngeal or C-spine pathology, pregnant patients and patients with haemodynamic or pulmonary compromise **Baseline characteristics** **C-MAC D-BLADE** • Age, mean (SD): 35 (± 10.4) years • Gender M/F, n: 19/21 • BMI, mean (SD): 21.74 (± 3.7) kg/m^2 • ASA I/II/III/IV, n: 30/10/0/0 • Mallampati 1/2/3/4, n: 27/13/0/0 **Macintosh** • Age, mean (SD): 33.8 (± 10.72) years • Gender M/F, n: 22/18 • BMI, mean (SD): 22.31 (± 3.2) kg/m^2 • ASA I/II/III/IV, n: 28/12/0/0 • Mallampati 1/2/3/4, n: 26/14/0/0
Interventions	**General details:** all intubations were performed by the same anaesthetist who had the experience of performing at least 50 successful intubations in patients with C-MAC D-BLADE. The tube was moulded with a stylet along the curvature of the CMAC D-BLADE (accentuated C-shaped stylet) and kept ready before laryngoscopy. For intubation with a Macintosh laryngoscope, a hockey shaped styletted tube was used. **C-MAC D-BLADE** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized n = 40; no losses; analysed = 40

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Agrawal 2020 *(Continued)*

	• #3 blade **VL classification:** hyperangulated Notes: all participants had MILS applied
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: unsuccessful intubation was defined as the inability to intubate in 120 s in 2 attempts. In such cases, MILS was abandoned, and the participant was intubated by the anaesthetist using a device of personal choice • Number of attempts • CL grade: 1-4 **Continuous outcomes** • IDS Notes: the time for tracheal intubation was quoted in the study as median (IQR). We excluded it from this review for this reason because a normal distribution cannot be assumed and therefore can not be converted to mean (SD).
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Patients were randomly allocated to two groups of 40 each using block randomization in a series of blocks of 10"
Allocation concealment (selection bias)	Low risk	"Allocation concealed in sealed envelopes which were opened just before the start of anesthesia." Well described allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	"All the observations except for modified Cormack and Lehane grading (in group M) and ease of insertion of the device were recorded by an independent observer who was not involved in the study any further."
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Unclear risk	According to registration document, retrospective registration with Clinical Trials Registry India (CTRI/2018/04/012941). A statement in the manuscript indicates prospective registration. Risk of bias is not clear

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Agrawal 2020 *(Continued)*

Experience of intubator	Low risk	"All intubations were performed by the same anesthesiologist (N.A.) who had the experience of performing at least 50 successful intubations in patients with C-MAC D-Blade."

Ahmad 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 50 **Country:** Saudi Arabia **Setting:** theatre; single centre **Inclusion criteria:** patients with normal IOP, for opthalmic surgery requiring tracheal intubation **Exclusion criteria:** not reported **Baseline characteristics** **GlideScope** • Age, mean (SD): 27.12 (± 9.33) years • Gender M/F, n: 14/11 • Weight, mean (SD): 73.23 (± 20.05) kg • Height, mean (SD): 1.63 (± 0.1) m • ASA I/II/III/IV, n: 16/9/0/0 **Macintosh** • Age, mean (SD): 25.96 (± 7.96) years • Gender M/F, n: 18/7 • Weight, mean (SD): 68.91 (± 16.51) kg • Height, mean (SD): 1.64 (± 0.11) m • ASA I/II/III/IV, n: 19/6/0/0
Interventions	**General details:** experience of intubator not quantified, noted to be experienced **GlideScope** • Randomized = 25; no losses; analysed = 25 **Macintosh** • Randomized = 25; no losses; analysed = 25 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Number of attempts **Continuous outcomes** • Time for tracheal intubation: not explicitly defined

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Ahmad 2015 *(Continued)*

	The study authors report IOP measurements as their primary outcome, but the only outcome relevant to this review is the time required for tracheal intubation and first pass success.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to assess selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single intubator, experienced in both techniques. Experience not further quantified

Ahmadi 2015

Study characteristics

Methods	Quasi-RCT; parallel design
Participants	**Total number of participants:** 97 **Country:** Iran **Setting:** ED; single centre **Inclusion criteria**: need for emergency intubation **Exclusion criteria:** patients with apnoea and cardiopulmonary arrest; failure to accurately record the intubation time; patients who were intubated by first-year emergency medicine resident or other individual **Baseline characteristics** **GlideScope**

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Ahmadi 2015 *(Continued)*

- Age, mean (SD): 52.3 (± 14.05) years
- Gender M/F, n: 29/20
- BMI, mean (SD): 22.1 (± 4.68) kg/m^2

Macintosh

- Age, mean (SD): 49.1 (± 12.49) years
- Gender M/F, n: 35/13
- BMI, mean (SD): 23.8 (± 5.17) kg/m^2

Notes: the study authors state: "Since this study was performed in an emergency situation, there was no possibility to randomly divide the patients into two groups of video laryngoscopy and DL; therefore the patients were divided as non-randomized."

The patients were divided into groups of difficult and easy airway based on a predefined set of criteria, following which the decision was made about the method of intubation.

Any of the following criteria was considered a difficult airway: reduced neck extension either pathological or due to immobilization (< 80° from neck flexion); decreased interincisor distance (< 3 fingers); short thyromental distance (< 6 cm); Mallampati score 3 or 4; airway obstruction

We combined population variables from the difficult and easy airway groups; for variables reported as mean (SD) we re-calculated these data according to Higgins 2021.

Interventions	**General details**: all patients were intubated by 3rd or 4th year emergency medicine residents. In case of failed intubation, patients were intubated by a specialist. A flexible stylet was used in all cases. **GlideScope** • Randomized = 49; no apparent losses; analysed = 49 • #4 blade **Macintosh** • Randomized = 48; no apparent losses; analysed = 48 • #3 and #4 blade **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as oesophageal intubation, changing to a different device or physician, inability to place tracheal tube after 3 attempts • Number of attempts **Continuous outcomes** • Time for tracheal intubation: defined as the time interval between placing the laryngoscope into the mouth and inserting the intubation tube to the vocal cords Notes: outcome variables were combined from the difficult and easy airway groups based on laryngoscope type, for outcomes reported as mean (SD) they were calculated as per Higgins 2021.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** January–December 2011
Risk of bias	

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Ahmadi 2015 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"Method of sampling was alternate randomized with Macintosh Laryngoscope and GlideScope Video Laryngoscope". Non-randomized sequence generation
Allocation concealment (selection bias)	High risk	No concealment possible with selected allocation method
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of outcome assessors not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Some attrition, which is not accounted for in the manuscript
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Year 3 or 4 emergency medicine residents performed all intubations. Relative experience with each device not specified

Akbar 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** Malaysia **Setting:** theatre; single centre **Inclusion criteria:** patients aged 18-60 years old, ASA I-II, scheduled for elective surgery under GA that required tracheal intubation **Exclusion criteria:** predicted difficult airway (Mallampati > 3, thyromental distance < 6 cm, BMI > 35 kg/m^2), pregnant, or other conditions associated with an increased risk of pulmonary aspiration, patients with cervical neck pathologies, hypertensive patients, allergies or contraindications to GA **Baseline characteristics** **C-MAC** • Age, mean (SD): 40.8 (± 15.1) years • Gender M/F, n: 23/22 • BMI, mean (SD): 26.2 (± 4.7) kg/m^2 • ASA I/II/III/IV, n: 30/15/0/0

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Akbar 2015 *(Continued)*

- Mallampati 1/2/3/4, n: 25/20/0/0

Macintosh

- Age, mean (SD): 41.6 (± 14.8) years
- Gender M/F, n: 21/24
- BMI, mean (SD): 26.9 (± 3.7) kg/m^2
- ASA I/II/III/IV, n: 32/13/0/0
- Mallampati 1/2/3/4, n: 22/23/0/0

Notes: all patients had MILS applied on induction

Interventions	**General details:** all intubations were performed by the investigator, an anaesthesia trainee whose previous experience includes > 30 intubations with the C-MAC and > 5 years' frequent use of the Macintosh laryngoscope. Any additional instruments to aid intubation were used if deemed necessary. These were reported as outcomes. **C-MAC** • Randomized = 45; no apparent losses; analysed = 45 • #3 blade **Macintosh** • Randomized = 45; no apparent losses; analysed = 45 • #3 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure after 3 attempts at intubation, > 3 min, or desaturation to SpO_2 < 92% • Hypoxia: defined as SpO_2 < 92% • Number of attempts • Airway trauma: dental trauma data only extracted • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as time from passage of laryngoscope past the lips to the first rise of the capnograph trace. Notes: study authors also reported lip trauma; we did not include these with data for other airway trauma (dental trauma) in order to avoid a unit of analysis error. Study authors also report haemodynamic outcomes, such as change in HR and BP.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

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Akbar 2015 *(Continued)*

Random sequence generation (selection bias)	Low risk	Random number generation (computer-generated)
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant attrition or incomplete data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	> 5 years' frequent use of Macintosh laryngoscope, > 30 intubations with C-MAC. Single intubator

Akbarzadeh 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 68 **Country:** Iran **Setting:** theatre; single centre **Inclusion criteria:** ASA I or II; BMI > 30 kg/m^2; elective surgical patients requiring intubation **Exclusion criteria:** patients with renal insufficiency (creatinine level of > 1.5 mg/dL) and impaired liver function (aspartate aminotransferase (AST) level of > 40 U/L and alanine aminotransferase (ALT) level of > 40 U/L) due to airway oedema or intubation delay problems; ischaemic or valvular heart disease; airway trauma; abscess or lump in the neck or throat; oropharyngeal masses (neck, pharynx, or larynx); coagulopathy **Baseline characteristics** **GlideScope** • Age, mean (SD): 46.55 (± 10.55) years • Gender M/F, n: 16/18 • BMI, mean (SD): 34.64 (± 1.75) kg/m^2 **Macintosh** • Age, mean (SD): 46.52 (± 11.09) years • Gender M/F, n: 17/17

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Akbarzadeh 2017 *(Continued)*

- BMI, mean (SD): 34.63 (± 2.02) kg/m^2

Notes: the population is obese.

The study includes a third comparison arm (McCoy), which we did not include in the review because it is not eligible

Interventions	**General details:** the experience of the single intubator is not reported. Use of additional equipment not reported **GlideScope** • Randomized = 34; no apparent losses; analysed = 34 **Macintosh** • Randomized = 34; no apparent losses; analysed = 34 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: data not extracted for use in meta-analysis **Continuous outcomes** • Time for tracheal intubation: time from entry of the laryngoscope into the mouth until tube insertion • POGO score: the POGO represents the POGO observed, defined by the linear span from the anterior commissure to the interarytenoid notch. A 100% POGO is a full view of the glottis from the anterior commissure to the interarytenoid notch. A POGO of 0 means that even the interarytenoid notch is not seen. Notes: we did not include data for the CL grade because this was reported in the study as mean (SD) rather than categorical values (I-IV). Similarly, we did not include data for intubation success rate, which was reported without data and described as being not significantly different.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Low risk	Numbered envelopes, which we assumed were sealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants were blind to their groupings, but blinding of the anaesthetist was not possible.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors

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Akbarzadeh 2017 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single intubator, no mention of prior experience with each device.

Aleksandrowicz 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Poland **Setting:** theatre; single centre **Inclusion criteria:** ASA I and II patients requiring elective tracheal intubation **Exclusion criteria:** predictors of difficult airway **Baseline characteristics:** no baseline characteristics reported and no statement indicating balanced characteristics between groups. Patients had MILS applied
Interventions	**General details:** 10 senior (consultant) anaesthetists participated in this study. Their experience varied between 6 and 10 years of clinical practice after completion of anaesthetic training. **King Vision** • Randomized = 20; no apparent losses; analysed = 20 **Macintosh** • Randomized = 20; no apparent losses; analysed = 20 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation **Continuous outcomes** • Time for tracheal intubation: the time of intubation was measured from the beginning of the procedure until the tube was placed in the trachea and the intubation device was removed. Notes: limited description of outcomes reported. A maximum of 2 intubation attempts with the evaluated devices was permitted. Study states, "100% intubation success rate with the KingVision video-laryngoscope compared with 75% for the Macintosh". Therefore, failed intubation rate of 25% in Macintosh group assumed. 1st and 2nd pass success not specified separately.

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Aleksandrowicz 2018 *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** study authors declare that they received no financial support or sponsorship and that they have no conflicts of interest. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomisation scheme involved the use of 10 variable digit tables prepared before the study with a 50% chance of selecting either device"
Allocation concealment (selection bias)	High risk	Open random allocation table
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient detail to make judgement. We assumed no losses in our analyses.
Selective reporting (reporting bias)	Unclear risk	It was not possible to obtain the study protocol. Without these documents it is not possible to make a judgement about selective reporting bias.
Experience of intubator	Unclear risk	"Ten senior (consultant) anaesthetists participated in this study." No specific mention of prior experience with given VL device, but all intubators experienced overall.

Al-Ghamdi 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 86 **Country:** Saudi Arabia **Setting:** theatre; single centre **Inclusion criteria:** patients aged 18-65 years; ASA I-II; scheduled for elective surgery and whose anaesthesia plan included routine orotracheal intubation **Exclusion criteria:** patients with an anticipated or known difficult intubation such as history of C-spine injury or surgery; limited neck mobility; previous oral or throat surgery or difficult direct laryngoscopy; a BMI > 35 kg/m^2; missing incisor teeth; unstable hypertension; asthma; if a RSI was indicated **Baseline characteristics** **Macintosh**

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Al-Ghamdi 2016 *(Continued)*

- Age, mean (SD): 31.4 (± 8.96) years
- Gender M/F, n: 8/14
- Weight, mean (SD): 74.6 (± 7.84) kg
- Height, mean (SD): 1.65 (± 0.07) m
- ASA I/II/III/IV, n: 7/15/0/0
- Mallampati 1/2/3/4, n: 13/9/0/0

GlideScope

- Age, mean (SD): 31.6 (± 11.83) years
- Gender M/F, n: 9/12
- Weight, mean (SD): 75.7 (± 10.31) kg
- Height, mean (SD): 1.66 (± 0.07) m
- ASA I/II/III/IV, n: 9/12/0/0
- Mallampati 1/2/3/4, n: 10/11/0/0

Airtraq

- Age, mean (SD): 34.5 (± 10.43) years
- Gender M/F, n: 10/11
- Weight, mean (SD): 74.5 (± 10.20) kg
- Height, mean (SD): 1.66 (± 0.07) m
- ASA I/II/III/IV, n: 8/13/0/0
- Mallampati 1/2/3/4, n: 11/10/0/0

King Vision

- Age, mean (SD): 34.3 (± 10.57) years
- Gender M/F, n: 10/12
- Weight, mean (SD): 78.1 (± 10.94) kg
- Height, mean (SD): 1.67 (± 0.06) m
- ASA I/II/III/IV, n: 12/10/0/0
- Mallampati 1/2/3/4, n: 12/10/0/0

Interventions

General details: all participants were intubated by one of 25 staff anaesthetists with prior experience using the Macintosh laryngoscope, but variable prior experience with the VLs (see notes). All intubators were exposed to a simulation session where they had an opportunity to practice intubation with the given device up to 10 times on a manikin.

Intubators were allowed to use any manoeuvre they would normally use to navigate the tracheal tube into the trachea including readjustment of head position, the blade or the tracheal tube, or to ask the supervising investigator to perform external laryngeal manipulation. Any cases of an unexpected difficult airway were excluded from the study.

Macintosh

- Randomized = 22; no losses; analysed = 22
- #3 or #4 blade

GlideScope

- Randomized = 21; no losses; analysed = 21
- #3 or #4 blade

Airtraq

- Randomized = 21; no losses; analysed = 21
- #3 blade

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Al-Ghamdi 2016 *(Continued)*

King Vision

- Randomized = 22; no losses; analysed = 22
- #3 blade

VL classification: hyperangulated, channelled

Notes: the King Vision device was used with the channelled blade. The Airtraq is a channelled device and the GlideScope is a hyperangulated VL.

In the CONSORT flow diagram there was a discrepancy between the number randomized (n = 22) and the number analysed (n = 21) in the Airtraq group. The flow diagram indicated no losses from the group. Based on the reported overall number of patients randomized (n = 86) it is likely the Airtraq "randomized" value is a typographical error.

The study also presents a table with anaesthetists' prior experience with a given device. All anaesthetists in the Macintosh group had used it > 15 times before. In the GlideScope group, 20 anaesthetists had > 15 uses, while 2 and 3 had 5-15 and < 5 uses respectively. In the Airtraq group 22 anaesthetists had used it < 5 times before, while only 3 had used it 5-15 times. In the King Vision group 16 anaesthetists had used it < 5 times before, while 6 and 3 had 5-15 and > 15 prior uses respectively.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: the laryngoscopy attempt was considered a failure if intubation took > 120 s, or if oxygen desaturation noted on the pulse oximeter, defined as SpO_2 < 92%. A second attempt was allowed with the allocated device. For patient safety, the failed second attempt was subsequently managed at the discretion of the supervising investigator with any device.
- Number of attempts
- Airway trauma: defined as any blood trace on the device or mucosa, or injury to the lips or teeth. We extracted only dental trauma data for inclusion in our analysis.
- Patient-reported sore throat: graded using a VAS ranging from 0-10 (0: none, 1-3: mild, 4-6: moderate, and 7-10: severe)
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as the time when the investigated laryngoscope passes the central incisors to when the tip of the tracheal tube passed through the glottis

Notes: we combined the outcomes for King Vision and Airtraq in analyses because both were channelled devices. Where continuous data were combined it was done so as per Higgins 2021.

Time to intubation presented only in graph form, therefore we were unable to extract mean (SD) from this study. The study did report time of laryngoscopy as well, but this was defined differently to time to intubation.

Notes

Funding/sponsor/declarations of interest: Mohamed R. El Tahan received free airway device samples from Ambu in April 2014 and Airtraq in 2015 for use in other studies and has no direct financial or other interest in Ambu or Airtraq. All other authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization code

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Al-Ghamdi 2016 *(Continued)*

Allocation concealment (selection bias)	Low risk	Sealed envelopes used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators. All laryngoscopes were present inside the operating room for each participant in an effort to minimize risk of bias.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors for most outcomes. An independent assessor collected data such as time to intubation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants lost to follow-up
Selective reporting (reporting bias)	Low risk	Study protocol reviewed (NCT01914523), prepublished, all outcomes reported
Experience of intubator	High risk	All intubations were performed by 25 anaesthetists without prior experience with a given VL. All anaesthetists had significant prior experience with Macintosh laryngoscopy. They were all exposed to a training session on manikins where they performed 10 intubations with the allocated device, prior to the clinical intubations studied.

Ali 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting**: theatre; single centre **Inclusion criteria:** Adult ASA I-II patients with cervical trauma undergoing elective cervical surgery requiring GA and tracheal intubation **Exclusion criteria:** patients with increased risk of pulmonary aspiration, history of difficult intubation, or anticipated airway difficulties **Baseline characteristics:** **King Vision** • Age, mean (SD): 38.26 (± 11.38) years • Gender M/F, n: 25/5 • BMI, mean (SD): 23.19 (± 2.27) kg/m^2 • ASA I/II/III/IV, n: 22/8/0/0 • Mallampati 1/2/3/4, n: 12/11/3/4 **Macintosh** • Age, mean (SD): 37.56 (± 8.24) years • Gender M/F, n: 26/4

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Ali 2017 *(Continued)*

- BMI, mean (SD): 24.61 (± 1.21) kg/m^2
- ASA I/II/III/IV, n: 26/4/0/0
- Mallampati 1/2/3/4, n: 22/6/2/0

Notes: included patients all had cervical trauma requiring MILS. The study includes a third comparison arm (McCoy), which we did not include in the review because it is not eligible.

Interventions	**General details**: single intubator, anaesthetist with previous experience with > 20 intubations with each device. Use of stylet or laryngeal manipulation was allowed. **King Vision** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification**: channelled Notes: King Vision VL device was used with the channelled blade.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: tracheal intubation was considered a failure if it could not be accomplished in 3 attempts • Hypoxia • Number of attempts • Airway trauma: mucosal trauma or dental injury. Only dental trauma data extracted for inclusion in the meta-analysis • CL grade: 1-4 • IDS: 0 = easy, 1-5 = slight difficulty, > 5 = major difficulty in intubation • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: the time from insertion of the laryngoscope to confirmation of intubation by capnography • POGO score: 0%-100%, 100 = full view of glottis from anterior commissure to the interarytenoid notch, 0 = even interarytenoid notch is not seen Note: study authors also reported mucosal trauma; we did not include these data with data for 'airway trauma' in order to avoid a unit of analysis error.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated codes"
Allocation concealment (selection bias)	Low risk	"Sequentially numbered opaque envelopes"

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Ali 2017 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of participants noted
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not feasible to assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Single intubator, > 20 previous intubations with each device

Altaiee 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Iraq **Setting**: theatre; single centre **Inclusion criteria:** patients aged 18-65 years, ASA I-II, undergoing elective surgery under GA requiring routine orotracheal intubation **Exclusion criteria**: patient refusal or any expected difficulty with intubation **Baseline characteristics** **McGrath MAC** • Age, mean (SD): 31.96 (± 11.19) years • Gender M/F, n: 34/16 • BMI, mean (SD): 25.38 (± 4.01) kg/m^2 **Macintosh** • Age, mean (SD): 29.16 (± 10.73) years • Gender M/F, n: 28/22 • BMI, mean (SD): 23.93 (± 4.63) kg/m^2 Notes: study authors also reported thyromental distance and preoperative oxygen saturation
Interventions	**General details**: use of stylet at the discretion of the intubator. Experience of intubator not reported **McGrath MAC** • Randomized = 50; no apparent losses; analysed = 50 • #3 or #4 blade

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Altaiee 2020 *(Continued)*

	Macintosh • Randomized = 50; no apparent losses; analysed = 50 • #3 or #4 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation • Hypoxia • Successful first attempt • Number of attempts **Continuous outcomes** • Time to tracheal intubation Notes: study authors report on use of stylet or other adjuncts for intubation. Ease of intubation reported as a continuous variable. Hypoxia presented as mean oxygen saturation during intubation attempt, reported to be 100% in both groups, with no SDs reported.
Notes	**Funding/sponsor/declarations of interest**: study authors report that they received no external funding, and they declare no conflicts of interest. **Study dates:** April–December 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition noted
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Experience not reported

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Altun 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 125 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria:** patients aged 18-65 years; ASA I or II; requiring GA with tracheal intubation undergoing otologic and rhinologic surgery **Exclusion criteria:** ASA > II; history or suspicion of difficult airway (Mallampati > 2, intraoral lesion, mouth opening < 3 cm, thyromental distance < 6 cm); hypertension; diabetes mellitus; treatment known to affect BP or HR **Baseline characteristics (only for analysed participants)** **Macintosh** • Age, mean (SD): 34.2 (± 13.12) years • Gender M/F, n: 19/21 • Weight, mean (SD): 69.69 (± 13.4) kg • Height, mean (SD): 1.65 (± 0.08) m • ASA I/II/III/IV, n: 33/7/0/0 **C-MAC** • Age, mean (SD): 35.9 (± 12.9) years • Gender M/F, n: 14/26 • Weight, mean (SD): 65.82 (± 13.46) kg • Height, mean (SD): 1.65 (± 0.09) m • ASA I/II/III/IV, n: 33/7/0/0 **McGrath** • Age, mean (SD): 34.7 (± 12.44) years • Gender M/F, n: 23/17 • Weight, mean (SD): 69.02 (± 11.02) kg • Height, mean (SD): 1.65 (± 0.08) m • ASA I/II/III/IV, n: 35/5/0/0 Notes: the study includes a fourth arm of a McCoy laryngoscope, which we did not include because it was not eligible.
Interventions	**General details**: all intubation procedures were performed by the same and experienced anaesthetist, who was familiar and trained (performed at least 20 intubations prior to the study) with all 4 laryngoscopes. A stylet was used if requested by the intubator after the first failed attempt at intubation. **Macintosh** • Randomized = 43; losses = 3 (see notes in outcomes box); analysed = 40; • #3 or #4 blade used for women and men, respectively **C-MAC** • Randomized = 40; no losses; analysed = 40; • #3 or #4 blade used for women and men, respectively

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Altun 2018 *(Continued)*

	McGrath • Randomized = 42; losses = 2 (see notes in outcomes box); analysed = 40; • #3 or #4 blade used for women and men, respectively **VL classification:** Macintosh-style Notes: for the outcomes of number of attempts and successful first attempt we included the failed intubations in the denominator; after combining the VL groups, this resulted in 43 and 82 analysed participants in the Macintosh and VL groups, respectively.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Number of attempts • Airway trauma • Patient-reported sore throat: patients were assessed for a sore throat at the second postoperative hour using an established 4-point scale. According to this scoring system, sore throat was graded as none: 1, mild (less severe than with a cold): 2, moderate (obvious to an observer): 3 and severe (aphonia): 4 • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the interval starting with the entrance of the blade to the mouth and ending with the passage of the tip of tracheal tube through the vocal cords Notes: the primary outcomes in this study were changes in SBP and HR. Airway trauma is mentioned as an outcome in the Methods section, but is not elaborated on in Results. In 7 participants (including participants from the McCoy group), successful intubation was achieved with > 2 attempts; these participants were excluded from the study. We therefore cannot infer failed intubation from the data presented for the review. Outcomes for the McGrath and C-MAC groups are combined for analyses as both laryngoscopes are Macintosh-style. For continuous outcomes we have combined results according to Higgins 2021.
Notes	**Funding/sponsor/declarations of interest**: study authors report that they received no financial support and they have no conflicts of interest. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Unclear risk	No description of concealment method
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias)	High risk	Not possible to fully blind outcome assessors

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Altun 2018 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participants requiring > 2 attempts to achieve successful intubation and those in whom the BIS level exceeded 60 at any stage during the study period were excluded from the statistical analysis of data. After allocation, there were 3 exclusions in the Macintosh group and 2 exclusions in the McGrath group. Small losses, balanced between groups, and accounted for
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	All intubation procedures were performed by the same and experienced anaesthetist, who was familiar and trained (performed at least 20 intubations prior to the study) with all 4 laryngoscopes.

Amini 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** Iran **Setting:** theatre; single centre **Inclusion criteria**: parturients with ASA I orII admitted for elective cesarean section by GA **Exclusion criteria:** patients with hypertension, predicted difficult airway, history of drug abuse, dehydration, history of any other cardiovascular diseases, history of consumption of any drugs known to affect the cardiovascular system and diabetes mellitus. **Baseline characteristics** **GlideScope** • Age, mean (SD): 29.7 (± 7.3) years • Gender M/F, n: 0/35 • Weight, mean (SD): 68.7 (± 7.9) kg • Height, mean (SD): 1.64 (± 0.08) m • Mallampati 1/2/3/4, n: 17/18/0/0 **Macintosh** • Age, mean (SD): 30.8 (± 8.3) years • Gender M/F, n: 0/35 • Weight, mean (SD): 71.0 (± 8.2) kg • Height, mean (SD): 1.63 (± 0.05) m • Mallampati 1/2/3/4, n: 13/22/0/0 Notes: the study included pregnant women exclusively
Interventions	**General details**: single experienced intubator. No further description of experience provided. There is no description of airway adjuncts used or whether stylets were used with the GlideScope or not. **GlideScope**

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Amini 2015 *(Continued)*

	• Randomized = 35; no losses; analysed = 35 **Macintosh** • Randomized = 35; no losses; analysed = 35 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Patient-reported sore throat: graded as none, mild, moderate and severe. We included data for mild and moderate sore throat. **Continuous outcomes** • Time for tracheal intubation: defined as the time from grasping the tracheal tube until observing a square wave on the capnograph. Notes: study authors also report haemodynamic outcomes, such as HR and BP, and the neonate's APGAR scores.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-based randomization method
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single experienced intubator, resident. No further quantification of experience provided

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Amor 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Morocco **Setting:** theatre; single centre **Inclusion criteria:** patients scheduled for elective ENT or ophthalmologic surgery under GA requiring tracheal intubation **Exclusion criteria:** BMI > 23 kg/m^2; emergency surgery; aspiration risk (e.g. not fasted); previous history of intubation failure; difficult intubation criteria (Mallampati > 2, thyromental distance < 6.5 cm, opening of the mouth < 3.5 cm, presence of prominent incisors, retrognathia and reduced cervical mobility) **Baseline characteristics** **Airtraq** • Age, mean (SD): 33 (± 11) years • Gender M/F, n: 36/24 • BMI, mean: 20.6 kg/m^2 • ASA, median (IQR): I (I-III) • Mallampati 1/2/3/4, n: 36/24/0/0 **Macintosh** • Age, mean (SD): 30 (± 12) years • Gender M/F, n: 39/12 • BMI, mean: 21.2 kg/m^2 • ASA, median (IQR): I (I-II) • Mallampati 1/2/3/4, n: 33/27/0/0 Notes: MILS was applied in all patients. Standard deviations not reported for BMI. ASA reported only as median (IQR)
Interventions	**General details**: all intubations were performed by 1 of 5 anaesthetists, each with > 1000 previous intubations with the Macintosh and > 50 intubations with the Airtraq. **Airtraq** • Randomized = 60; no losses; analysed = 60 **Macintosh** • Randomized = 60; no losses; analysed = 60 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: If the tracheal intubation could not be performed within 120 s, the patient was intubated in the standard fashion with a Macintosch laryngoscope, neck extended and MILS released • Airway trauma: dental and lip injury reported separately • CL grade

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Amor 2013 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as the time interval between the insertion of the blade of the laryngoscope into the patient's mouth and the placement of the tracheal tube through the vocal cords, confirmed visually by the intubator • IDS: 0, 1, 2-6, > 6 Notes: study authors also report haemodynamic outcomes. IDS was reported as mean (SD) and as dichotomized variables, but with the categories 0, 1, 2-6, > 6. We included the data for 1-6 as 1-5 and > 6 as > 5 in our categorization, respectively.
Notes	**Funding/sponsor/declarations of interest:** funding sources not reported but study authors declare that they have no conflicts of interest **Study dates:** June–December 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer random number generation
Allocation concealment (selection bias)	Low risk	Sealed envelopes used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	No attempts noted to blind outcome assessor
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses noted
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	5 experienced anaesthetists with > 1000 Macintosh intubations and > 50 Airtraq intubations

Anandraja 2021

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre

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Anandraja 2021 *(Continued)*

	Inclusion criteria: both sexes, age 18–55 years, ASA I or II, Mallampati < 3, mouth opening > 2 fingers, BMI < 40 kg/m^2 and any elective surgery requiring tracheal intubation **Exclusion criteria:** ASA > II, Mallampati > 2, anticipated difficult intubation, reflux disease, respiratory diseases, cardiovascular diseases, hypertension, history of upper/lower respiratory tract infection within 2 weeks of intubation and unwillingness to participate **Baseline characteristics** **McGrath** • Gender M/F, n: 9/21 • ASA I/II/III/IV, n: 19/11/0/0 **Macintosh** • Gender M/F, n: 11/19 • ASA I/II/III/IV, n: 17/13/0/0 Notes: the study included a third intervention, the intubating LMA, which we did not include in the review because it was not eligible. Only ASA and gender are reported as baseline characteristics.
Interventions	**General details:** participants were intubated by an experienced anaesthesiology consultant with > 8 years' clinical experience. There is no explicit mention of experience with each device. Tracheal intubation was attempted only twice with a particular technique. **McGrath** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** Macintosh-style Notes: there is no specification of what type of blade McGrath is used in the study. For the purposes of the analyses a Macintosh-style blade is assumed.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation Notes: the study reports haemodynamic parameters as the primary outcome. The only outcome relevant to the review that can be extracted is failed intubation.
Notes	**Funding/sponsor/declarations of interest**: study authors report that they received no financial support or sponsorship and have no conflicts of interest. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers generated by a computer

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Anandraja 2021 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Experienced single intubator, experience with both devices assumed

Ander 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** Sweden **Setting:** theatre; single-centre **Inclusion criteria:** ASA status I-III; surgery under GA requiring orotracheal intubation and mechanical ventilation; BMI > 35 kg/m^2 **Exclusion criteria**: age < 18 years; previous difficult intubation; anticipated difficult intubation not related to obesity (Mallampati 4, small interincisor opening, reduced neck movement and short thyromental distance); head-and-neck surgery **Baseline characteristics** **C-MAC** • Age, mean (SD): 42 (± 12) years • Gender M/F, n: 10/30 • Weight, mean (SD): 122.0 (± 18.8) kg • Height, mean (SD): 1.70 (± 0.08) m • BMI, mean (SD): 42.2 (± 5.6) kg/m^2 • Mallampati 1/2/3/4, n: 8/28/3/0 **Macintosh** • Age, mean (SD): 42 (± 13) years • Gender M/F, n: 14/26 • Weight, mean (SD): 115.2 (± 18.0) kg

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Ander 2017 *(Continued)*

- Height, mean (SD): 1.69 (± 0.09) m
- BMI, mean (SD): 39.9 (± 4.0) kg/m^2
- Mallampati 1/2/3/4, n: 8/28/3/0

Notes: this study evaluated the interventions in obese patients.

Interventions	**General details**: all intubations were performed by 1 of 2 anaesthetists experienced with both devices used in the study (> 50 intubations with each device). All participants were anaesthetized in a slight reverse Trendelenburg position with a small pillow under the head and shoulder. The use of intubation aids such as external laryngeal manipulation and stylet was allowed. **C-MAC** • Randomized = 40; losses = 4 (1: loss of case report form or due to logistical problems; 3 losses for sore throat data which are unexplained); analysed for sore throat at 1 h = 36; analysed for other outcomes = 39; • #3 blade **Macintosh** • Randomized = 40; losses = 1 (loss of case report form or due to logistical problems); analysed = 39; • #3 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: an intubation attempt > 60 s was regarded as a failed intubation. • Successful first attempt • Patient-reported sore throat: graded on a numeric rating scale, 0-3 (0 = no sore throat; 1 = mild sore throat; 2 = moderate sore throat; 3 = severe). Reported at 1 h, 24 h and > 24 h post-extubation. In the review, we included data at 1 h post-extubation. **Continuous outcomes** • Time for tracheal intubation: measured from the moment the anaesthetist took the laryngoscope handle until $ETCO_2$ was registered on the ventilator monitor. Notes: the study authors reported a subjectively evaluated difficulty of intubation, graded on a numeric rating scale from 0-100. We did not include this in the review as we were not able to convert this outcome to the IDS.
Notes	**Funding/sponsor/declarations of interest**: financial support from the Research Fund of the Örebro County Council, Örebro, Sweden. The study authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation not reported
Allocation concealment (selection bias)	Low risk	Sealed envelope with concealed allocation reported

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Ander 2017 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Attempts made at blinding participants to allocation, but intubators and outcome assessors not blinded
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants out of 80 lost to follow-up, 1 due to logistical problems, 1 due to the loss of the case report form
Selective reporting (reporting bias)	Low risk	Prospective clinical trials registration (NCT01827085; first received April 2013). Outcomes listed in the clinical trials register were consistent with those in the published study report.
Experience of intubator	Low risk	All intubations were performed by 1 of 2 anaesthetists experienced with both devices used in the study (> 50 intubations with each device).

Andersen 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Denmark **Setting**: theatre; single centre **Inclusion criteria**: all patients scheduled for elective bariatric surgery; BMI > 35 kg/m^2; age > 18 and < 60 years **Exclusion criteria**: severe mental illness; ongoing alcohol or substance abuse; previous difficult intubation; patient considered by the anaesthetist to require a different procedure of anaesthesia or intubation (e.g. fibreoptic intubation) than prescribed by the study protocol **Baseline characteristics** **GlideScope** • Age, mean (SD): 42 (± 10) years • Gender M/F, n: 15/35 • Weight, mean (SD): 125 (± 10) kg • Height, mean (SD): 1.71 (± 0.1) m • BMI, mean (SD): 42 (± 6) kg/m^2 • Mallampati ≥ 3, n: 11 **Macintosh** • Age, mean (SD): 41 (± 8) years • Gender M/F, n: 9/31 • Weight, mean (SD): 122 (± 18) kg • Height, mean (SD): 1.72 (± 0.07) m • BMI, mean (SD): 41 (± 5) kg/m^2

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Andersen 2011 *(Continued)*

	• Mallampati ≥ 3, n: 16 Notes: the study included only obese patients.
Interventions	**General details**: all intubations performed by 1 of 5 certified nurse anaesthetists or 2 anaesthetists, all with prior experience with at least 20 GlideScope intubations and with extensive experience in anaesthetising obese patients. **GlideScope** • Randomized = 50; no losses; analysed = 50 • #4 blade; stylet bent at 90 °, as per manufacturer guidelines **Macintosh** • Randomized = 50; no losses; analysed = 50 • #3 or #4 blade at intubator's discretion; hockey-stick-shaped stylets **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as not achieving intubation in maximum 2 attempts • Hypoxia: defined as oxygen saturation < 93% • Number of attempts • Airway trauma: defined as mucosal injury, airway bleeding, dental trauma. Dental trauma only extracted for inclusion into meta-analysis for internal consistency • Patient-reported sore throat: assessed at 1 h post-extubation on a VAS • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from gripping the laryngoscope until registration of expired CO2 • IDS Notes: the time to tracheal intubation reported as median (IQR), not included in the analysis. IDS scores reported for each score in a table, we were able to extract data for each device from the table for analysis.
Notes	**Funding/sponsor/declarations of interest**: departmental funding only **Study dates:** September 2008–September 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated random numbers"
Allocation concealment (selection bias)	Low risk	"Sealed opaque envelopes packed by an outside investigator" Does not state that envelopes are sequentially numbered, but low risk of bias assumed with use of outside investigator
Blinding of participants and personnel (performance bias)	High risk	Not possible to blind anaesthetist

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Andersen 2011 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	No attempt to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"One hundred consecutive patients were enrolled after which the trial was ended as planned. All eligible patients gave consent to participate, none were excluded or failed to complete, and all were included in the final analysis"
Selective reporting (reporting bias)	Low risk	Copy of protocol on clinicaltrials.gov sought and compared with published trial (clinical trials ID NCT00917033); all outcomes reported
Experience of intubator	Low risk	"All intubations were performed by one of five certified nurse anaesthetists or two anaesthetists all with prior experience from at least 20 GS (*GlideScope)* intubations and with wide experience in anesthetizing obese patients"

Aoi 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 36 **Country:** Japan **Setting**: theatre **Inclusion criteria:** patients aged 20-80 years; ASA I or II; scheduled to undergo elective surgery requiring intubation **Exclusion criteria**: risk factors for cardiopulmonary disease; predicted or history of difficult intubation (C-spine abnormality, restricted neck mobility); gastric aspiration risk **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 61.7 (± 8.8) years • Gender M/F, n: 8/10 • Weight, mean (SD): 59.7 (± 14.1) kg • Height, mean (SD): 1.6 (SD ± 0.08) m • Mallampati 1/2/3/4, n: 10/8/0/0 **Macintosh** • Age, mean (SD): 56.7 (± 17.3) years • Gender M/F, n: 13/5 • Weight, mean (SD): 63.5 (± 11.3) kg • Height, mean (SD): 1.64 (± 0.07) m • Mallampati 1/2/3/4, n: 8/9/1/0
Interventions	**General details**: laryngoscopy was performed by a single anaesthetist experienced in the use of both devices. A pillow was placed under the participant's head, and an appropriately sized semirigid cervical collar was fitted around the neck to simulate limited neck movements. **Pentax AWS**

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Aoi 2010 *(Continued)*

- Randomized = 18; losses = 1 (excluded due to > 3 attempts at intubation; analysed = 17

Macintosh

- Randomized = 18; losses = 1 (excluded due to dental injury); analysed = 17
- #3 or #4 blade

Notes: the post-randomization losses detailed above were excluded from the complications analysis but were included in analysis of intubation success, number of attempts and intubation time.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as > 3 failed intubation attempts, when the operator gave up the trial because of high possibility of complication, or whenever tooth injury occurred
- Number of attempts
- Airway trauma: dental trauma data only extracted
- Patient-reported sore throat
- CL grade: 1-4
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: defined as time when the airway device was handed to the anaesthetist to time when the presence of CO_2 was confirmed in the exhaled breath on the vital sign monitor
- IDS

Notes: failed intubations (2 cases, 1 in the Pentax AWS group due to insufficient interincisor distance, 1 in the Macintosh group due to dental injury) were excluded from complications analysis in this study. We have extracted data for these cases into our failed intubation and airway trauma analyses.

Notes

Funding/sponsor/declarations of interest: none declared

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomized but no additional details given
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind anaesthetist
Blinding of outcome assessment (detection bias) All outcomes	High risk	Time measured by independent observer, but not possible to blind observer for other outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant from each group had failed intubation, and subsequent analyses of outcomes did not include these missing participants. However, losses were few

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Aoi 2010 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to make a judgement about selective reporting bias without these documents.
Experience of intubator	Low risk	All laryngoscopies performed by 1 anaesthetist experienced with both devices

Aqil 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** Saudi Arabia **Setting:** theatre; single centre **Inclusion criteria**: adult patients aged 18-60 years; ASA I and II; BMI 18-30 kg/m^2; Mallampati 1 and 2; planned to undergo elective surgery requiring GA with intubation **Exclusion criteria:** patients undergoing day case surgery; history of anticipated or previous difficult intubation or mask ventilation; history of gastroesophageal reflux; C-spine injury or history of allergy to any anaesthetic agent used in this study **Baseline characteristics** **GlideScope** • Age, mean (SD): 36.53 (± 10.77) years • Gender M/F, n: 19/21 • Weight, mean (SD): 72.98 (± 8.80) kg • Height, mean (SD): 1.65 (± 0.06) m • BMI, mean (SD): 26.61 (± 2.52) kg/m^2 • Mallampati 1/2/3/4, n: 17/23/0/0 **Macintosh** • Age, mean (SD): 37.38 (± 11.28) years • Gender M/F, n: 17/23 • Weight, mean (SD): 72.10 (± 9.93) kg • Height, mean (SD): 1.65 (± 0.07) m • BMI, mean (SD): 26.36 (± 2.95) kg/m^2 • Mallampati 1/2/3/4, n: 19/21/0/0
Interventions	**General details**: all the intubations were performed by trainee residents having > 1 year experience and who had successfully performed > 50 tracheal intubations with each device. External pressure on the front of the neck in BURP was applied by an assistant, if desired by the operator. **GlideScope** • Randomized = 40; no losses; analysed = 40 • #4 blade; technique as per manufacturer recommendations, rigid GlideRite stylet **Macintosh** • Randomized = 40; no losses; analysed = 40 • #4 blade

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Aqil 2016 *(Continued)*

	VL classification: hyperangulated (GlideScope)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if 2 attempts were unsuccessful in tracheal tube placement, it was considered failed intubation; after which, the failed intubation algorithm was followed • Number of attempts: the attempt was stopped if its duration was > 120 s or oxygen saturation by pulse oximeter dropped below 92% and manual ventilation was done between the attempts with the same anaesthetic mixture. • CL grade **Continuous outcomes** • Time for tracheal intubation: measured from the time of entry of the instrument into patient's oral cavity till detection of $ETCO_2$ tracing on the monitor after onset of positive pressure ventilation • IDS: the operator was asked to rank IDS ranging from 0-10. An IDS score of 0 represented ideal intubating conditions, and increasing scores represented progressively more difficult intubating conditions. • POGO score: for POGO scoring, the operator was asked to score the percentage of visibility of the glottis during tracheal intubation ranging from 0%-100%. Notes: IDS, which was the study's primary outcome, was reported as mean (SD) only. We were unable to convert the reported data to dichotomous data, and they were not included in the analyses. The study authors report: "Overall IDS was 2.78 ±1.39 with GlideScope, and 4.85 ±1.75 with Macintosh (p < 0.001)." The authors also reported incidence of blood on intubation instruments as an indicator of airway trauma. We have not extracted these data, with dental injury alone used for internal consistency within our review. The lowest oxygen saturation during intubation attempts was recorded as mean (SD) but the incidence of hypoxia was not reported
Notes	**Funding/sponsor/declarations of interest**: this study was supported by College of Medicine Research Centre, Deanship of Scientific Research, King Saud Universiy, Riyadh, Saudi Arabia **Study dates:** January 2012-February 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Online software was used to divide the patients into 2 groups to ensure randomization (www.randomizer.org)."
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses reported

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Aqil 2016 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study protocol was not referenced. It is not possible to make a reporting bias judgement in the absence of a published protocol
Experience of intubator	Low risk	Mixed experience of anaesthetics trainees with each having performed > 50 intubations with each device prior to the study.

Aqil 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 140 **Country:** Saudi Arabia **Setting:** theatre **Inclusion criteria**: adult patients aged 18–60 years; ASA I and II; Mallampati 1 and 2; BMI < 35 kg/m^2; undergoing elective surgical procedures (not exceeding 2 h in duration) requiring endotracheal intubation **Exclusion criteria:** patients undergoing day case, bariatric, cardiac, nasal, oral or head and neck surgeries; requiring placement of throat pack or nasogastric/orogastric tube; patients assigned to RSI; hoarseness; patients with anticipated difficult intubation; history of recent upper respiratory tract infection; history of difficult intubation; psychiatric disorders hindering proper evaluation; use of steroids (oral or inhalational) or nonsteroidal anti-inflammatory drugs within 1 week of surgery; previous surgery within last 2 weeks **Baseline characteristics** **GlideScope** • Age, mean (SD): 36.8 (± 10.9) years • Gender M/F, n: 33/37 • Weight, mean (SD): 74.9 (± 10.5) kg • Height, mean (SD): 1.64 (± 0.07) m • BMI, mean (SD): 27.8 (± 3.7) kg/m^2 • Mallampati 1/2/3/4, n: 31/39/0/0 **Macintosh** • Age, mean (SD): 38.6 (± 10.7) years • Gender M/F, n: 26/44 • Weight, mean (SD): 73.0 (± 11.7) kg • Height, mean (SD): 1.65 (± 0.08) m • BMI, mean (SD): 26.9 (± 4.1) kg/m^2 • Mallampati 1/2/3/4, n: 35/35/0/0
Interventions	**General details**: all intubations were performed by anaesthetists who had done at least 100 intubations with each device prior. No mention of stylet or gum-elastic bougie use **GlideScope** • Randomized = 70; no losses; analysed = 70 • #4 blade

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Aqil 2017 *(Continued)*

	Macintosh • Randomized = 70; no losses; analysed = 70 • #4 blade **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if 2 attempts were unsuccessful in proper tracheal tube placement, the failed intubation algorithm was followed. • Number of attempts: the allowed time for successful intubation was up to 2 min. If the time to intubation exceeded 2 min or SpO_2 dropped below 92%, the patient's lungs were ventilated with 100% oxygen containing 2% sevoflurane for 30 s and a second intubation trial was attempted. • Patient-reported sore throat: incidence at 6 h • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: outcome reported but not defined in manuscript • IDS • POGO score: 0%-100% Notes: the primary outcome in this study was postoperative sore throat, which was reported at 4 different time points; 0, 6, 12 and 24 h postoperatively. For internal consistency within our review we have extracted the incidence of postoperative sore throat at the 6-h time-point. The lowest SpO_2 during intubation was reported as mean (SD), but incidence data for hypoxia were not available. IDS was reported as median (IQR) and hence could not be included in the analysis. The study did report incidence of blood staining on intubation equipment but did not report dental trauma, which is the only airway trauma outcome of interest to our analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** January 2012–January 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The randomization scheme was generated through online software using the (www.randomizer.org)."
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident

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Aqil 2017 *(Continued)*

Selective reporting (reporting bias)	High risk	Retrospectively registered at clinicaltrials.gov, all outcomes reported (NCT02848365). The stated number for actual enrolment on clinicaltrials.gov is 420, compared to only 140 participants with reported outcomes in the published manuscript.
Experience of intubator	Low risk	Experienced anaesthesia trainees with > 100 intubations with each device prior

Arici 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country**: Turkey **Setting**: theatre **Inclusion criteria**: pregnant women undergoing caesarean section surgery under GA **Exclusion criteria**: presence of cardiovascular, hepatic, renal or neuromuscular disease; non-co-operation; restricted neck movements; retrognathia; ASA III or IV; Mallampati 4; history of airway-related surgery; emergency surgery. Additionally, patients who had > 2 of the following criteria were excluded: Mallampati 3, maximal mouth-opening capacity < 35 mm, thyromental distance < 65 mm **Baseline characteristics** **McGrath Series 5** • Age, mean (SD): 27.55 (± 3.82) years • Gender M/F, n: 0/40 • Weight, mean (SD): 77.90 (± 13.71) kg • Height, mean (SD): 1.63 (± 0.06) m • BMI, mean (SD): 29.45 (± 5.6) kg/m^2 • ASA I/II/III/IV, n: 28/12/0/0 • Mallampati 1/2/3/4, n: 19/19/2/0 **Macintosh** • Age, mean (SD): 29.25 (± 4.41) years • Gender M/F, n: 0/40 • Weight, mean (SD): 72.32 (± 9.82) kg • Height, mean (SD): 1.61 (± 0.06) m • BMI, mean (SD): 27.98 (± 3.22) kg/m^2 • ASA I/II/III/IV, n: 24/16/0/0 • Mallampati 1/2/3/4, n: 21/19/0/0 Notes: these were exclusively pregnant women undergoing caesarian section under GA.
Interventions	**General details:** all intubations were performed by an experienced anaesthetist. Experience with each of the devices not further specified. A stylet was used in all intubations. **McGrath series 5** • Randomized = 40; no losses reported; analysed = 40

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Arici 2014 *(Continued)*

- Stylet used

Macintosh

- Randomized = 40; no losses reported; analysed = 40
- #3 or #4 blade

VL classification: hyperangulated

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts • Airway trauma: dental trauma data only extracted • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from the anaesthetist taking the laryngoscope in his hand until the first upward deflection on the capnograph after the connection of the anaesthetic ventilation system to the tracheal tube. • POGO score: 0%-100%, reported as mean (SD) Notes: the study also reports haemodynamic outcomes, which are not of interest to our meta-analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported. State over a period of about 18 months

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated random numbers"
Allocation concealment (selection bias)	Low risk	"Sealed-envelope technique"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Assumed no attempts made to blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to make a judgement regarding selective reporting bias without these documents.
Experience of intubator	Unclear risk	"All intubations were performed by an experienced anaesthetist."

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Arima 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 109 **Country:** Japan **Setting**: prehospital; single centre **Inclusion criteria**: age ≥ 18 years and requiring emergency tracheal intubation in the prehospital setting only during the day shift **Exclusion criteria**: none given **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 74.4 (± 13.6) years • Gender M/F, n: 34/22 • Cardiac arrest: 54/56 **Macintosh** • Age, mean (SD): 74.1 (± 13.0) years • Gender M/F, n: 38/15 • Cardiac arrest: 47/53 Notes: these were mostly patients in cardiac arrest.
Interventions	**General details:** 6 physicians had previously worked as anaesthetists with an estimated range of 15-30 Pentax AWS intubations or > 100 Macintosh intubations per year. The remaining 5 were physicians with at least 50 Macintosh intubations but relatively fewer experiences with AWS intubation (but had received manikin training sessions). All physicians have > 3 years of working experience and are sufficiently skilled and trained in emergency medicine and the use of both the AWS and Macintosh devices in daily practice. A suction device and Magill forceps were available for use at any time. **Pentax AWS** • Randomized = 61; losses = 5; analysed = 56 • Reasons for exclusion: 3 insufficient records, 2 equipment problems **Macintosh** • Randomized = 58; losses = 5; analysed = 53 • Reasons for exclusion: 5 insufficient records **VL classification:** channelled Notes: the study authors judged all intubators to be sufficiently skilled in using both devices prior to starting the study.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: the study defined successful intubation as intubation completed within 600 s regardless of the device used. See notes below

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Arima 2014 *(Continued)*

- Number of attempts

Continuous outcomes

- Time for tracheal intubation: measured from insertion of the blade between the teeth to confirmation of tracheal tube placement by capnograph. If intubation failed and the device for intubation was changed, time was measured from insertion on the first attempt to success on the second or successive attempts.
- IDS

Notes: IDS and TTI data reported as median (IQR) and could not be extracted for inclusion in the meta-analysis.

The study considered intubation to be successful if it was completed within 600 s regardless of the device used. However the study authors reported that, "initial intubation with the AWS (VL) failed in 20 cases but was followed by successful intubation with the Macintosh laryngoscope". There was no attempt to use the AWS videolaryngoscope in 3 of these cases. We have therefore counted 17 of these as instances of failed intubation on the basis of change of device (meeting our study definition of failure) and excluded the 3 cases due to protocol violation.

The reasons given for inability to intubate with the Pentax AWS were oral contamination (12 cases), poor visualization of the glottis (4 cases), inability to insert the AWS blade (1 case), obscured display (1 case) and unknown (2 cases).

Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** February 2012–March 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Allocation was changed in a serial manner and was controlled by personnel at the physician car system center"
Allocation concealment (selection bias)	Unclear risk	"The operators were told which of the two devices had been allocated to them to use only when en route to the incident in the ambulance"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	All outcomes assessed by physician who was not blinded. Some potential for bias in the outcomes as operators were encouraged to complete intubation as quickly as possible, even if it was achieved by switching devices. Operators could be biased to familiar equipment; therefore change to an alternative device made frequently
Incomplete outcome data (attrition bias) All outcomes	High risk	"Of 121 patients enrolled in this study, 12 were excluded due to missing data, age < 18 years, or problems with the device used, leaving 109 for final analysis" High level of losses; no explanation about what problems with the device led to the exclusion of some participants
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. Without these documents it is not possible to make a judgement about reporting bias.
Experience of intubator	Unclear risk	"6 physicians had generally performed N 100 intubations per year as they had previously worked as anesthetists. The number of AWS intubations they have

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Arima 2014 *(Continued)*

	performed is not precisely known, but is estimated to be in the range of 15 to 30 AWS intubations per physician per year. The remaining 5 physicians had done an anesthesia rotation and had performed at least 50 intubations, but with relatively fewer experiences with AWS intubation" Some variety of experience among personnel; unclear if these personnel were balanced between intervention and comparison groups

Arora 2013

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 110 **Country:** India **Setting:** theatre **Inclusion criteria**: adult ASA I patients of either gender, aged 18-60 years, scheduled to undergo an elective surgical procedure that required GA with oral intubation **Exclusion criteria**: modified Mallampati 3 and 4; thyromental distance < 6.5 cm; interincisor distance < 4 cm; history of difficult airway; C-spine injury; risk of regurgitation, e.g. full stomach; emergency surgery; pregnancy; obesity (BMI > 30 kg/m^2) **Baseline characteristics** **Truview EVO2** • Age, mean (SD): 36.9 (± 13.2) years • Gender M/F, n: 39/15 • BMI, mean (SD): 25 (± 5.8) kg/m^2 • ASA I/II/III/IV, n: 54/0/0/0 • Mallampati 1/2/3/4, n: 46/8/0/0 **Macintosh** • Age, mean (SD): 34.2 (± 13.2) years • Gender M/F, n: 38/16 • BMI, mean (SD): 23.2 (± 2.6) kg/m^2 • ASA I/II/III/IV, n: 54/0/0/0 • Mallampati 1/2/3/4, n: 33/21/0/0
Interventions	**General details**: laryngoscopy was performed twice in each participant using in turn both the Macintosh laryngoscope and Truview EVO2 laryngoscope in a random order generated by a computer. Trachea was intubated after second laryngoscopy using an appropriate sized cuffed tracheal tube preloaded with stylet. When required, anterior laryngeal pressure was applied to facilitate orotracheal intubation. An experienced anaesthetist performed the laryngoscopy, but this is not quantified further. **Truview EVO2** • Randomized = 55; excluded = 1; analysed = 54 **Macintosh**

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Arora 2013 *(Continued)*

- Randomized = 55; excluded = 1; analysed = 54
- #3 blade

VL classification: hyperangulated

Notes: for the purposes of this review, we categorized the Truview EVO2 as a hyperangulated laryngoscope. It is unclear whether a video port was used with the EVO2 in this study or not. The authors categorize it as a VL. Therefore, we decided to include it in the review.

There were 2 failed intubations due to technical reasons rather than due to failure of the laryngoscope or the anaesthetist to secure the airway. In the first case, a defective stylet was used, which could not conform to the shape of the tracheal tube, and in the other there was improper anti-fogging due to disconnection of the oxygen tubing from the anaesthesia machine. Therefore, we excluded these 2 cases from the statistical analysis and analysed data of only 108 participants.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as when the trachea could not be intubated or when > 120 s was required to achieve intubation
- Number of attempts: 1-3
- Airway trauma: only dental trauma data extracted
- CL grade: 1-4. Assessed by both devices in sequence

Continuous outcomes

- Time for tracheal intubation: defined as the time taken from insertion of the second blade between the teeth until the tracheal tube was placed through the vocal cords, as confirmed visually by the anaesthetist. If the tracheal tube was not visualized passing through the vocal cords, the intubation attempt was not considered complete until the tracheal tube was connected to the a breathing circuit and evidence obtained of the presence of CO_2 in the exhaled breath.
- IDS: 0, 1-5, > 5
- POGO score: 0% when glottis is not visible and 100% when the entire glottis is visible. No laryngeal pressure was applied to improve this score.

Notes: POGO score reported as median (IQR) and therefore not included in the analysis

Notes

Funding/sponsor/declarations of interest: none declared

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random sequence
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors

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Arora 2013 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants, 1 from each group, were excluded due to technical issues
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to make a judgement about selective reporting without these documents.
Experience of intubator	Unclear risk	Experienced anaesthetist performing all intubations

Arslan 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Turkey **Setting:** theatre **Inclusion criteria:** ASA I and II; aged 18-65 years; undergoing elective surgery that required tracheal intubation **Exclusion criteria**: presence of laryngeal or pharyngeal pathology; a known or expected difficult airway (e.g. interincisor distance < 2.5 cm; Mallampati 3 or 4; thyromental distance < 6 cm; sternomental distance < 12 cm; BMI > 35 kg/m^2); high cardiac or respiratory system insufficiency; recent upper respiratory tract infection (within the past 10 days); pregnancy **Baseline characteristics** **McGrath MAC X-blade** • Age, median (IQR): 47 (29-56.8) years • Gender M/F, n: 7/33 • Weight, mean (SD): 70.2 (± 13.9) kg • Height, median (IQR): 1.63 (1.60-1.68) m • ASA I/II/III/IV, n: 25/15/0/0 • Mallampati 1/2/3/4, n: 22/18/0/0 **GlideScope** • Age, median (IQR): 40 (33-57.8) years • Gender M/F, n: 8/32 • Weight, mean (SD): 65.8 (± 11.8) kg • Height, median (IQR): 1.63 (1.60-1.68) m • ASA I/II/III/IV, n: 26/14/0/0 • Mallampati 1/2/3/4, n: 22/18/0/0 **Macintosh** • Age, median (IQR): 42 (31.5-49.8) years • Gender M/F, n: 5/35 • Weight, mean (SD): 68.4 (± 13.9) kg • Height, median (IQR): 1.62 (1.56-1.67) m • ASA I/II/III/IV, n: 27/13/0/0 • Mallampati 1/2/3/4, n: 21/19/0/0

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Arslan 2017 *(Continued)*

	Notes: this was a 3-arm study. Other baseline characteristics reported were interincisor distance, thyromental distance, sternomental distance and tooth morphology. There is an even but skewed distribution across a number of baseline characteristics, such as age, gender and height.
Interventions	**General details**: all intubations were performed by clinicians with at least 5 years of experience and who had performed at least 50 successful intubations using each device. Cricoid pressure was applied during all the intubations by an anaesthesia resident with at least 4 years' experience. To determine the optimal glottic visualization, handling force and reinsertion manoeuvres were used in GlideScope and McGrath MAC X-Blade groups. **McGrath MAC X-blade** • Randomized = 40; no losses; analysed = 40 • A conventional, angled malleable stylet shaped like the McGrath MAC was used **GlideScope** • Randomized = 40; no losses; analysed = 40 • The dedicated GlideRite rigid stylet was used **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated (McGrath MAC X-blade, GlideScope)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if the duration of intubation exceeded 120 s or if intubation was deemed impossible after 3 attempts, it was recorded as failed • Number of attempts • Airway trauma: dental trauma data only extracted • Patient-reported sore throat • CL grade: CL grades under cricoid pressure were taken as the baseline view and then, as the cricoid pressure was gradually decreased, the change in the laryngeal view was recorded • Oesophageal intubation: listed as a secondary outcome in methods, but not explicitly reported in results **Continuous outcomes** • Time for tracheal intubation: the intubation time was defined as the time that elapsed from the moment the device entered the oral cavity until the tracheal tube was clearly visualized passing through the vocal cords. If the first attempt failed and the second attempt succeeded, the intubation time was defined as the time that elapsed from the moment the device first entered the oral cavity until successful intubation. Notes: the primary outcome measure was the determination of the effect of cricoid pressure on the laryngeal view during intubation using the 3 laryngoscopes. For the purposes of this review we included the CL grade before application of cricoid pressure. Seeing as both the McGrath MAC X-blade and GlidesScope are hyperangulated devices and would be included in the same analysis, we elected to combine the data reported for these 2 interventions in order to avoid unit of analysis issues. Time for tracheal intubation was reported as median (IQR) and therefore not included in the analysis. Mucosal, mouth and dental trauma data was reported in this study. We only extracted dental trauma data for internal consistency within the review.
Notes	**Funding/sponsor/declarations of interest**: none declared

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Arslan 2017 *(Continued)*

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No mention of random sequence generation
Allocation concealment (selection bias)	Low risk	Sealed envelope technique
Blinding of participants and personnel (performance bias) All outcomes	High risk	Unable to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unable to blind outcome assessors for outcomes relevant to review
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition noted
Selective reporting (reporting bias)	Low risk	Protocol examined on clinicaltrials.gov (NCT 02588157). The authors report on all planned outcomes and more
Experience of intubator	Low risk	Various staff with > 5 years' experience and > 50 intubations with each device

Avula 2019

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 60 **Country:** India **Setting**: theatre **Inclusion criteria**: adult ASA I or II patients of either sex, aged 18-60 years, scheduled for elective surgical procedures requiring GA with tracheal intubation **Exclusion criteria:** patients with known airway pathology and C-spine injury and those who required RSI were excluded from the study. **Baseline characteristics** **King Vision** • Age, mean (SD): 42 (± 14) years • Weight, mean (SD): 67 (± 11) kg • ASA I/II/III/IV, n: 13/17/0/0 • Mallampati 1/2/3/4, n: 16/11/3/0 **Macintosh**

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Avula 2019 *(Continued)*

- Age, mean (SD): 38 (± 8) years
- Weight, mean (SD): 63 (± 12) kg
- ASA I/II/III/IV, n: 15/15/0/0
- Mallampati 1/2/3/4, n: 15/12/3/0

Notes: CL grades obtained by the first anaesthetist were also reported in the patient characteristics table.

Interventions	**General details**: following induction, all patients in both the groups underwent an initial direct laryngoscopy by a separate anaesthetist using a Macintosh laryngoscope, and the CL grade was scored. Following this, ventilation was continued and then the trachea was intubated using either the Macintosh or the King Vision according to the study allocation. All intubations were performed by a second anaesthetist, a resident in training, with experience of having performed a minimum of 100 intubations with the Macintosh blade and 20 intubations using the King Vision blade prior. This resident anaesthetist was blinded to the CL grading given by the first anaesthetist, and during this intubation, a second CL score was given. **King Vision** • Randomized = 30; no losses; analysed = 30 • A preformed stylet (TrueFlex) was used **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** hyperangulated Notes: the King Vision VL is available with channelled and non-channelled blades. The study authors specify they used a hyperangulated non-channeled blade in this study. We have therefore classified it as a hyperangulated device.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: scores were recorded twice by 2 independent anaesthetists. The difference in scores between the 2 devices was the primary endpoint of the study. **Continuous outcomes** • Time for tracheal intubation: taken as the time from the introduction of the laryngoscope (Macintosh or King Vision) blade into the mouth to the appearance of `end-tidal` CO_2 trace on the monitor after inflation of the tracheal tube cuff. Notes: the study authors also report haemodynamic outcomes. For participants in the Macintosh group we have extracted the CL grade reported at initial laryngoscopy. For participants in the King Vision group we have extracted the CL grade reported at the time of intubation. The study did not report a second CL score for participants in the Macintosh group at the time of intubation. This is a potential source of error, as the initial laryngoscopy and subsequent intubation with the allocated device were performed by different intubators.
Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** January–June 2018
Risk of bias	

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Avula 2019 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"These intubations were performed by a different resident anesthetist, who was under training with an experience of having performed a minimum of 100 intubations with the Macintosh blade and 20 intubations using the King vision blade."

Aziz 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 296 **Country:** USA **Setting**: theatre **Inclusion criteria:** patients with objective predictors of potentially difficult tracheal intubation: reduced cervical motion from pathological condition or C-spine precautions (limited capacity to flex or extend the neck or managed with a cervical collar, but with negative imaging), Mallampati classification score of 3 or 4, reduced mouth opening (< 3 cm), history of difficult direct laryngoscopy **Exclusion criteria**: a documented easy tracheal intubation (success on first attempt), history of failed intubation and failed bag-mask ventilation, known unstable C-spine injury, age < 18 years, presentation for an emergency surgical procedure **Baseline characteristics** **C-MAC** • Age, mean (SD): 54 (± 14) years • Gender M/F, n: 74/75 • BMI, mean (SD): 34 (± 10) kg/m^2

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Aziz 2012 *(Continued)*

	• ASA I/II/III/IV, n: 3/60/80/6 **Macintosh** • Age, mean (SD): 55 (± 15) years • Gender M/F, n: 83/64 • BMI, mean (SD): 34 (± 10) kg/m^2 • ASA I/II/III/IV, n: 2/53/87/5 Notes: all patients had objective predictors of potential difficult intubation.
Interventions	**General details**: laryngoscopy was performed by attending anesthesiologists, certified registered nurse anaesthetists, and anaesthesiology residents with > 6 months of anaesthesia experience. Extent of experience varied. External laryngeal manipulation, use of gum-elastic bougie allowed at request of intubator **C-MAC** • Randomized = 150; losses = 1 (device unavailability); analysed = 149 • #3 or #4 blade **Macintosh** • Randomized = 150; losses = 3 (switched to VL due to provider preference); analysed = 147 • #3 or #4 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: a failed attempt was defined as removal of the laryngoscope from the mouth, with subsequent attempts using device selected at discretion of the anaesthetist. In our review, change of device was included as an instance of failed intubation • Hypoxia: defined as oxygen saturation < 90% • Successful first attempt: defined as confirmation of tracheal tube placement by $ETCO_2$ with a single blade insertion • Airway trauma: dental trauma only included in our analysis • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time between blade insertion into the mouth and inflation of the tracheal tube cuff Notes: the study authors also report success rates based on provider background (attending, resident, CRNA). TTI reported as mean (95% CI) and converted to SD as per Higgins 2021. Reported traumatic outcomes included lip/gum/oral trauma and dental trauma. For internal consistency in our review and to avoid unit of analysis issues, we have only extracted data for dental injuries.
Notes	**Funding/sponsor/declarations of interest:** supported by an investigator-initiated grant (no. 00520743-2) from Karl Storz Endoscopy-America **Study dates**: not reported **Additional**: contact made with study author to confirm denominator figures in Table 3; e-mail response in file
Risk of bias	

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Aziz 2012 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was performed in a 1:1 allocation ratio via specialized computer software"
Allocation concealment (selection bias)	Low risk	"Individual randomization cards were placed in concealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Both the study team and the anesthesia team remained blinded until the patient entered the operating room" Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	"One of the investigators or a study nurse followed each patient into the operating room to record the relevant intubation and post intubation data" For patient-reported outcomes; no details of whether other outcome assessors were blinded or not
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Three hundred patients were consented and enrolled in this randomized controlled study. There were four randomization failures that were excluded from analysis" Losses too few to create bias
Selective reporting (reporting bias)	Low risk	"Pre-registered online as NCT00956592" Clinical trial register protocol sourced; protocol outcomes comparable with study-reported outcomes
Experience of intubator	High risk	"In three cases, the anesthesia team deviated from randomization to DL (*Macintosh)* and intubated with a video laryngoscope because of provider preference" Does not state whether all operators had equivalent experience with C-MAC, but it is known that some operators preferred a particular device. Also, the level of qualification of the operators differed between devices, with more resident anaesthetists using the Macintosh, and more CRNAs using the C-MAC

Bag 2014

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 200 **Country:** India **Setting:** theatre **Inclusion criteria:** patients aged 12-80 years, ASA I or II, who were scheduled for elective surgery under GA and requiring elective tracheal intubation **Exclusion criteria:** patients with compromised cardiovascular and respiratory function, emergency cases, those requiring RSI and patients with head and neck pathology were excluded from the study **Baseline characteristics**

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Bag 2014 *(Continued)*

Truview PCD

- Age, mean (SD): 31.62 (± 18.07) years
- Gender M/F, n: 47/53
- Weight, mean (SD): 53.19 (± 17.30) kg
- ASA I/II/III/IV, n: 85/15/0/0
- Mallampati 1/2/3/4, n: 45/53/2/0

Macintosh

- Age, mean (SD): 34.66 (± 13.22) years
- Gender M/F, n: 48/52
- Weight, mean (SD): 56.06 (± 10.72) kg
- ASA I/II/III/IV, n: 85/15/0/0
- Mallampati 1/2/3/4, n: 29/67/4/0

Notes: the inclusion lower age limit was 12 years old and it was not possible to determine the number of participants aged 12-16 included in the study. It is likely from demographic data that they will represent a small proportion of participants and we have chosen to include this study in our analysis.

Interventions	**General details**: the anaesthetists who performed all the laryngoscopies and intubations had experience of minimum 20 intubations with the Truview PCD before the study was commenced. In group TV, Truview PCD laryngoscope was used initially to visualize the vocal cords for CL grading and to spray the vocal cords with 10% lignocaine. Then the participant was ventilated with 100% oxygen for 1 min and Macintosh laryngoscope was used to visualize the vocal cords for CL grading and proceed with intubation. In Group ML, Macintosh laryngoscope was used initially to visualize the vocal cords for CL grading and to spray the vocal cords with 10% lignocaine. Then the participant was ventilated for 1 min with 100% oxygen and Truview PCD laryngoscope was used to visualize the vocal cords for CL grading and proceed with intubation. No laryngeal manipulation was used to improve the laryngoscopic view to improve this score. **Truview PCD** • Randomized = 100; no losses; analysed = 100 **Macintosh** • Randomized = 100; no losses; analysed = 100 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Airway trauma: only dental trauma data extracted • CL grade: 1-4 Notes: the study did not provide SD data for time to intubation, which meant that it could not be extracted for use in our analysis. The study authors reported "no difference between groups" for number of attempts, but insufficient data were available for extraction. For CL grading we extracted the event data from the laryngoscopy attempt immediately prior to intubation.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

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Bag 2014 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	"Close envelope technique."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"The anaesthetists who performed all the laryngoscopies and intubations had experience of minimum 20 intubations with the Truview^{PCD} before the study was commenced."

Bakshi 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 126 **Country:** India **Setting:** theatre **Inclusion criteria:** ASA I - II patients, > 18 years, scheduled to undergo elective surgical procedures requiring GA and tracheal intubation **Exclusion criteria**: refusal to consent; history of difficult airway or anticipated difficult airway (Mallampati ≥ 3 or other clinical findings suggestive of difficult airway); the presence of indications for RSI of anaesthesia; patients with BMI > 30 **Baseline characteristics** **McGrath Series 5** • Age, mean (SD): 43.1 (± 13.1) years • Gender M/F, n: 15/27 • BMI, mean (SD): 22.8 (± 3.74) kg/m^2

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Bakshi 2015 *(Continued)*

- ASA I/II/III/IV, n: 27/15/0/0
- Mallampati 1/2/3/4, n: 32/10/0/0

Truview

- Age, mean (SD): 50.2 (± 13.47) years
- Gender M/F, n: 16/26
- BMI, mean (SD): 22.3 (± 3.63) kg/m^2
- ASA I/II/III/IV, n: 26/16/0/0
- Mallampati 1/2/3/4, n: 30/12/0/0

Macintosh

- Age, mean (SD): 45.8 (± 11.6) years
- Gender M/F, n: 19/23
- BMI, mean (SD): 22.13 (± 3.25) kg/m^2
- ASA I/II/III/IV, n: 32/10/0/0
- Mallampati 1/2/3/4, n: 33/6/0/0

Notes: the study authors report baseline characteristics separately for each VL and for 3 different levels of intubator experience (novice to intubation, novice to scope, expert). Patients were randomized to undergo intubation by an anaesthetist from 1 of these 3 groups and then further randomized to 1 of 3 devices. Each group ended up with 42 participants, and each device was used 14 times.

For the purposes of this review we combined the data for the main analyses and separately extracted data based on experience for the subgroup analysis. Where continuous data points were combined this was done as per Higgins 2021. The baseline characteristics across all categories were well balanced.

Interventions

General details: patients were randomized to have tracheal intubation performed by an anaesthetist, from 1 of the 3 predefined groups by computer-generated program. Each intubating anaesthetist had a set of 7 opaque envelopes containing the name of the laryngoscope in a random order. These envelopes were prepared at the very beginning of the trial, to ensure that each intubating anaesthetist did at least 2 intubations with each scope. Thus, there were 42 intubations in each group, 14 with each scope.

For intubations with VLs, a `pre-shaped` stylet was used as recommended and was not considered as an additional intubation aid.

McGrath Series 5

- Randomized = 42; no losses; analysed = 42

Truview

- Randomized = 42; no losses; analysed = 42

Macintosh

- Randomized = 42; no losses; analysed = 42

VL classification: hyperangulated (McGrath Series 5, Truview)

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: a failed intubation was defined as when the user could not intubate the participant's trachea after 2 attempts. Each attempt was terminated after 90 s or if the oxygen saturation on pulse oximeter fell below 90% whichever was earlier.

Notes: we combined outcomes across groups of different experience in our analysis. We combined outcomes for McGrath Series 5 and Truview as both devices are considered hyperangulated VLs for the

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Bakshi 2015 *(Continued)*

purpose of our meta-analysis. There was a significant number of failures in the McGrath group, with most of these failures occurring in the novice groups.

Airway trauma data were reported as a composite of blood on laryngoscope blade, visible trauma to lips, oral mucosa or teeth. For internal consistency we are only using dental trauma data in our analysis and we were unable to extract these data for inclusion.

CL data were reported as a dichotomous outcome (1 or ≥ 2), which did not offer sufficient detail for inclusion in our dataset. Sore throat was reported only in the narrative without any data suitable for extraction. TTI reported graphically only and it was not possible to extract data.

Ease of intubation was reported on a subjective numerical rating scale, but was not an outcome of interest to our analysis.

Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Opaque envelopes used, specifically for allocations to device, but not clear how allocation was done to intubator
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registered prospectively with the Clinical Trials Registry of India. (CRTI 2012/04/002562), all pre-specified outcomes reported
Experience of intubator	High risk	Mixed group of intubators with regards to experience - some complete novices to intubation

Bakshi 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 74 **Country:** India **Setting:** theatre

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Bakshi 2019 *(Continued)*

Inclusion criteria: adult patients; ASA I-II; posted for elective surgery needing lung isolation

Exclusion criteria: history of or anticipated difficult airway on clinical examination (including Mallampati 3 and 4, thyromental distance < 6.5 cm, sternomental distance < 12.5 cm, interincisor gap < 3 cm, BMI > 30 kg/m^2); presence of indications for RSI of anaesthesia

Baseline characteristics

McGrath MAC

- Age, mean (SD): 46.9 (± 17) years
- Gender M/F, n: 25/12
- Weight, mean (SD): 57.9 (± 10) kg
- Height, mean (SD): 1.63 (± 0.09) m
- BMI, mean (SD): 21.8 (± 3) kg/m^2
- Mallampati 1/2/3/4, n: 29/8/0/0

Macintosh

- Age, mean (SD): 49.8 (± 16) years
- Gender M/F, n: 23/14
- Weight, mean (SD): 59.9 (± 13) kg
- Height, mean (SD): 1.61 (± 0.1) m
- BMI, mean (SD): 23.0 (± 3) kg/m^2
- Mallampati 1/2/3/4, n: 23/14/0/0

Notes: the purpose of this study was to compare direct and video laryngoscopy for DLT insertion.

Interventions

General details: 11 anaesthetists experienced with the use of McGrath MAC VL with single lumen tubes but inexperienced with the use of VL in for DLT placement performed the intubations. All patients were intubated with DLTs. All DLTs were preloaded with stylets.

McGrath MAC

- Randomized = 37; no losses; analysed = 37

Macintosh

- Randomized = 37; 1 excluded; analysed = 36

VL classification: Macintosh-style

Notes: in this study, a single participant from the Macintosh arm was excluded from further analysis due to failed intubation. We have included this participant in our analysis in the failed intubation and number of attempts outcomes. This participant was intubated with a single lumen tube and a bronchial blocker was used for lung isolation, while all other participants in the study were intubated with a DLT.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined when the intubator could not intubate the participant's trachea after 2 attempts
- Number of attempts
- Patient-reported sore throat
- CL grade

Continuous outcomes

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Bakshi 2019 *(Continued)*

- Time for tracheal intubation: defined as the time from advancement of laryngoscope from dental arches to first deflection of capnograph.

Notes: airway trauma was reported in terms of injury to the lip or oral mucosa and presence of blood on laryngoscope blade. This outcome was not included in our analysis because incidence of dental trauma was not included. In cases of failure to intubate, the data were not analysed for TTI, postoperative sore throat and CL grade. Ease of intubation data were reported but not extracted for use in our analysis.

Notes	**Funding/sponsor/declarations of interest**: departmental funding **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Computer-generated chart to balance out groups in terms of intubator and device
Allocation concealment (selection bias)	Low risk	Sealed envelopes used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind the intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 failed intubation in the Macintosh group that was excluded prior to analysis
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2014/07/004763). Study registered retrospectively. All prespecified outcomes reported
Experience of intubator	High risk	11 anaesthetists experienced with the use of McGrath MAC VL with single-lumen tube but inexperienced with the use of VL in for DLT placement (nonexperts)

Barak 2007

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 170 **Country:** Israel **Setting:** theatre **Inclusion criteria**: adult patients who were scheduled to undergo elective surgery requiring GA and tracheal intubation

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Barak 2007 *(Continued)*

Exclusion criteria: ASA ≥ IV; coagulopathy or use of anticoagulants; indication for RSI of anaesthesia; surgery involving the oral cavity, larynx, pharynx or neck, where postoperative sore throat may occur from surgical factors

Baseline characteristics

Truview EVO

- Age, mean (SD): 60 (± 12) years
- Gender M/F, n: 36/44
- Weight, mean (SD): 79 (± 13) kg
- ASA I/II/III/IV, n: 24/41/13/0
- Mallampati 1/2/3/4, n: 20/30/27/3

Macintosh

- Age, mean (SD): 48 (± 18) years
- Gender M/F, n: 42/48
- Weight, mean (SD): 74 (± 13) kg
- ASA I/II/III/IV, n: 19/53/18/0
- Mallampati 1/2/3/4, n: 40/45/5/0

Notes: there was a statistically significant difference between the groups in mean weight of the participants. Also, there was a significantly higher oropharyngeal Mallampati view and a higher number of restricted cervical or temporomandibular joint mobility in the Truview group.

Interventions

General details: 3 anaesthetists, each with at least 2 years' experience, performed the intubations. Each anaesthetist had performed at least 5 preliminary intubations using the Truview blade prior to the start of the study.

Truview EVO

- Randomized = 80; no losses; analysed = 80

Macintosh

- Randomized = 90; no losses; analysed = 90

VL classification: hyperangulated

Notes: group size differed by 10 participants in this study. There was no explanation provided for this discrepancy.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: not explicitly defined. The study authors state: "When initial intubation failed, the anaesthetist was instructed to act according to his/her preference, such as changing blades, patient position or applying external laryngeal pressure." They report the number of instances a change of blade type (or size) was required and we have included that in our definition of failed intubation
- Number of attempts
- Hypoxia: defined as < 95%
- Airway trauma: we only extracted data for dental damage
- Patient-reported sore throat
- CL grade

Continuous outcomes

- Time for tracheal intubation: defined as from the introduction of the laryngoscope into the mouth until inflation of the tracheal tube cuff, in seconds

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Barak 2007 *(Continued)*

	Notes: airway trauma data reported included dental and soft tissue damage and bleeding of gums or lips. We extracted dental damage data alone for internal consistency in this review.
Notes	**Funding/sponsor/declarations of interest**: not declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Mention of random allocation but no description of random sequence generation
Allocation concealment (selection bias)	Unclear risk	No description
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	3 anaesthetists, each with at least 2 years' experience, performed the intubations. Each anaesthetist had performed at least 5 preliminary intubations using the Truview blade prior to the start of the study. Balance of experience likely to favour DL

Barman 2017

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** India **Setting:** theatre **Inclusion criteria**: adults aged 35-65 years; NYHA I and II; Mallampati 1 or 2; scheduled for elective primary CABG surgery **Exclusion criteria:** patients with NYHA III and IV; ejection fraction < 30%; diabetes; renal disease; hepatic disease; neurological diseases; severe respiratory disease; anticipated difficult intubation (Mallampati 3 or 4, thyromental distance < 6 cm, interincisor gap < 3 cm); oral pathology or mass; history of

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Barman 2017 *(Continued)*

	relevant drug allergy; risk of gastric aspiration; any bleeding diathesis; permanent pacemaker; refused to give consent; undergoing emergency CABG **Baseline characteristics** **King Vision** • Age, mean (SD): 55.69 (± 5.98) years • Gender M/F, n: 29/6 • Weight, mean (SD): 58.23 (± 5.64) kg • Height, mean (SD): 1.63 (± 0.05) m • Mallampati 1/2/3/4, n: 2/33/0/0 **Macintosh** • Age, mean (SD): 53.20 (± 6.30) years • Gender M/F, n: 28/7 • Weight, mean (SD): 60.80 (± 7.53) kg • Height, mean (SD): 1.64 (± 0.06) m • Mallampati 1/2/3/4, n: 4/31/0/0
Interventions	**General details**: all laryngoscopies were performed by the same anaesthetist having experience of using both types of laryngoscope. This is not further quantified. **King Vision** • Randomized = 35; no losses; analysed = 35 • #3 blade **Macintosh** • Randomized = 35; no losses; analysed = 35 • #3 or #4 blade **VL classification:** channelled Notes: the King Vision device is available with either channelled or non-channelled blades. The study authors explicitly stated that a channelled blade was used in this study.
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: defined as from the time the laryngoscope was picked up until the blade was removed from the mouth after successful intubation Notes: the study primarily reported haemodynamic outcomes, but does report time for tracheal intubation.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table used

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Barman 2017 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"All laryngoscopies were performed by the same anaesthetist having experience of using both types of laryngoscope." This is not further quantified.

Bashir 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre; single-centre **Inclusion criteria:** patients undergoing elective surgery requiring tracheal intubation; patients of either sex; aged 20-70 years; ASA I and II; Mallampati 1-4 **Exclusion criteria**: age < 20 or > 70 years; ASA III and IV; refused to participate **Baseline characteristics** **King Vision** • Age, mean (SD): 39.65 (± 11.51) years • Gender M:F, ratio: 1.22:1 • ASA I/II/III/IV, n: 26/14/0/0 • Mallampati 1/2/3/4, n: 23/9/7/1 **Macintosh** • Age, mean (SD): 41.22 (± 9.24) years • Gender M:F, ratio: 1.24:1 • ASA I/II/III/IV, n: 24/16/0/0 • Mallampati 1/2/3/4, n: 21/14/4/1

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Bashir 2020 *(Continued)*

Interventions	**General details**: all intubations were performed by a senior anaesthetist who had experience of at least 40 intubations in patients using VL. A stylet was used for intubation in both groups. **King Vision** • Randomized = 40; no losses; analysed = 40 • Non-channelled, #3 blade **Macintosh** • Randomized = 40; no losses; analysed = 40 • #3 for patients < 50 kg, #4 for patients > 50 kg **VL classification**: hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failure was defined as the inability to intubate after 3 attempts or an intubation that requires > 60 s to perform. • Number of attempts: an attempt was defined as the time from introduction of laryngoscope into the oral cavity until its removal. • Airway trauma: the blade of the laryngoscope was checked for blood staining along with inspection of any trauma to tongue, teeth or soft tissues. • CL grade **Continuous outcomes** • Time for tracheal intubation: time elapsed from insertion of the blade between the dental arches to the first deflection on capnography. Notes: we did not include time for intubation because study authors did not report SDs with mean data.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: unknown, over a period of 1 year

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization tables
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias)	Low risk	No losses evident

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Bashir 2020 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All intubation were performed by a senior anaesthetist who has experience of at least 40 intubation in patients using VL." Experience still likely to favour DL

Bensghir 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 68 **Country:** Morocco **Setting**: theatre; single centre **Inclusion criteria**: age > 18 years; ASA I or II; scheduled for elective thoracic surgery **Exclusion criteria**: RSI; anticipated difficult airway; contraindication against use of DLT **Baseline characteristics** **X-lite** • Age, mean (SD): 41.8 (± 9) years • Gender M/F, n: 28/6 • BMI, mean (SD): 24 (± 2.9) kg/m^2 • ASA I/II/III/IV, n: 23/11/0/0 • Mallampati 1/2/3/4, n: 26/8/0/0 **Macintosh** • Age, mean (SD): 44.6 (± 10) years • Gender M/F, n: 29/5 • BMI, mean (SD): 22.98 (± 2.19) kg/m^2 • ASA I/II/III/IV, n: 20/14/0/0 • Mallampati 1/2/3/4, n: 24/10/0/0
Interventions	**General details**: anaesthetist had > 5 years' experience with use of DLT and training in the use of X-lite but no experience in use of X-lite with DLT. No details of experience with Macintosh provided. Stylet used in both groups. DLT used in both groups **X-lite** • Randomized = 34; no losses; analysed = 34 **Macintosh** • Randomized = 34; no losses; analysed = 34 **VL classification:** Macintosh-style

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Bensghir 2010 *(Continued)*

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as not successful after 3 attempts followed by intubation with alternative device • Hypoxia: desaturation to SpO_2 < 94% • Number of attempts • Airway trauma: dental trauma, oesophageal or vocal cord trauma or bleeding. Only data trauma data were extracted for inclusion into the meta-analysis • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from insertion of the blade into the mouth until capnography reading
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** March 2008–February 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Numbers concealed in envelopes until moment of intubation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Assumed outcome assessors were not blinded from outcomes measured in theatre
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Anaesthesiologist had > 5 years' experience with use of DLT and training in the use of X-lite but no experience in use of X-lite with DLT. No details of experience with Macintosh provided

Bensghir 2013

Study characteristics

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Bensghir 2013 *(Continued)*

Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** Morocco **Setting**: theatre; single centre **Inclusion criteria**: age > 18 years; ASA I or II; scheduled for elective thyroid surgery **Exclusion criteria**: anticipated difficult intubation; limited interdental distance; limited cervical mobility; limited thyromental distance or Mallampati 4; those needing RSI; those with gastro-oesophageal reflux; hiatus hernia; diabetes; obesity **Baseline characteristics** **Airtraq** • Age, mean (SD): 45.1 (± 8.8) years • Gender M/F, n: 14/21 • Weight, mean (SD): 70.8 (± 5.5) kg • Height, mean (SD): 1.72 (± 0.04) m • BMI, mean (SD): 24.1 (± 2.4) kg/m^2 • ASA I/II/III/IV, n: 23/12/0/0 • Mallampati 1/2/3/4, n: 14/11/8/2 **X-lite** • Age, mean (SD): 43.5 (± 11.1) years • Gender M/F, n: 11/24 • Weight, mean (SD): 71.1 (± 8.3) kg • Height, mean (SD): 1.73 (± 0.03) m • BMI, mean (SD): 23.9 (± 2.9) kg/m^2 • ASA I/II/III/IV, n: 28/7/0/0 • Mallampati 1/2/3/4, n: 16/13/5/1 **Macintosh** • Age, mean (SD): 48.8 (± 12.7) years • Gender M/F, n: 8/27 • Weight, mean (SD): 73.9 (± 8.2) kg • Height, mean (SD): 1.72 (± 0.04) m • BMI, mean (SD): 25.0 (± 3.1) kg/m^2 • ASA I/II/III/IV, n: 25/10/0/0 • Mallampati 1/2/3/4, n: 15/10/8/2
Interventions	**General details**: 3 intubators with experience of > 500 intubations with Macintosh and > 60 with X-lite and Airtraq. External laryngeal manoeuvres used, with bougie if needed **Airtraq** • Randomized = 35; no losses; analysed = 35 **X-lite** • Randomized = 35; no losses; analysed = 35 **Macintosh** • Randomized = 35; no losses; analysed = 35

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Bensghir 2013 *(Continued)*

- #3 blade

VL classification: channelled (Airtraq), Macintosh-style (X-lite)

Notes: we extracted outcomes for the Airtraq and X-lite devices separately into the channelled and Macintosh-style blade analyses respectively.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: an attempt was considered unsuccessful if it took > 120 s or SpO_2 fell below 92%. If > 3 attempts were required to intubate then it was considered to have failed and use of the alternate device was allowed
- Hypoxia: defined as oxygen saturation < 92%
- Number of attempts
- Airway trauma: presence of blood on blade, dental or laryngeal trauma. Only dental trauma data was used for inclusion in our analysis
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as sum of times for glottic visualization plus time from glottic visualization to tracheal intubation. Overall TTI was measured from the insertion of the blade into the patient's mouth until visualization of the capnography trace
- IDS: 0 = easy, 1-5 = slight difficulty, >5 moderate to major difficulty

Notes

Funding/sponsor/declarations of interest: none declared

Study dates: February 2011–March 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Concealed in envelopes, but no additional details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome assessors independent but not possible to blind assessors in theatre
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses after randomization
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Bensghir 2013 *(Continued)*

Experience of intubator	Low risk	Although intubators had less experience with X-lite, they were still sufficiently experienced in both devices.

Bhandari 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre **Inclusion criteria:** ASA I and II; age 16-65 years; either sex **Exclusion criteria:** patients with head injury; psychiatric disorder; respiratory tract (oropharynx, larynx) pathology; endocrine disorder; predicted difficult airway (such as mouth opening < 2 cm, modified Mallampati 3 and 4, BMI > 35 kg/m^2); gastroesophageal reflux disease; hiatus hernia; pregnancy **Baseline characteristics** **Airtraq** • Age, mean (SD): 38.30 (± 16.51) years • Gender M/F, n: 14/26 • Weight, mean (SD): 51.17 (± 7.95) kg • Height, mean (SD): 1.56 (± 0.06) m • BMI, mean (SD): 20.74 (± 1.99) kg/m^2 • ASA I/II/III/IV, n: 27/13/0/0 • Mallampati 1/2/3/4, n: 25/15/0/0 **Macintosh** • Age, mean (SD): 38.97 (± 13.68) years • Gender M/F, n: 10/30 • Weight, mean (SD): 51.75 (± 6.49) kg • Height, mean (SD): 1.56 (± 0.05) m • BMI, mean (SD): 21.42 (± 1.99) kg/m^2 • ASA I/II/III/IV, n: 28/12/0/0 • Mallampati 1/2/3/4, n: 22/18/0/0
Interventions	**General details**: relative experience and number of intubators was not specified. The use of optimization manoeuvres or a stylet was allowed and was reported in outcomes. **Airtraq** • Randomized = 40; no losses; analysed = 40 **Macintosh** (n = 40) • Randomized = 40; no losses; analysed = 40 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors**

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Bhandari 2013 *(Continued)*

Dichotomous outcomes

- Failed intubation: defined as when the trachea could not be intubated despite optimization manoeuvres, or requiring >120 s to perform intubation
- Number of attempts
- Airway trauma: dental trauma data only extracted
- Patient-reported sore throat

Continuous outcomes

- Time for tracheal intubation: defined as the time elapsed from insertion of the blade between the dental arches until the tracheal tube was placed through the vocal cords and confirmed by chest rise, auscultation, and square wave capnography.

Notes: 2 participants were not intubated on the first attempt with the Macintosh blade. Both were intubated successfully with the Airtraq (the alternate device) on the second attempt and we included them in our analysis in the "number of attempts" outcome on an ITT basis. POGO scores were reported in quartile categories and could not be extracted for use in our analysis. Patient-reported sore throat was reported on a subjective scale 0-3, which we have extracted as a dichotomous outcome in which any score of ≥ 1 was included as an instance of sore throat.

Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random tables
Allocation concealment (selection bias)	Unclear risk	No description
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	No mention of intubator

Bhat 2015

Study characteristics

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Bhat 2015 *(Continued)*

Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** India **Setting:** single centre; theatre **Inclusion criteria**: age ≥ 18 years; ASA I, II or III **Exclusion criteria**: increased risk of pulmonary aspiration; C-spine pathology; anticipated airway difficulties (e.g. Mallampati 4 or thyromental distance < 6 cm) **Baseline characteristics** **C-MAC** • Age, mean (SD): 37.02 (± 15.13) years • Gender M/F, n: 33/17 • Weight, mean (SD): 48.8 (± 7.90) kg • Mallampati 1/2/3/4, n: 31/19/0/0 **Macintosh** • Age, mean (SD): 36.92 (± 15.1) years • Gender M/F, n: 25/33 • Weight, mean (SD): 50.54 (± 8.46) kg • Mallampati 1/2/3/4: 36/14/0/0
Interventions	**General details**: all participants were intubated by a consultant anaesthetist well versed with the use of both the C-MAC laryngoscope and a conventional laryngoscope. Use of additional equipment was reported as an outcome. **C-MAC** • Randomized = 50; no losses; analysed = 50 • No explicit mention of blade used for C-MAC, Macintosh-style assumed **Macintosh** • Randomized = 50; no losses; analysed = 50 **VL classification:** Macintosh-style Notes: all participants were intubated in the lateral position.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to intubate the trachea within 3 attempts • Hypoxia: defined as SpO_2 < 95% • Number of attempts: any single insertion of the laryngoscope past the patient's lips was considered an intubation attempt • Airway trauma: dental injury • CL grade • Mortality • Oesophageal intubation **Continuous outcomes**

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Bhat 2015 *(Continued)*

	• Time for tracheal intubation: defined as the time from picking up the laryngoscope to confirmation of tracheal intubation by capnography. Notes: study authors also reported lip injury and blood detected on the device. We did not include these data in 'airway trauma'
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	All participants intubated by a consultant anaesthetist well versed in the use of both DL and VL. Extent of experience with VL unclear.

Bilehjani 2009

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 78 **Country:** Iran **Setting**: theatre; single centre **Inclusion criteria:** patients scheduled for elective CABG **Exclusion criteria:** patients with renal disease; hepatic disease; bleeding diathesis; diabetes mellitus; Mallampati 3 or 4; history of a difficult intubation; ASA class IV **Baseline characteristics**

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Bilehjani 2009 *(Continued)*

	GlideScope • Age, mean (SD): 57.28 (± 9.91) years • Gender M/F, n: 23/17 • Weight, mean (SD): 71.45 (± 12.16) kg • Height, mean (SD): 1.64 (± 0.1) m • Mallampati 1/2/3/4, n: 21/16/3/0 **Macintosh** • Age, mean (SD): 58.58 (± 10.87) years • Gender M/F, n: 29/9 • Weight, mean (SD): 72.26 (± 15.47) kg • Height, mean (SD): 1.65 (± 0.08) m • Mallampati 1/2/3/4, n: 25/12/1/0
Interventions	**General details**: reportedly an experienced intubator, but no specific details provided. Use of stylet in both groups was allowed when required **GlideScope** • Randomized = 40; no losses reported; analysed = 40 **Macintosh** • Randomized = 40; losses = 2 (for prolonged postoperative intubation); analysed = 38 (n = 38) • #3 or #4 blade **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to intubate participant within 2 attempts • Number of attempts • Airway trauma: bleeding or trauma to lips, teeth or tongue. Dental trauma was not reported separately therefore we were unable to extract data for this outcome. • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as "time from opening mouth to filling the tube cuff"
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** July – November 2008

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Using online software (http://www.graphpad.com/quickcalcs/randomize1.cfm), patients were randomly allocated" Computer-generated randomization method
Allocation concealment (selection bias)	Unclear risk	Not described

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Bilehjani 2009 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	No mention of blinding; unlikely as timing of intubation was involved
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Two patients were excluded because of long postoperative intubation period" Low number, unlikely to cause bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"All of tracheal intubations were performed by experienced anaesthetists" The specific extent of experience with each device was not clear.

Blajic 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 180 **Country:** Slovenia **Setting:** theatre; single centre **Inclusion criteria**: women undergoing caesarean sections (category 2–4) under GA **Exclusion criteria**: predicted difficult airway requiring awake intubation; ASA > III; allergy to any study medication; category-1 caesarean section **Baseline characteristics** **King Vision** • Age, mean (SD): 33 (± 5) years • Gender M/F, n: 0/59 • BMI, mean (SD): 29 (± 4) kg/m^2 • ASA I/II/III/IV, n: 0/52/7/0 • Mallampati 1/2/3/4, n: 5/34/20/0 **C-MAC** • Age, mean (SD): 33 (± 5) years • Gender M/F, n: 0/59 • BMI, mean (SD): 30 (± 5) kg/m^2 • ASA I/II/III/IV, n: 0/52/8/0 • Mallampati 1/2/3/4, n: 13/34/12/1 **Macintosh**

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Blajic 2019 *(Continued)*

- Age, mean (SD): 32 (± 5) years
- Gender M/F, n: 0/59
- BMI, mean (SD): 27 (± 4) kg/m^2
- ASA I/II/III/IV, n: 0/52/7/0
- Mallampati 1/2/3/4, n: 12/32/14/1

Notes: these were pregnant women undergoing caesarean section.

Interventions	**General details**: laryngoscopy was attempted by 1 of the 3 attending anaesthetists, all of whom had performed > 30 intubations with the respective devices. Participants were induced with RSI with cricoid force applied **King Vision** • Randomized = 60; losses = 1 (incomplete data); analysed = 59 • Channelled #3 blade used. **C-MAC** • Randomized = 60; no losses; analysed = 60 • An "appropriately sized" Macintosh blade used - #3 or #4 assumed. All tracheal tubes pre-styletted **Macintosh** • Randomized = 60; losses = 1 (incomplete data); analysed = 59 • An "appropriately sized" Macintosh blade used – #3 or #4 assumed. All tracheal tubes pre-styletted **VL classification:** Macintosh-style (C-MAC), channelled (King Vision)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt to place the tracheal tube involve > 2 intubating attempts, failure to place the tube in the trachea within 60 s or desaturation to < 92% • Number of attempts: each subsequent attempt defined as a re-insertion of the laryngoscope blade • Airway trauma: lip lacerations and mucosal bleeding. Dental injury was not explicitly reported in results therefore no data were extracted for this outcome. • Patient-reported sore throat • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the interval between insertion of the blade and detection of the $ETCO_2$ (CO_2 signal) • IDS Notes: IDS reported on VAS 0-100 as median (IQR). Need for additional optimization manoeuvres reported
Notes	**Funding/sponsor/declarations of interest**: this study was funded from the Department of Anaesthesia and Intensive Therapy, University Medical Centre Ljubljana, Slovenia. 1 study author was given trial products for clinical use and evaluation from Ambu, Cook Medical, Storz and Fannin; he also received funding for travel and accommodation to give lectures from Covidien and has received equipment to conduct airway workshops from Storz, Ambu and Fannin. No other external funding or competing interests declared **Study dates:** March 2015–December 2016
Risk of bias	

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Blajic 2019 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants excluded from analysis due to incomplete data, unlikely to affect results
Selective reporting (reporting bias)	Unclear risk	Examined trial registration (ACTRN12616000527460). Retrospectively registered. All prespecified outcomes reported
Experience of intubator	Low risk	"Laryngoscopy was attempted by one of the three attending anaesthetists, all of whom had performed > 30 intubations with the respective devices."

Buhari 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single-centre **Inclusion criteria:** ASA I patients; 18-40 years of age; elective surgery under GA **Exclusion criteria:** **Baseline characteristics** **C-MAC D-BLADE** • Age, mean (SD): 32 (± 5.8) years • Weight, mean (SD): 67.8 (± 13.9) kg • Height, mean (SD): 1.64 (± 0.08) m **Macintosh** • Age, mean (SD): 28.6 (± 6.8) years • Weight, mean (SD): 62.0 (± 11.6) kg • Height, mean (SD): 1.58 (± 0.05) m

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Buhari 2016 *(Continued)*

	Notes: a third arm compared the McCoy laryngoscope. We did not include this study arm in the review because it was not eligible.
Interventions	**General details**: laryngoscopy and intubation were performed by a single senior anaesthetist in all cases, who was familiar and experienced in intubation using both McCoy and C-MAC laryngoscope. The tracheal tubes were loaded with stylet shaped in a hockey stick fashion in all participants. **C-MAC D-BLADE** • Randomized = 30 **Macintosh** • Randomized = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** Notes: this study only reported haemodynamic outcomes and no outcomes relevant to this review.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Cakir 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 62 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria:** patients undergoing elective bariatric surgery; ASA II-III; age 18-65 years **Exclusion criteria:** patients with a history of a difficult airway; known airway pathology; spinal cord surgery **Baseline characteristics** **McGrath** • Age, mean (SD): 42.0 (± 10.5) years • Gender M/F, n: 7/24 • BMI, mean (SD): 46.1 (± 6.6) kg/m^2 • Mallampati 1/2/3/4, n: 2/11/17/1 **Macintosh** • Age, mean (SD): 39.0 (± 9.8) years • Gender M/F, n: 3/28 • BMI, mean (SD): 46.5 (± 4.2) kg/m^2 • Mallampati 1/2/3/4, n: 1/12/16/2

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Cakir 2020 *(Continued)*

	Notes: this study included only obese patients.
Interventions	**General details**: all participants were intubated by an anaesthetist who was experienced in both devices. **McGrath** • Randomized = 31; no losses; analysed = 31 • All tracheal tubes preloaded with stylet **Macintosh** • Randomized = 31; no losses; analysed = 31 **VL classification:** Macintosh-style Notes: McGrath laryngoscope blade/device type not specified, MAC assumed. Blade sizes used not further specified
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: any intubation attempt that lasted > 3 times or > 120 s • Number of attempts • Airway trauma: dental trauma data only extracted • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the time from the laryngoscope blade being placed into the mouth until the $ETCO_2$ level was seen. The CL grade was dichotomized into 2 groups of 1-2I and 3-4. We therefore could not extract data for the meta-analysis. For airway trauma, study authors also reported complications of bleeding, laceration, and 'other issues' as composite data.
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declared no conflicts of interest **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers list
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias)	High risk	Not possible to fully blind outcome assessors

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Cakir 2020 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"All patients were intubated by an anaesthetist who was experienced in both devices." No further detail provided

Caparlar 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 78 **Country:** Turkey **Setting:** theatre **Inclusion criteria:** patients aged 18- 65 years; ASA I-II; undergoing elective surgery under GA **Exclusion criteria**: a known allergy; elevated IOP; glaucoma; a history of eye surgery; intubation likely to be difficult **Baseline characteristics** **C-MAC** • Age, mean (SD): 48.44 (± 11.75) years • Gender M/F, n: 20/19 • BMI, mean (SD): 26.9 (± 1.6) kg/m^2 • ASA I/II/III/IV, n: 27/12/0/0 **Macintosh** • Age, mean (SD): 44.1 (± 12.23) years • Gender M/F, n: 21/18 • BMI, mean (SD): 26.18 (± 2.69) kg/m^2 • ASA I/II/III/IV, n: 24/15/0/0
Interventions	**General details**: no account of intubator experience **C-MAC** • Randomized = 39, no losses; analysed = 39 **Macintosh** • Randomized = 39; no losses; analysed = 39 **VL classification:** Macintosh-style

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Caparlar 2019 *(Continued)*

	Notes: unclear what blade was used with C-MAC, Macintosh-style blade assumed
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Patient-reported sore throat • CL grade **Continuous outcomes** • Time for tracheal intubation: the time from the laryngoscope entering the mouth to removal with $ETCO_2$ on the monitor Notes: the study examined postoperative sore throat at 10 min and 24 h time points postoperatively. We extracted data from the 10 min time point for use in our analysis. It was assumed that the unit of TTI measurement was published in error as "minutes" (not seconds).
Notes	**Funding/sponsor/declarations of interest:** statement indicating no conflicts of interest or financial support **Study dates:** January 2017-August 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Random computer allocation."
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear from manuscript
Selective reporting (reporting bias)	Unclear risk	The clinical trial registration (NCT03279172) was examined. It is unclear whether the trial was registered prospectively or retrospectively. There are no apparent omissions in outcomes reported.
Experience of intubator	Unclear risk	Not reported

Carassiti 2013

Study characteristics

Methods	RCT; cross-over design

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Carassiti 2013 *(Continued)*

Participants	**Total number of participants:** 30 **Country:** Italy **Setting**: theatre; single centre **Inclusion criteria**: adult patients scheduled for elective surgery under GA; aged > 18 years to < 65 years; ASA I or II **Exclusion criteria:** patients likely to be difficult to intubate according to recommendations from the Italian Society of Anesthesia Resuscitation and Intensive Care, Task Force on Difficult Airway Management (see Petrini 2005) **Baseline characteristics** **GlideScope followed by Macintosh** • Age, mean (SD): 44 (± 11) years • Gender M/F, n: 8/7 • BMI, mean (SD): 25.5 (± 3) kg/m^2 **Macintosh followed by GlideScope** • Age, mean (SD): 41 (± 12) years • Gender M/F, n: 8/7 • BMI, mean (SD): 26.4 (± 2.8) kg/m^2
Interventions	**General details**: single intubator experienced in both techniques; > 100 intubations with each device **Macintosh followed by GlideScope** • Randomized = 15; no losses reported; analysed = 15 • Laryngoscopy with Macintosh DL; intubated with GlideScope VL • #4 blade, hockey-stick stylet used **GlideScope followed by Macintosh** • Randomized = 15; no losses reported; analysed = 15 • Laryngoscopy with GlideScope VL; intubated with Macintosh DL • #3 or #4 blade **VL classification:** hyperangulated Notes: for the meta-analysis, intubation-related outcomes taken from the device patients were intubated with.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined in the study • Airway trauma: airway "injuries" or dental trauma. We only extracted dental trauma data for inclusion **Continuous outcomes** • Time for tracheal intubation: defined as time from insertion of blade between incisors until tube cuff was inflated.
Notes	**Funding/sponsor/declarations of interest**: departmental funding only; no conflicts of interest **Study dates:** not reported

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Carassiti 2013 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of a random number generator
Allocation concealment (selection bias)	Unclear risk	"Numbered coded vehicles was the method used to achieve allocation concealment". Not clear what this means and whether this is sufficient
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Participants blinded to group assignment, but intraoperative data collected by non-blinded anaesthetists and caregivers
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents
Experience of intubator	Low risk	Single intubator experienced in both techniques; > 100 intubations with each device

Castillo-Monzon 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 46 **Country:** Spain **Setting:** theatre; single centre **Inclusion criteria:** BMI ≥ 40 kg/m^2; ≥ 18 years; ASA III **Exclusion criteria**: background of difficult intubation, except morbid obesity as the only factor; gastroesophageal symptomatic reflux; gastric bands; urgent surgery; rigid C-spine; mouth opening < 2.5 cm; allergy to any of the drugs used during the procedure **Baseline characteristics** **Airtraq** • Age, mean (SD): 43.43 (± 12.77) years • Gender M/F, n: 5/18 • BMI, mean (SD): 45.97 (± 3.61) kg/m^2

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Castillo-Monzon 2017 *(Continued)*

- Mallampati 1/2/3/4, n: 1/9/13/0

Macintosh

- Age, mean (SD): 41.57 (± 9.02) years
- Gender M/F, n: 6/17
- BMI, mean (SD): 46.87 (± 4.38) kg/m^2
- Mallampati 1/2/3/4, n: 2/14/7/0

Notes: these were morbidly obese patients

Interventions	**General details**: airway management of the participants was performed by only 1 of the researchers with 19 years of experience in the use of the Macintosh laryngoscope and who had performed 30 tracheal intubations with the Airtraq laryngoscope before starting the research. **Airtraq** • Randomized = 23; no losses; analysed = 23 **Macintosh** • Randomized = 23; no losses; analysed = 23 **VL classification:** channelled Notes: need for adjuncts and manoeuvres reported as outcomes
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: > 5 attempts were regarded as a failure of intubation • Hypoxia: hypoxaemia was considered if SpO_2 was < 92% • Number of attempts: the success of the intubation was expressed by the number of intubation attempts, being established that if the intubation failed at the first attempt, an additional attempt could be made with the same laryngoscope, and after a second attempt, it would be changed to another type of laryngoscope. • Airway trauma: dental trauma data only extracted • CL grade • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from the insertion of the blade between the teeth until the tracheal tube was placed through the vocal cords, evidenced by the direct visual confirmation of the anaesthetist and confirmed by the presence of CO_2 in the exhaled flow. Notes: there is a discrepancy of definitions of failed intubation as compared to the definition proposed in our review. We defined the need for change of device, which in this study would happen after 2 intubation attempts, as failed intubation. Data extracted accordingly. CL scores reported in dichotomized fashion (using modified CL scores), not permitting data extraction. Data on IDS scores was insufficient to allow extraction. Study authors reported other airway trauma (lip trauma, oral epithelium trauma, blood-stained laryngoscope)
Notes	**Funding/sponsor/declarations of interest:** study authors state that they received no financial support and that they have no conflicts of interest. **Study dates:** not reported

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Castillo-Monzon 2017 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Airway management of the studied patients was performed by only one of the researchers with 19 years of experience in the use of the Macintosh laryngoscope and who had performed 30 tracheal intubations with the Airtraq laryngoscope before starting the research."

Cattano 2013

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 50 **Country:** USA **Setting:** theatre; single centre **Inclusion criteria**: age 18-80 years; ASA I-III; Mallampati 1-3 **Exclusion criteria**: history of difficult airway; potential risks factors for difficult intubation: morbidly obese patients with BMI ≥ 40 kg/m^2, Mallampati > 3, mouth opening < 3 cm, neck movement > 2 on a scale of 1 (no reduction) to 3 (severe reduction) **Baseline characteristics** **C-MAC Direct first (intubated indirect)** • Age, mean (SD): 46.2 (± 14.2) years • Gender M/F, n: 7/18 • BMI, mean (SD): 30.4 (± 6.6) kg/m^2

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Cattano 2013 *(Continued)*

- ASA I/II/III/IV, n: 2/13/10/0
- Mallampati 1/2/3/4, n: 11/11/3/0

C-MAC Indirect first (intubated direct)

- Age, mean (SD): 49.1 (± 15.2) years
- Gender M/F, n: 8/17
- BMI, mean (SD): 29.4 (± 5.9) kg/m^2
- ASA I/II/III/IV, n: 1/16/8/0
- Mallampati 1/2/3/4, n: 8/12/5/0

Interventions	**General details**: all intubations were performed by an anaesthesiology resident under the direct supervision of an attending. All intubators and the attendings were trained and performed a minimum of 3 intubations with the C-MAC VL prior to commencing the study. **Storz C-MAC Direct first:** • Randomized = 25; no losses; analysed = 25 • #3 blade **Storz C-MAC Indirect first:** • Randomized = 25; no losses; analysed = 25 • #3 blade **VL classification:** Macintosh-style Notes: all participants were intubated with a Storz C-MAC VL, used either as a DL or an indirect/VL. Participants in the Direct first group had laryngoscopy performed as with a DL and subsequent second laryngoscopy and intubation after looking at the screen. Participants in the Indirect first group had laryngoscopy performed via the video screen first and subsequent second laryngoscopy and intubation without looking at the screen, as with a DL. Intubators were instructed to perform the first intubation without a stylet in the tracheal tube. Intubators were allowed a maximum of 1 unsuccessful intubation with a tracheal tube that was not styletted.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt: number of attempts not reported explicitly. "With the exception of one patient in the direct first group, all patients were successfully intubated on the first attempt." Data were extracted for first pass success, but not for number of attempts • CL grade: reported for laryngoscopy prior to and after BURP, and first and second laryngoscopy separately. Data were extracted for laryngoscopy without BURP **Continuous outcomes** • Time for tracheal intubation: defined as the time from holding the tracheal tube to the first CO_2 trace after successful intubation. Notes: we did not include the TTI in our analysis as the definition of the outcome differed significantly from other studies and our proposed definition. Ease of intubation was assessed on a subjective scale from 1-5. This outcome is not of interest to our analysis.
Notes	**Funding/sponsor/declarations of interest:** Storz (Germany) provided financial support for the conduct of this study. The company did not have any role in the drafting, editing, or approval of this manuscript. No competing interest declared.

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Cattano 2013 *(Continued)*

Study dates: February–September 2010

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Immediately before induction of anesthesia, each patient randomization was revealed by computer generated assignment. No blocked randomization was used."
Allocation concealment (selection bias)	Low risk	"Immediately before induction of anesthesia, each patient randomization was revealed by computer generated assignment. No blocked randomization was used."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT01104090). Trial registered retrospectively, all prespecified outcomes reported in final manuscript
Experience of intubator	Unclear risk	"Laryngoscopy and intubation were performed by an anesthesiology resident physician under direct supervision of an attending anesthesiologist. All the residents and the attending anesthesiologists were trained based on manufacturer's recommendations and performed a minimum of three intubations with the C-MAC VL prior to working on any patients in clinical conditions, as well as three laryngoscopy and intubations on a manikin to simulate the study conditions (attempts, direct indirect first, positioning, timing, and record collection)." Unclear what the potential imbalance between experience with DL and VL might have been

Cavus 2011

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 150 **Country:** Germany **Setting:** theatre; single-centre **Inclusion criteria:** ASA I-III; scheduled for elective surgery in supine position with GA, requiring tracheal intubation

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Cavus 2011 *(Continued)*

Exclusion criteria: pathology of the upper respiratory or alimentary tract known or suspected; RSI indicated; awake intubation appropriate because of a suspected or known difficult airway

Baseline characteristics

C-MAC #3

- Age, median (range): 54 (20-74) years
- Gender M/F, n: 10/27
- Height, median (range): 168 (150-186) cm
- Weight, median (range): 76 (54-98) kg
- BMI, median (range): 27 (20-40) kg/m^2
- Mallampati 1/2/3/4, n: 8/23/6/0

Macintosh

- Age, median (range): 49 (23-82) years
- Gender M/F, n: 21/29
- Height, median (range): 170 (156-196) cm
- Weight, median (range): 81 (60-179) kg
- BMI, median (range): 27 (20-63) kg/m^2
- Mallampati 1/2/3/4, n: 16/20/13/1

C-MAC #4

- Age, median (range): 46 (34-72) years
- Gender M/F, n: 11/7
- Height, median (range): 173 (163-188) cm
- Weight, median (range): 82 (54-150) kg
- BMI, median (range): 27 (20-40) kg/m^2
- Mallampati 1/2/3/4, n: 4/6/7/1

C-MAC #4/SBT

- Age, median (range): 58 (27-79) years
- Gender M/F, n: 28/17
- Height, median (range): 173 (155-193) cm
- Weight, median (range): 78 (48-135) kg
- BMI, median (range): 27 (19-44) kg/m^2
- Mallampati 1/2/3/4, n: 9/21/15/0

Interventions

General details: 1 of 3 anaesthetists with ≥ 8 years' experience (after training with manikins for C-MAC scope)

C-MAC #3:

- Randomized = 37; no losses reported; analysed = 37
- #3 blade

C-MAC #4:

- Randomized = 18; no losses reported; analysed = 18
- #4 blade
- Note that part way through the study (after the first 50 participants) participants were instead randomized to the C-MAC #4/SBT group

C-MAC #4/SBT:

- Randomized = 45; no losses reported; analysed = 45

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Cavus 2011 *(Continued)*

- #4 blade used as a Miller blade (lifting the epiglottis)
- Participants were only allocated to this group after the first 50 participants had been randomized in the study

Macintosh:

- Randomized = 50; no losses reported; analysed = 50
- #3 or #4 blade

VL classification: Macintosh-style

Notes: the study authors state, "all patients underwent three separate laryngoscopies using the standard Macintosh laryngoscope with an appropriate size 3 or 4, the C-MAC size 3, and the C-MAC size 4 VL, respectively, in the sequence determined by randomisation". After 50 participants, C-MAC #4 was changed to a straight blade technique (C-MAC #4/SBT). Intubation was performed with the last device used for laryngoscopy.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as intubated with alternative device owing to limited glottic visualization
- Number of attempts
- Airway trauma: any palatoglossal arch or dental injury. Only dental trauma data extracted for inclusion
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from touching tube to performing successful endotracheal placement

Notes: not possible to extract CL grade data as reported grouped. We combined the data for time for tracheal intubation for VL devices as per Higgins 2021.

Notes

Funding/sponsor/declarations of interest: equipment supplied by Storz manufacturer. 1 study author is a member of the Storz advisory team and receives grant support for airway management studies.

Study dates: not reported

Additional: cross-over study with 3 arms, changed to 4 arms part of the way through the study. High risk of bias was introduced by changing protocol part of the way through.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias)	High risk	Not possible to fully blind outcome assessors

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Cavus 2011 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	High risk	Protocol changed part of the way through the study - data not provided before and after protocol change. Therefore, not possible to assess whether high levels of bias were introduced by the decision. An additional group was introduced part of the way through the study, which led to exclusion of some participants from C-MAC groups.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	1 of 3 anaesthetists with ≥ 8 years' experience (after training with manikins for C-MAC scope). Although personnel are described as experienced, the level of experience with C-MAC is unclear.

Cengiz 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria**: normotensive and hypertensive patients; aged 18-75 years; scheduled to undergo elective surgery under GA **Exclusion criteria:** patients < 18 years of age; known difficult intubation history; ejection fraction < 40%; Mallampati 3-4; ASA IV or V; preoperative SBP > 180 mmHg or DBP > 100 mmHg **Baseline characteristics:** patients were divided into 2 groups (hypertensive, normotensive) and then randomized to VL or DL thereafter. Baseline characteristics reported for hypertensive and normotensive groups only, so we were not able to extract data for each device, respectively.
Interventions	**General details**: all intubations were performed by the same anaesthetist who had 3 years of experience (Macintosh DL > 1500 times, C-MAC VL > 100 times) **C-MAC** • Randomized = 100; no losses • #3 for women, #4 for men **Macintosh** • Randomized = 100; no losses • #3 for women, #4 for men **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation

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Cengiz 2019 *(Continued)*

	Notes: the only outcome relevant to this review reported in the study was time to tracheal intubation, which was reported as median (IQR). We did not convert it to mean (SD) as the data might have had a skewed distribution.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** June 2016–March 2018 Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Cha 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Korea **Setting:** theatre; single-centre **Inclusion criteria:** ASA I or II; requiring tracheal intubation for elective surgery **Exclusion criteria**: poor dentition; previous history of difficult intubation; refusal to participate **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 43.2 (± 16.92) years • Gender M/F, n: 30/30 • Weight, mean (SD): 66.5 (± 12.69) kg • Height, mean (SD): 1.63 (± 0.08) m • ASA I/II/III/IV, n: 41/19/0/0 • Mallampati 1/2/3/4, n: 49/9/2/0 **Macintosh** • Age, mean (SD): 42.7 (± 15.48) years • Gender M/F, n: 28/32 • Weight, mean (SD): 64.4 (± 11.10) kg • Height, mean (SD): 1.64 (± 0.08) m • ASA I/II/III/IV, n: 44/16/0/0 • Mallampati 1/2/3/4, n: 53/6/1/0
Interventions	**General details**: all intubations performed by an anaesthetist with 3 years' prior experience on patients and manikins, which the study authors define as sufficient. **Pentax AWS** • Randomized = 60; no losses; analysed = 60 **Macintosh** • Randomized = 60; no losses; analysed = 60 **VL classification:** channelled

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Cha 2009 *(Continued)*

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Sore throat: reported as none/mild/moderate/severe. We only extracted data for moderate and severe **Continuous outcomes** • POGO score • Time for tracheal intubation: defined from the time when the laryngoscope enters the mouth to the time the tracheal tube passes the vocal cords Notes: the study primarily reported haemodynamic outcomes.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Simple random sampling method using cards
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	All intubations performed by an anaesthetist with 3 years' prior experience on patients and manikins, which the authors define as sufficient.

Chalkeidis 2010

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 63

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Chalkeidis 2010 *(Continued)*

Country: Greece

Setting: theatre; single centre

Inclusion criteria: ASA I-III; scheduled to undergo elective surgery

Exclusion criteria: patients requesting regional anaesthesia; need for armoured tracheal tube; need for nasotracheal tracheal tube; history of impossible or difficult intubation; emergency surgery

Baseline characteristics

Airtraq

- Age, mean (SD): 36.4 (± 16.4) years
- Weight, mean (SD): 82.5 (± 17.3) kg
- Height, mean (SD): 1.75 (± 0.09) m
- BMI, mean (SD): 26.7 (± 4.2) kg/m^2
- Mallampati 1/2/3/4, n: 19/6/10/0

Macintosh

- Age, mean (SD): 38.5 (± 17.2) years
- Weight, mean (SD): 80.6 (± 14.8) kg
- Height, mean (SD): 1.72 (± 0.08) m
- BMI, mean (SD): 26.9 (± 3.6) kg/m^2
- Mallampati 1/2/3/4, n: 13/9/5/1

Interventions

General details: 4 anaesthetists were involved in this study. They were all consultants with similar experience and none of them had ever used the Airtraq laryngoscope prior to this study. They each performed 15 intubations with the Airtraq laryngoscope before data collection.

Airtraq

- Randomized = 35; losses = 2 (outlying data for time to intubation); analysed for time to intubation = 33; analysed for failed intubation = 35

Macintosh

- Randomized = 28; losses = 3 (outlying data for time to intubation; analysed for time to intubation = 25; analysed for failed intubation = 28
- #3 blade

VL classification: channelled

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation

Continuous outcomes

- Time for tracheal intubation

Notes

Funding/sponsor/declarations of interest: the study authors declare no conflicts of interest and make no financial disclosures.

Study dates: October 2007–May 2008

Risk of bias

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Chalkeidis 2010 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer software randomization
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Small number of participants excluded from analysis of time to intubation owing to outlying data; data for outliers were provided separately and we judged that study was at low risk of attrition bias.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	4 anaesthetists versed in DL, but minimal to no prior experience with Airtraq

Chandrashekaraiah 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Bahrain **Setting:** theatre; single centre **Inclusion criteria:** ASA I and II; age 18-65 years; no predictors of difficult airway; undergoing elective surgery requiring GA with tracheal intubation **Exclusion criteria**: previous neck surgery; unstable C-spine; trauma; obesity; emergency surgery; patients with previous burns; chronic obstructive pulmonary disease; asthma; chest infections within last 4 weeks **Baseline characteristics** **C-MAC** • Age, mean (SD): 36.43 (± 11.48) years • Gender M/F, n: 17/13 • Weight, mean (SD): 74.90 (± 17.82) kg • Height, mean (SD): 1.66 (± 0.11) m • BMI, mean (SD): 27.03 (± 5.21) kg/m^2 **Macintosh**

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Chandrashekaraiah 2017 *(Continued)*

- Age, mean (SD): 40.90 (± 14.30) years
- Gender M/F, n: 19/11
- Weight, mean (SD): 75.13 (± 8.00) kg
- Height, mean (SD): 1.65 (± 0.07) m
- BMI, mean (SD): 27.68 (± 3.12) kg/m^2

Notes:

All patients had MILS applied, simulated a difficult airway.

Interventions	**General details**: a single experienced anaesthetist performed all intubations. Not clear from manuscript what the extent of experience was. **C-MAC** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** Macintosh-style Notes: MILS was applied to all participants prior to intubation and after induction
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade **Continuous outcomes** • IDS Notes: the authors also report haemodynamic outcomes, which were not relevant to this review
Notes	**Funding/sponsor/declarations of interest**: not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomization done using validated online software
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias)	Low risk	No losses evident

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Chandrashekaraiah 2017 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"An assigned experienced anaesthetist did the laryngoscopy in order to avoid subjective bias." No further quantification of experience provided

Chen 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 440 **Country:** China **Setting:** theatre; single centre **Inclusion criteria:** patients scheduled to undergo intubation under GA for elective surgery; age 18-60 years; ASA physical status I-III; no upper airway abnormality; no airway infection; written informed consent for study participation **Exclusion criteria**: no exclusion criteria reported **Baseline characteristics** **UEScope** • Age, mean (SD): 45.03 (± 0.96) years • Gender M/F, n: 117/102 • Weight, mean (SD): 61.43 (± 0.90) kg • Height, mean (SD): 1.63 (± 0.05) m • BMI, n: <18.5 kg/m^2: 22; 18.5-23.9 kg/m^2: 117; 24-28 kg/m^2: 66; >28 kg/m^2: 14. • ASA I/II/III/IV, n: 75/131/13/0 • Mallampati 1/2/3/4, n: 97/104/15/3 **Macintosh** • Age, mean (SD): 45.69 (± 1.05) years • Gender M/F, n: 115/102 • Weight, mean (SD): 60.03 (± 0.65) kg • Height, mean (SD): 1.63 (± 0.05) m • BMI, n: <18.5 kg/m^2: 24; 18.5-23.9 kg/m^2: 129; 24-28 kg/m^2: 56; >28 kg/m^2: 8. • ASA I/II/III/IV, n: 92/115/10/0 • Mallampati 1/2/3/4, n: 90/108/19/0 Notes: BMI reported as dichotomous variables
Interventions	**General details**: all intubations were carried out by 1 of 6 expert anaesthetists, who were skilled in different laryngoscopic techniques and had work experience of > 5 years. **UEScope**

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Chen 2019 *(Continued)*

- Randomized = 220; losses = 1 (change to intubation method because of failure with UEScope) analysed for failed intubation = 220; analysed for other outcomes = 219

Macintosh

- Randomized = 220; losses = 3 (change to intubation method because of failure with Macintosh) analysed for failed intubation = 220; analysed for other outcomes = 217

VL classification: hyperangulated

Notes: blade sizes not reported

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: recorded when the tube could not be successfully placed within 2 attempts • Successful first attempt • Number of attempts • CL grade **Continuous outcomes** • Time for tracheal intubation: measured from the moment of blade insertion into the patients' mouth to the first capnography upstroke after intubation Notes: the final analysis excluded failed intubations. For the purposes of data extraction for that specific outcome we used 220 as the denominator in both groups. The primary outcome was the anaesthetist's perception of patients' oral malodour.
Notes	**Funding/sponsor/declarations of interest:** study authors stated that they received no funding and that they have no conflicts of interests. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Low risk	Sealed envelopes revealed when the patient was in theatre
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors. Participants were blinded to the type of laryngoscopy that was carried out.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intubation failures (4 participants) excluded from final analysis but accounted for in manuscript, and represented few overall losses

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Chen 2019 *(Continued)*

Selective reporting (reporting bias)	Low risk	We examined the publicly available trial registration data published (ChiCTR-IOR15007038). The trial was prospectively registered and all outcomes reported.
Experience of intubator	Unclear risk	All intubations were carried out by 1 of 6 expert anaesthetists, who were skilled in different laryngoscopic techniques and had work experience of > 5 years. Specific extent of experience with study devices not specified

Choi 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Korea **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II; scheduled to undergo GA; aged 15-60 years **Exclusion criteria**: thyroid-to-chin length ≤ 5 cm; Mallampati class ≥ 3; mouth opening < 3 cm; restriction in neck extension or protruding front teeth; predicted to be difficult in intubation; airway difficulty score > 8 **Baseline characteristics** **GlideScope** • Age, mean (SD): 39.5 (± 13.4) years • Gender M/F, n: 16/14 • Weight, mean (SD): 64.5 (± 9.2) kg • Height, mean (SD): 1.66 (± 0.08) m **Macintosh** • Age, mean (SD): 43.0 (± 14.9) years • Gender M/F, n: 15/15 • Weight, mean (SD): 61.2 (± 11.7) kg • Height, mean (SD): 1.63 (± 0.11) m Notes: some participants were < 18 years of age and were not separated in the data.
Interventions	**General details**: all intubations performed by 1 anaesthetist, fully experienced and familiar with GlideScope. Use of cricoid force by an assistant in both groups. **GlideScope** • Randomized = 30; no losses reported; analysed = 30 **Macintosh** • Randomized = 30; no losses reported; analysed = 30 • #3 blade **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors**

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Choi 2011 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as time from when anaesthetist grabbed handle to when tube passed vocal cords • POGO score: 0%-100% Notes: ease of intubation reported on VAS by intubator (0 most easy - 10 most difficult). We did not extract these data for inclusion in our analysis.
Notes	**Funding/sponsor/declarations of interest**: none reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"All patients were randomly allocated" Randomization method not otherwise specified
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No evident losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Study was carried out by a fully experienced anaesthetist familiar with the GlideScope". No further detail provided on extent of experience with study devices

Colak 2015

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 150 **Country:** Turkey **Setting**: theatre; single centre

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Colak 2015 *(Continued)*

Inclusion criteria: patients who were to undergo GA for abdominal surgery; ASA I-III; aged 20-75 years

Exclusion criteria: history of emergency intubation or difficult intubation; BMI > 35 kg/m^2; rheumatologic disease that causes limitation of cervical motion; previous history of neck surgery or tumour; trauma or infection of the upper airway; absence of teeth; thyromental distance < 6 cm; sternomental distance < 12 cm; interincisor gap < 3 cm; neck circumference > 42 cm; lower face height of between 5.5 and 8 cm

Baseline characteristics

Truview EVO2

- Age, mean (SD): 48.21 (± 15.06) years
- Gender M/F, n: 25/23
- Weight, mean (SD): 79.27 (± 18.96) kg
- Height, mean (SD): 1.73 (± 0.1) m
- Mallampati 1/2/3/4, n: 11/25/9/3

Aritraq

- Age, mean (SD): 47.70 (± 16.86) years
- Gender M/F, n: 23/23
- Weight, mean (SD): 72.30 (± 11.23) kg
- Height, mean (SD): 1.71 (± 0.08) m
- Mallampati 1/2/3/4, n: 15/27/4/0

Macintosh

- Age, mean (SD): 49.69 (± 16.04) years
- Gender M/F, n: 25/24
- Weight, mean (SD): 76.02 (± 15.33) kg
- Height, mean (SD): 1.71 (± 0.08) m
- Mallampati 1/2/3/4, n: 20/17/11/1

Interventions

General details: all intubations were performed by 1 anaesthetist. Experience unclear

Truview EVO2

- Randomized = 50; losses = 2 (TTI > 120 s); analysed for failed intubation = 50; analysed for other outcomes = 48
- Stylet inserted into tracheal tube prior

Airtraq

- Randomized = 50; losses = 4 (TTI > 120 s); analysed for failed intubation = 50; analysed for other outcomes = 46

Macintosh

- Randomized = 50; losses = 1 (TTI > 120 s); analysed for failed intubation = 50; analysed for other outcomes = 49

VL classification: hyperangulated (Truview EVO2); channelled (Airtraq)

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: if the TTI was > 120 s, the patients were ventilated for 1 min with a face mask, and then intubation was performed using a fibreoptic laryngoscope for unsuccessful intubations; these patients were excluded from the study.

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Colak 2015 *(Continued)*

- Airway trauma: dental trauma data only extracted
- CL grade

Continuous outcomes

- Time for tracheal intubation: the duration from the laryngoscope blade passing the lips and the placement of the tube into trachea
- IDS

Notes: the primary outcome was cervical motion during intubation, which is not relevant to this review.

2 participants in the Truview group, 4 participants in the Airtraq group and 1 participant in the Macintosh group, were excluded from the final analysis due to a failed intubation as per the study definition. These participants are included in our comparison of failed intubation.

IDS reported only for > 5 and therefore excluded from the analysis

Study authors also reported other airway complications (laceration, throat bleeding, or blood on blade)

Notes	**Funding/sponsor/declarations of interest**: study authors stated that they received no financial support and they declared that they had no conflicts of interest. **Study dates:** January 2011–December 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Random sequence claimed but not specified explicitly
Allocation concealment (selection bias)	Low risk	"Patients were randomly assigned into three groups using the sealed envelope method"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study authors excluded participants from analysis if intubation time was > 120 s. Overall loss was < 10%
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not explicitly reported what the experience of the single intubator was

Colak 2019

Study characteristics

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Colak 2019 *(Continued)*

Methods	RCT; parallel design
Participants	**Total number of participants:** 96 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria:** ASA I and II; aged ≥ 65 years; undergoing elective surgery that required GA and tracheal intubation. Elective surgical cases that would not last > 2 h and included abdominal, gynaecological, urological, and orthopedic surgeries **Exclusion criteria**: limited mouth opening; Mallampati 4; difficult airway predicted; hypertension; cardiac disease; known long QT interval (> 440 ms); used drugs known to prolong the QT interval; device malfunction during ECG acquisition **Baseline characteristics:** **McGrath MAC** • Age, mean (SD): 71.1 (± 5.5) years • Gender M/F, n: 25/20 • Weight, mean (SD): 66.6 (± 9.8) kg • Height, mean (SD): 1.66 (± 0.08) m • BMI, mean (SD): 24.0 (± 3.3) kg/m^2 • ASA I/II/III/IV, n: 14/31/0/0 • Mallampati 1/2/3/4, n: 22/19/5/0 **Macintosh** • Age, mean (SD): 71 (± 5.6) years • Gender M/F, n: 25/20 • Weight, mean (SD): 65.8 (± 9.31) kg • Height, mean (SD): 1.65 (± 0.09) m • BMI, mean (SD): 23.7 (± 3.7) kg/m^2 • ASA I/II/III/IV, n: 10/35/0/0 • Mallampati 1/2/3/4, n: 22/16/6/0
Interventions	**General details**: all intubations were performed by a single anaesthetist who had undergone 3 years of anaesthesia training, had experience with the use of Macintosh laryngoscopes, and had performed at least 20 intubations with the McGrath MAC VL. Stylets were used for both groups. **McGrath MAC** • Randomized = 48; losses = 3 (2 problems with ECG device; 1 prolongation of intubation); analysed = 45 **Macintosh** • Randomized = 48; losses = 3 (2 problems with ECG device; 1 prolongation of intubation); analysed = 45 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if the intubation failed, then the duration of each attempt was aggregated, with a maximum of 3 attempts allowed • Number of attempts • Successful first attempt

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Colak 2019 *(Continued)*

	• CL grade • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation Notes: the primary outcome was assessment of mean BP. Failed intubation was defined but not explicitly reported
Notes	**Funding/sponsor/declarations of interest:** Inonu University Department of Scientific Research Projects. No conflicts declared **Study dates:** June–October 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Web-based randomization sequence
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	6 participants were excluded from the final analysis after randomization with reasons provided (prolongation of intubation attempt, problems with ECG recording). However, losses were balanced between groups, and < 10%
Selective reporting (reporting bias)	Low risk	Trial registration examined (NCT02816775). Prospectively registered and all pre-specified outcomes reported in the final manuscript.
Experience of intubator	Low risk	"All intubations were performed by a single anesthetist who had received 3 years of anesthesia training, had experienced with the use of Macintosh laryngoscopes, and had practiced at least 20 intubations with the McGRATH MAC videolaryngoscope."

Cordovani 2019

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 44 **Country:** Canada **Setting:** theatre; single centre

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Cordovani 2019 *(Continued)*

Inclusion criteria: ASA I-III; aged > 18 years; undergoing elective surgical procedures requiring single-lumen tracheal tube. In addition, ≥ 1 risk factors for difficult direct laryngoscopy was required: modified Mallampati score at least 3; interincisor gap < 3.5 cm; thyromental distance < 6.5 cm; sternomental distance < 12.5 cm; reduced neck extension and flexion

Exclusion criteria: need for a RSI; alternative intubation method; known or suspected oral, pharyngeal or laryngeal masses; poor dentition; symptomatic gastro-oesophageal reflux; C-spine instability; unstable hypertension; coronary artery disease; cerebral disease; resources not available to conduct the procedure on the scheduled date of surgery

Baseline characteristics

Macintosh followed by GlideScope

- Age, mean (SD): 56.5 (± 11.6) years
- Gender M/F, n: 11/13
- Weight, mean (SD): 79.9 (± 15.1) kg
- Height, mean (SD): 1.65 (± 0.12) m
- BMI, mean (SD): 29.2 (± 4.6) kg/m^2
- Mallampati ≥ 3, n: 24

GlideScope followed by Macintosh

- Age, mean (SD): 54.0 (± 11.2) years
- Gender M/F, n: 12/8
- Weight, mean (SD): 74.7 (± 13.4) kg
- Height, mean (SD): 1.67 (± 0.09) m
- BMI, mean (SD): 26.8 (± 4.3) kg/m^2
- Mallampati ≥ 3, n: 20

Notes: 39 participants (89%) had ≥ 2 features of difficult direct laryngoscopy

Interventions	**General details**: the laryngoscopists were staff anaesthetists, fellows or senior anaesthesia residents who had used the GlideScope on at least 25 occasions. **GlideScope** • Randomized to receive Macintosh followed by GlideScope = 24; no losses for review outcomes; analysed = 24 **Macintosh** • Randomized to receive GlideScope followed by Macintosh= 20; no losses for review outcomes; analysed = 20 **VL classification:** hyperangulated Notes: all participants underwent 2 sequential laryngoscopies, depending on randomization. Sequence A: Macintosh followed by GlideScope; Sequence B: GlideScope followed by Macintosh
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation Notes: the primary outcome was force required for intubation. The study also reports time required for laryngoscopy, but this does not equate time for intubation and is reported as median (IQR). The study authors also reported CL views for both laryngoscopies. As per the review protocol we did not extract data for CL grades from this cross-over study to avoid unit of analysis issues.

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Cordovani 2019 *(Continued)*

Notes	**Funding/sponsor/declarations of interest**: this study had institutional funding, Department of Anesthesia and Pain Management, Toronto General Hospital. One of the authors (RC) is an unpaid consultant to Verathon Medical, manufacturer of the GlideScope. **Study dates:** July 2011–April 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated code
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Clinical trial registry examined (NCT01814176). Prospectively registered and all outcome data reported.
Experience of intubator	Low risk	"The laryngoscopists were staff anaesthetists, fellows or senior anaesthesia residents who had used the GlideScope on at least 25 occasions."

Das 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I-III; aged 18-65 years; scheduled for surgical procedures requiring tracheal intubation **Exclusion criteria**: risk factors for gastric aspiration; risk factors for difficult intubation (Mallampati 3 or 4; thyromental distance < 6 cm; interincisor distance < 4.0 cm); raised IOP; history of relevant drug allergy **Baseline characteristics** **Airtraq**

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Das 2016 *(Continued)*

	• Age, mean (SD): 44.15 (± 11.22) years • Gender M/F, n: 32/13 • Weight, mean (SD): 63.65 (± 10.78) kg **Macintosh** • Age, mean (SD): 40.25 (± 9.44) years • Gender M/F, n: 29/16 • Weight, mean (SD): 69.10 (± 5.22) kg
Interventions	**General details**: all participants were intubated by an anaesthetist, experienced in the use of both laryngoscopes **Airtraq** • Randomized = 45; no losses; analysed = 45 **Macintosh** • Randomized = 45; no losses; analysed = 45 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Airway trauma: blood on the device and tongue/lip/dental trauma. Dental trauma was reported within a composite outcome (not separately), therefore we could not extract data. Notes: the main outcome studied was changes in IOP at the time of laryngoscopy; this was not an outcome of interest in our review.
Notes	**Funding/sponsor/declarations of interest:** funding not reported. Study authors declare that they have no conflicts of interest. **Study dates:** not reported We did not complete risk of bias assessments because this study reported no relevant review outcomes.

Dashti 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 59 **Country:** Iran **Setting**: theatre; single centre **Inclusion criteria:** 40-60 years of age; untreated hypertension; undergoing elective surgery **Exclusion criteria:** BP > 180/110 mmHg; predicted difficult airway; history of drug abuse; dehydration; history of other cardiovascular disease; history of consumption of any drugs known to affect cardiovascular system; diabetes mellitus; end-organ damage due to hypertension **Baseline characteristics**

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Dashti 2014 *(Continued)*

	GlideScope • Age, mean (SD): 54.82 (± 5.76) years • Gender M/F, n: 19/11 • Weight, mean (SD): 72.14 (± 9.72) kg **Macintosh** • Age, mean (SD): 57.82 (± 4.83) years • Gender M/F, n: 15/14 • Weight, mean (SD): 66.25 (± 6.15) kg
Interventions	**General details**: all intubations performed by a single experienced anaesthesiology resident **GlideScope** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; losses = 1 (excluded for post-induction hypotension); analysed = 29 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: defined as time from grasping tracheal tube until passing tube through vocal cords Notes: study aimed to assess haemodynamic changes but included relevant outcomes
Notes	**Funding/sponsor/declarations of interest**: none reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomized using permuted blocks
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 1 exclusion; not likely to affect outcome data

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Dashti 2014 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"The patients were intubated by a single experienced anesthesiology resident". No details on whether experience is equivalent with both devices

Dey 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 248 **Country:** India **Setting:** ICU; single centre **Inclusion criteria**: all ICU patients requiring elective tracheal intubation **Exclusion criteria**: age < 18 years; pregnancy or lactation; facial trauma including burn injury; suspected or confirmed C-spine injury; lack of time for randomization and inclusion due to ongoing resuscitative efforts; unable to obtain informed consent **Baseline characteristics** **C-MAC** • Age, mean (SD): 48.3 (± 16.8) years • Gender M/F, n: 63/45 • BMI, mean (SD): 23.9 (± 6.8) kg/m^2 **Macintosh** • Age, mean (SD): 45.8 (± 16.2) years • Gender M/F, n: 67/43 • BMI, mean (SD): 24.8 (± 7.6) kg/m^2 Notes: patients were admitted to a 32-bedded ICU
Interventions	**General details**: intubating anaesthetists had experience of minimum 50 videolaryngoscopies using C-MAC VL. Intubators were categorized into junior (up to 3 years), senior (3–8 years) and consultant (> 8 years) based on their years of anaesthesia experience. Use of stylets or bougies was allowed but not predefined. All intubations were performed in the presence of 2 anaesthetists, 1 of them being either senior or consultant anaesthetist. **C-MAC** • Randomized = 124; losses = 16 (8 cardiac arrest, 3 had > 3 attempts, 5 difficult mask ventilation); analysed for failed intubation = 124; analysed for other outcomes = 108 • #3 or #4 blade **Macintosh**

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Dey 2020 *(Continued)*

	• Randomized = 124; losses = 14 (7 cardiac arrest, 4 had > 3 attempts, 3 difficult mask ventilation); analysed for failed intubation = 124; analysed for other outcomes = 110 • #3 or #4 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: after 3 failed attempts at intubation alternative techniques were used and subsequently the participants were excluded from the analysis. • Successful first attempt • Number of attempts • CL grade **Continuous outcomes** • POGO score Notes: the study authors also present a table with intubation success rates based on intubator seniority. For the purposes of the meta-analysis we took the data for failed intubation > 3 attempts that were excluded from the per-protocol analysis and used the ITT denominator. We used the per-protocol analysis denominators for all other outcomes.
Notes	**Funding/sponsor/declarations of interest**: study authors stated that they received no funding and that they had no conflicts of interest. **Study dates:** January 2017–June 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Sequential sealed opaque envelopes used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	16 out of 124 participants were excluded after randomization from the C-MAC arm (8 cardiac arrest, 3 > 3 attempts at intubation, 5 difficult mask ventilation). 14 out of 124 patients were excluded after randomization from the Macintosh arm (7 cardiac arrest, 4 > 3 attempts at intubation, 3 difficult mask ventilation).
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Dey 2020 *(Continued)*

Experience of intubator	Low risk	"Intubating anaesthetists (laryngoscopist) had experience of minimum fifty videolaryngoscopies using C-MAC VL. Laryngoscopists were categorized (based on exposure) into junior (up to three years), senior (3–8 years) and consultant (more than 8 years) based on their years of anaesthesia experience." A heterogeneous group of intubators, but all had significant and balanced experience with both devices.

Dharanindra 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 140 **Country:** India **Setting:** ICU; single-centre **Inclusion criteria**: age group of 18–70 years requiring intubation in the ICU for any physiological derangement **Exclusion criteria**: not reported **Baseline characteristics: no**t reported. Abstract only
Interventions	**General details** **King Vision** • Randomized = 70; no losses reported **Macintosh** • Randomized = 70; no losses reported **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors:** **Dichotomous outcomes:** • Successful first attempt **Continuous outcomes:** • Time for tracheal intubation Notes: study authors report first-pass success rate only in percentage points. We did not include data reported for CL because data were only reported for participants with a score of 1. We did not include data for airway trauma because this was not defined in the abstract.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

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Dharanindra 2020 *(Continued)*

Notes: contacted study author for further data to inform risk of bias assessment and further extraction, we have not received a response as of September 2021.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Sequentially numbered, opaque, sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No clear report of CONSORT flow diagram. Abstract only
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not reported

Dostalova 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** Czechia **Setting:** theatre **Inclusion criteria:** patients undergoing elective neurosurgery. Age > 18 years; ASA I-III; no cognitive deficits **Exclusion criteria**: planned postoperative ventilation; laryngeal tumours; previous tracheotomy or tracheal or laryngeal surgery; previous C-spine surgery; history of airway difficulties; high risk of airway difficulties **Baseline characteristics** **GlideScope** • Age, mean (SD): 56.4 (± 11.3) years • Gender M/F, n: 21/24 • Weight, mean (SD): 88.1 (± 16.9) kg

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Dostalova 2019 *(Continued)*

- Height, mean (SD): 1.73 (± 0.10) m
- BMI, mean (SD): 29.6 (± 4.9) kg/m^2
- ASA I/II/III/IV: 0/36/9/0
- Mallampati, median (IQR): 2 (2, 3)

Macintosh

- Age, mean (SD): 57.9 (± 12.6) years
- Gender M/F, n: 26/19
- Weight, mean (SD): 84.4 (± 16.2) kg
- Height, mean (SD): 1.74 (± 0.09) m
- BMI, mean (SD): 27.9 (± 4.2) kg/m^2
- ASA I/II/III/IV: 0/35/10/0
- Mallampati, median (IQR): 2 (1, 2)

Notes: Mallampati scores reported as median (IQR)

Interventions

General details: experience of intubators not reported

GlideScope

- Randomized = 45; no losses; analysed = 45
- LoPro T4 blade used

Macintosh

- Randomized = 45; no losses; analysed = 45
- Blade #3 in women, #4 in men

VL classification: hyperangulated

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Number of attempts
- Patient-reported sore throat

Continuous outcomes

- Time for tracheal intubation: defined as time from interruption of face-mask ventilation to connection of the tracheal tube to the anaesthetic circuit. Adjustment of the tracheal tube position was performed subsequently and was not included in the intubation time.

Notes: CL grades reported as number (%) of participants with CL grade > 1. We were not able to extract the number of participants with a CL grade of 2, but there was a significant difference (GlideScope CL > 1: 2/45; Macintosh CL > 1: 26/45)

Notes

Funding/sponsor/declarations of interest: none declared

Study dates: June–November 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported

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Dostalova 2019 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT03184246). Study registered prospectively and all prespecified outcomes reported in the manuscript.
Experience of intubator	Unclear risk	Intubator experience not specified

Driver 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 198 **Country:** USA **Setting:** ED; single-centre **Inclusion criteria**: adult patients who were to undergo emergency orotracheal intubation using direct laryngoscopy were eligible for enrolment. **Exclusion criteria**: pregnancy; prisoners; an approach other than direct laryngoscopy planned by the consultant on the first intubation attempt **Baseline characteristics** **C-MAC VL** • Age, mean (SD): 52.6 (± 17.1) years • Gender M/F, n: 62/41 **C-MAC Macintosh DL** • Age, mean (SD): 51.6 (± 18.8) years • Gender M/F, n: 63/32 Notes: ED-based study population. A small subset of participants, 5 in DL and 4 in VL arm, were in cardiac arrest at the time of intubation.
Interventions	**General details**: most intubators were third year emergency medicine residents with > 4 months' regular experience intubating with both devices/methods. A small subset of participants was intubated by consultants and by second year residents. Use of a gum-elastic bougie was allowed and reported as an outcome.

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Driver 2016 *(Continued)*

	C-MAC VL • Randomized = 103; no losses; analysed = 103 • #3 or #4 C-MAC blade **C-MAC DL** • Randomized = 95; no losses; analysed = 95 • #3 or #4 C-MAC blade **VL classification:** Macintosh-style Notes: a Storz C-MAC was used in both groups. In group DL it was used a DL device with the intubator not being able to see the video screen. In group VL it was used as a video laryngoscope with the intubator viewing the screen.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined in the study, but we considered failed intubation when the device was switched, which the authors report • Hypoxia: defined as an oxygen saturation level < 93% within 2 min of an intubation attempt • Successful first attempt: if the first attempt failed subsequent attempts could proceed with any device or technique. The study authors report the success rates for actual device used separately. We used these reported data for our analysis. • Number of attempts: reported as mean (95% CI) • Mortality: reported as survival to hospital to discharge **Continuous outcomes** • Time for tracheal intubation: reported as duration of first attempt. An attempt was defined as from the laryngoscope entering the mouth until it was removed Notes: there were a number of protocol violations noted. Firstly, 4 out of 95 participants in the DL arm and 4 out of 103 participants in the VL arm were intubated using the actual Macintosh DL. Furthermore, the intubator viewed the screen in the DL arm in 5 out of 95 cases. Conversely, 16 out of 103 participants were intubated without looking at the screen in the VL arm. This introduces significant risk of bias into the interpretation of outcomes from this study. The study authors also report first-pass success, the primary outcome, in the context of actual device used.
Notes	**Funding/sponsor/declarations of interest**: none reported **Study dates:** November 2011–February 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random sequence of numbers in blocks of 20
Allocation concealment (selection bias)	Low risk	"When a patient was enrolled in the study, a research associate opened the next sequentially numbered envelope to ascertain the treatment assignment, which was disclosed to the intubating physician."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator

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Driver 2016 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No losses evident. There was a significant number of protocol violations noted, 5 in the DL group and 16 in the VL group.
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT01710891). Registered retrospectively. All outcomes reported
Experience of intubator	Unclear risk	All participants were intubated by third year emergency medicine residents with > 4 months' regular intubating experience with both devices prior to the study. Extent of experience with study devices not otherwise quantified

Ducharme 2017

Study characteristics	
Methods	RCT; cluster cross-over design
Participants	**Total number of participants:** 82 **Country:** USA **Setting**: prehospital; 2 emergency medical services (1 rural, 1 suburban) run from a single command centre **Inclusion criteria**: all participants where the provider made the decision to perform tracheal intubation **Exclusion criteria**: no intubation attempt made; blind or nasotracheal intubation attempted primarily; participants believed to be under the age of 18. **Baseline characteristics** **King Vision** • Age, n: 18-29 years: 0; 30-39 years: 2; 40-49 years: 5; 50-59 years: 4; 60-69 years: 5; 70-79 years: 7; > 80 years: 17 • Gender M/F, n: 28/12 • Weight, n: < 76 kg: 8; 76-100 kg: 12; 101-150 kg: 15; > 150 kg: 2 **Macintosh** • Age, n: 18-29 years: 2; 30-39 years: 3; 40-49 years: 3; 50-59 years: 5; 60-69 years: 6; 70-79 years: 14; > 80 years: 9 • Gender M/F, n: 28/12 • Weight, n: < 76 kg: 10; 76-100 kg: 11; 101-150 kg: 13; > 150 kg: 4 Notes: age and estimated weight reported as grouped ranges with incidences. Medical cardiac arrest was the most common indication (88.1% in DL group and 97.5% in VL group). The trial was terminated early due to slow enrolment.
Interventions	**General details**: all participants were intubated by paramedics with previous clinical experience with direct laryngoscopy but not videolaryngoscopy. In preparation for the study all intubators had didactic and skills sessions training on manikins.

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Ducharme 2017 *(Continued)*

	King Vision • Analysed (ITT) = 40 **Macintosh** • Analysed (ITT) = 42 **VL classification:** channelled/hyperangulated Notes: the King Vision VL was initially used as a channelled device but 3 months into the trial they changed to using the King Vision without the channel guide at the request of the intubating paramedics. The stated reason for this was the fact that 3 unintended extubations had occurred immediately after successful intubation. The investigators felt that the channel guide might have contributed to this and changed protocol 3 months into the study. It is unclear how many participants were intubated with the King Vision as a channelled device and how many as a non-channelled device. They do note that they re-ran the analysis with the data from the first 3 months excluded and it did not alter the findings of the final per-protocol or ITT analysis.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: extrapolated from overall success • Successful first attempt: an intubation attempt was defined as any time the tip of the laryngoscope blade passed the participant's lips. First attempt success was defined as the successful placement of an tracheal tube on the first intubation attempt. • CL grade: 1-4 **Continuous outcomes** • POGO score Notes: the primary outcome was first attempt success rate. The POGO score was reported as median (IQR). The study authors performed and reported an ITT and per-protocol analysis. Data were collected for all cases. However, the study authors did not account for clustering in the reported manuscript. We therefore did not extract outcomes for this study.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not defined. The data collection period spanned 34 months, after which the study was terminated as they were unable to achieve the recruitment target by that point. We did not complete risk of bias assessments because this study reported no relevant review outcomes.

Echeverri 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 82 **Country:** Colombia **Setting:** theatre; single centre **Inclusion criteria**: adults scheduled for surgery who required GA

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Echeverri 2020 *(Continued)*

	Exclusion criteria: predictors of difficult airway **Baseline characteristics:** data presented only in abstract form. Baseline characteristics not reported
Interventions	**General details**: experience of intubators not quantified **C-MAC D-BLADE** • Randomized = 41; no losses; analysed = 41 • D-BLADE used **Macintosh** • Randomized = 41; no losses; analysed = 41 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Number of attempts: no outcome data provided • Airway trauma: type of trauma is not defined. Dental injuries not specified, therefore no data were extracted for this outcome **Continuous outcomes** • Time for tracheal intubation: not explicitly defined Notes: number of attempts only reported in the narrative without data. The study authors also report haemodynamic and patient satisfaction outcomes.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported. Only described as randomized
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not clear from abstract

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Echeverri 2020 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not described

El-Tahan 2017a

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 35 **Country:** Saudi Arabia **Setting:** theatre; single centre **Inclusion criteria**: aged 18-65 years undergoing GA with tracheal intubation for elective surgery; ASA I or II **Exclusion criteria**: previous neck surgery; pregnancy; an anticipated or known difficult intubation (e.g. because of a history of C-spine injury or surgery); previous oral or throat surgery; BMI > 35 kg/m^2; no incisor teeth; RSI indicated, risk factors for aspiration of gastric contents **Baseline characteristics** • Age, median (IQR): 25 (18-57) years • Gender M/F, n: 22/7 • Weight, mean (SD): 78 (± 11.6) kg • Height, mean (SD): 1.70 (± 0.10) m • ASA I/II/III/IV, n: 16/13/0/0 • Mallampati 1/2/3/4, n: 19/10/0/0 Notes: participant characteristics reported for both groups due to cross-over design
Interventions	**General details**: all laryngoscopies and intubations were performed by 1 of the 2 anaesthetists with > 4 years' experience with both laryngoscopes. A channelled blade was used for all King Vision intubations. **Macintosh followed by King Vision** • Randomized = 18; losses = 4 (3 unclear radiographic landmarks, 1 poor-quality radiological images); analysed = 14 **King Vision followed by Macintosh** • Randomized = 17; losses = 2 (1 unclear radiographic landmarks, 1 poor-quality radiological images); analysed = 15 **VL classification:** channelled Notes: in the Macintosh followed by King Vision group, laryngoscopy was performed twice in each participant, first with the Macintosh laryngoscope and then with the King Vision. For each device, the tip of the tracheal tube was advanced just beyond the vocal cords and then withdrawn, with the tracheal intubation being completed with the second device. Between laryngoscopies, the participant's lungs were ventilated using a bag-mask with sevoflurane in oxygen to avoid hypoxaemia. In the King Vision followed by Macintosh group the laryngoscopies were applied in reverse order.
Outcomes	**Outcomes relevant to the review reported by study authors**

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El-Tahan 2017a *(Continued)*

Dichotomous outcomes

- Failed intubation: defined as an attempt that took > 120 s, or oxygen desaturation with an SpO_2 < 92% being noted on the pulse oximeter
- Number of attempts
- CL grade

Continuous outcomes

- Time for tracheal intubation: defined as the time when the investigated laryngoscope passed the central incisors to when the tip of the tracheal tube passed beyond the glottis, as confirmed visually by the anaesthetist in the Macintosh group, or by the investigator in the King Vision group using the display screen
- IDS

Notes: the reported number of attempts were attempts at laryngoscopy as opposed to attempts at intubation. We chose not to include this in our meta-analysis. First pass success is reported as well, separately for both groups. A mean average is reported for the intubation difficulty graded on a VAS scale from 0-100. CL grade data reported. We did not extract these data due to the cross-over design in accordance with the review protocol.

Notes

Funding/sponsor/declarations of interest: Mohamed R. El Tahan received free airway device samples from Ambu in April 2014 for use in the present study and from Airtraq in March 2015 for use in another study. He has no direct financial or other interest in Ambu or Airtraq (in the context of this and other studies). Ambu, the manufacturer of King Vision, had no role in the data analysis or manuscript preparation.

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization code
Allocation concealment (selection bias)	Low risk	Drawing sequentially numbered sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	All participants received allocated interventions, but 4 and 2 participants in the Macintosh followed by King Vision and the King Vision followed by Macintosh groups were excluded prior to analysis, respectively. All were excluded due to difficulties with obtaining measurements pertaining to cervical motion. There were no failures to intubate in this group. This left 14 and 15 participants, respectively, for the final analysis.
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT01914601). The study was registered prospectively and all outcomes were reported in the final manuscript.
Experience of intubator	Unclear risk	"All laryngoscopies were performed by one of the two MD anaesthetists (> 4 years of experience) experienced in the use of each laryngoscope."

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El-Tahan 2017a *(Continued)*

	Extent of experience with the study devices was not otherwise quantified

El-Tahan 2017b

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 133 **Country:** Saudi Arabia **Setting:** theatre; single centre **Inclusion criteria**: age 18-70 years; ASA II-III; undergoing GA with DLT intubation for one-lung ventilation during elective thoracic surgery **Exclusion criteria:** NYHA functional classification of III-IV; forced expiratory volume in 1 s or forced vital capacity of < 50% of predicted values; severe asthma; pregnancy; anticipated or known difficult intubation (e.g. because of BMI > 40 kg/m^2 or incisor gap < 3 cm); RSI indicated; risk factors for aspiration of gastric contents; postoperative ventilation planned **Baseline characteristics** **Macintosh** • Age, mean (SD): 27.5 (± 9.83) years • Gender M/F, n: 19/13 • Weight, mean (SD): 65.2 (± 17.9) kg • Height, mean (SD): 1.67 (± 0.09) m • ASA I/II/III/IV, n: 0/22/10/0 • Mallampati 1/2/3/4, n: 17/13/2/0 **GlideScope** • Age, mean (SD): 39.9 (± 17.52) years • Gender M/F, n: 26/8 • Weight, mean (SD): 71.1 (± 17.59) kg • Height, mean (SD): 1.66 (± 0.11) m • ASA I/II/III/IV, n: 0/20/14/0 • Mallampati 1/2/3/4, n: 12/18/4 **Airtraq** • Age, mean (SD): 33.8 (± 13.37) years • Gender M/F, n: 31/4 • Weight, mean (SD): 70.2 (± 16.31) kg • Height, mean (SD): 1.70 (± 0.07) m • ASA I/II/III/IV, n: 0/19/16/0 • Mallampati 1/2/3/4, n: 11/16/8/0 **King Vision** • Age, mean (SD): 31.3 (± 14.80) years • Gender M/F, n: 27/5 • Weight, mean (SD): 72.4 (± 23.73) kg • Height, mean (SD): 1.68 (± 6.73) m

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El-Tahan 2017b *(Continued)*

- ASA I/II/III/IV, n: 0/20/12/0
- Mallampati 1/2/3/4, n: 14/12/6/0

Interventions	**General details**: all tracheal intubations in the study were performed by 13 anaesthesia consultants, specialists, or trainees with at least 7 years, 3 years, or 6 months of clinical anaesthesiology experience, respectively. The respective previous experience in terms of using DLs and specific VLs for DLT insertion is reported in a table in the manuscript. All intubators had performed > 50 insertions of DLTs with a Macintosh laryngoscope. Of the remaining devices, consultants had the most experience with the GlideScope and Airtraq, but less so with King Vision. Most residents had very limited previous experience with using VL for DLT insertion. **Macintosh** • Randomized = 32; no losses; analysed = 32 **GlideScope** • Randomized = 34; no losses; analysed = 34 **Airtraq** • Randomized =35; no losses; analysed = 35 **King Vision** • Randomized =32; no losses; analysed = 32 • Used with the non-channelled blade **VL classification:** hyperangulated (GlideScope and King Vision*), channelled (Airtraq) *The King Vision device can be used with either channelled or non-channelled blades. The study authors specified the use of the non-channelled blade in this study.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: the laryngoscopy attempt was considered to have failed if intubation took > 150 s or if oxygen desaturation (SpO_2 < 92%) was noted. A second attempt was permitted with the device under investigation. A failed second attempt was managed by the use of any device at the discretion of the supervising investigator. • Successful first attempt • Number of attempts: defined as the number of times the laryngoscope was removed from the mouth and then replaced, not actual attempts at intubation. We did not extract this outcome for this study. "First pass success" was reported separately. • Airway trauma: defined as any blood trace on the device or mucosa or injury to the lips or teeth. Dental trauma data only extracted • Patient-reported sore throat: graded on a VAS from 0 (none) to 10 (severe) • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from the laryngoscope passing the central incisors to the tip of the DLT passing beyond the glottis, as confirmed visually by the anaesthetist in the Macintosh group or by the investigator using the display screen in the VL groups. In cases in which > 1 attempt was needed, the successful intubation time was the total time spent on each laryngoscopy attempt, without including the time interval between the attempts. • IDS • POGO score

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El-Tahan 2017b *(Continued)*

	Notes: ease of intubation was reported on a subjective scale from 0 (extremely easy) to 5 (extremely difficult). TTI and POGO scores reported as median (IQR). We did not convert these outcomes to mean (SD) as we could not assume a normal distribution. We reported outcomes for GlideScope and King Vision (non channelled blade) combined as both devices are categorized as hyperangulated VLs for the purposes of this review.
Notes	**Funding/sponsor/declarations of interest:** M.R. El-Tahan received free airway device samples from Ambu USA (Ballerup, Denmark) in 2014 and Airtraq UK (Swadlincote, Derbyshire, UK) in 2015 for use in 2 other studies and has no direct financial or other interest in Ambu or Airtraq UK (in the context of this and other studies). Airtraq UK provided free airway device samples for use in the present study **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization code
Allocation concealment (selection bias)	Low risk	"The allocation was accomplished by drawing sequentially numbered, sealed, opaque envelopes containing a computer-generated randomization code."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT02305667). Prospectively registered and all outcomes reported
Experience of intubator	High risk	All intubations were performed by 13 different anaesthetists with a varying level of previous experience (consultants, specialists, residents). The median number of uses by grade per device is reported in a table in the manuscript. There is an imbalance between different laryngoscopes in virtually all groups.

Enomoto 2008

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 203 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria**: scheduled for elective surgery

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Enomoto 2008 *(Continued)*

Exclusion criteria: pathology of the neck, upper respiratory tract or upper alimentary tracts; at risk of pulmonary aspiration of gastric contents

Combined baseline characteristics

- Age, mean (SD): 57 (± 16) years
- Gender M/F, n: 117/86
- Weight, mean (SD): 61 (± 12) kg
- Height, mean (SD): 1.60 (± 0.09) m
- BMI, mean (SD): 24 (± 3.9) kg/m^2
- ASA I/II/III/IV, n: 62/140/1/0
- Mallampati 1/2/3/4, n: 154/40/8/1

Notes: all participants had MILS applied

Interventions	**General details**: no details provided on intubator experience. In the cross-over design of the study, all participants underwent laryngoscopy with both devices in an order determined by the flipping of a coin. Participants were intubated following the second laryngoscopy. **Pentax AW** • Randomized = 99; no losses reported; analysed = 99 **Macintosh:** • Randomized = 104; no losses reported; analysed = 104 • #3 or #4 blade. Use of bougie allowed **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to intubate within 120 s. According to the study protocol, the alternate device was used for the next attempt. This meets our study definition of failed intubation for change of device. • Successful first attempt • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: for Macintosh, time from tracheal tube passing gap between upper and lower incisors to confirmation of CO_2 waveforms after tracheal intubation; for Pentax, time from touching tracheal tube (attached to scope) to confirmation of CO_2 waveforms Notes: there were some inconsistencies within the study report regarding denominator figures for successful tracheal intubation.
Notes	**Funding/sponsor/declarations of interest:** 1 study author given an honorarium from manufacturer for writing a lecture and was loaned an AWS for the study. Other departments had to provide their own. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The order was randomized by tossing a coin"

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Enomoto 2008 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details of operator experience.

Erden 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 33 **Country:** Turkey **Setting**: theatre; single centre **Inclusion criteria:** ASA I and II adult patients (≥ 18 years old); without C-spine problems or known or suspected difficult airway; scheduled for elective interventional radiology procedures; requiring anaesthesia and tracheal intubation **Exclusion criteria**: underlying C-spine pathology and need for either a RSI or an awake intubation **Baseline characteristics** **Airtraq** • Age, mean (SD): 42.3 (± 13.1) years • Gender M/F, n: 7/9 • Weight, mean (SD): 69.2 (± 12.1) kg • ASA I/II/III/IV, n: 9/7/0/0 • Mallampati 1/2/3/4, n: 8/6/2/0 **Macintosh** • Age, mean (SD): 51.6 (± 15) years • Gender M/F, n: 6/10 • Weight, mean (SD): 70.5 (± 10.4) kg • ASA I/II/III/IV, n: 4/12/0/0 • Mallampati 1/2/3/4, n: 6/7/3/0

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Erden 2010 *(Continued)*

Interventions	**General details**: all intubations were performed by the same anaesthetist, experienced with direct laryngoscopy and Airtraq. Experience not further quantified **Airtraq** • Randomized = 17; losses = 1 (failed intubation); analysed for failed intubation = 17; analysed for other outcomes = 16 • #3 device **Macintosh** • Randomized = 16; no losses; analysed = 16 • #3 blade **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failed tracheal intubation was defined as > 2 intubation attempts • Hypoxia: defined as SpO_2 < 94% for > 10 s • Airway trauma: lip or dental injury was reported as a composite outcome of both. We were therefore unable to extract data for dental trauma alone and we did not include the data in the meta-analysis • CL grade • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time from the passage of the tip of the intubation device through the lips of the participant to the time the tracheal cuff was inflated. Notes: we used 17 as the denominator for failed intubation extraction in the case of Airtraq as this was not included in the final analysis. For airway trauma, study authors also reported data for mucosal injury (blood detected on airway device). Data for lip and dental injury were not reported separately.
Notes	**Funding/sponsor/declarations of interest**: not declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers table
Allocation concealment (selection bias)	High risk	Open random allocation schedule
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Erden 2010 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant excluded from final analysis due to failed intubation but this was reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Intubations were performed by the same [anaesthetist] experienced with direct laryngoscopy and Airtraq." Experience not further quantified

Erdivanli 2018

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 388 **Country:** Turkey **Setting:** theatre; single-centre **Inclusion criteria**: all patients scheduled for GA with tracheal intubation **Exclusion criteria**: emergency surgery; age < 18 or > 60 years; interincisor distance < 2 cm; ASA II; ankylosis; degenerative osteoarthritis; glottic or supraglottic mass (such as lingual, thyroid or tonsillar hypertrophy); mediastinal masses; anomaly of the oropharynx (such as subglottic stenosis); Treacher-Collins, Pierre Robin or Down syndrome; history of surgery or surgery scheduled for any of these conditions **Combined baseline characteristics** • Age, median (IQR): 48.5 (37-55) years • Gender M/F, n: 230/158 • Weight, median (IQR): 80 (70-88) kg • Height, median (IQR): 1.71 (1.65-1.75) m • BMI, median (IQR): 26.9 (24.3-30.9) kg/m^2 • ASA I/II/III/IV, n: 192/196/0/0 • Mallampati 1/2/3/4, n: 79/113/107/89 Notes: cross-over study. All participants underwent both laryngoscopy and intubation with both devices.
Interventions	**General details**: all participants were intubated with both laryngoscopes in succession. The order of intubation was randomized. There were 5 laryngoscopists, with an average of 9.8 ± 3.3 years of experience with the Macintosh laryngoscope and 1.2 ± 0.4 years with the King Vision. **King Vision** • #3 channelled scope used for first attempt, if unsuccessful intubation then an unchannelled blade could be used for the next attempt **Macintosh** • Blade #3 or #4

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Erdivanli 2018 *(Continued)*

	VL classification: channelled Notes: participants were randomized to receive King Vision or Macintosh laryngoscopy in an order determined by the flipping of a coin. There were 388 participants in the study all of whom underwent laryngoscopy and intubation with each device, with no participants excluded following randomization. The study authors did not report how many participants were randomized to receive intubation with a DL or VL first.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined by the study authors. For the purpose of our analysis a change of device was taken as a failed intubation. • Hypoxia: defined as $SpO_2 < 94\%$ • Number of attempts • CL grade **Continuous outcomes** • Time for tracheal intubation: not explicitly defined Notes: primary outcomes were first pass success rate and time for tracheal intubation. Time to intubation was not properly defined in the manuscript. The number of participants randomized to first receive either intubation by VL or DL was not specified, potentially introducing bias.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** January–June 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	The order of device use was determined by flipping a coin
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT02482870). The study was registered retrospectively. All outcomes reported
Experience of intubator	Unclear risk	All participants were intubated by 1 of 5 laryngoscopists, with an average of 9.8 ± 3.3 years of experience with the Macintosh laryngoscope and 1.2 ± 0.4

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Erdivanli 2018 *(Continued)*

	years with the King Vision. Quantitative extent of experience in terms of number of intubations not specified

Erturk 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** Turkey **Setting:** theatre **Inclusion criteria**: age 18-65 years; requiring surgery under GA; ASA I or II; consented **Exclusion criteria**: pregnancy; gastroesophageal reflux; delayed gastric emptying; intraoral and neck surgery; serious respiratory and cardiovascular conditions; emergency surgery; neck dissection; laryngeal and thyroid surgery; past history of failed intubation; patients refusing to participate **Baseline characteristics** **Airtraq** • Age, mean (SD): 38.5 (± 15.0) years • Gender M/F, n: 25/15 • ASA I/II/III/IV, n: 33/7/0/0 • Mallampati 1/2/3/4, n: 16/13/8/3 **Macintosh** • Age, mean (SD): 40.4 (± 13.7) years • Gender M/F, n: 26/14 • ASA I/II/III/IV, n: 31/9/0/0 • Mallampati 1/2/3/4, n: 19/15/5/1
Interventions	**General details**: no detail provided on experience of intubators **Airtraq** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized= 40; no losses; analysed = 40 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts • CL grade: 1-4 Notes: TTI reported as median (IQR) and therefore not converted to mean (SD) as normal distribution not evident. Failed intubation was not explicitly defined, but all participants were intubated within 2 attempts with a maximum intubation duration of 80 s, which indicates that all intubations were suc-

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Erturk 2015 *(Continued)*

	cessful by our study definition of failure. The study reported airway trauma but did not differentiate between lip or dental injury therefore we have not been able to extract these data for use in the analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** May 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Opaque envelopes opened just prior to induction
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not reported

Ferrando 2011

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 60 **Country:** Spain **Setting:** theatre **Inclusion criteria:** patients scheduled for any kind of surgery who required tracheal intubation **Exclusion criteria:** patients who could require RSI; ASA IV; age < 18 years; an interincisor distance < 3 cm **Baseline characteristics** • Age, mean (SD): 46 (± 24) years • Gender M/F, n: 41/19 • BMI, n:

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Ferrando 2011 *(Continued)*

	◦ <25 kg/m^2: 41 ◦ 25-30 kg/m^2: 14 ◦ >30 kg/m^2: 5 • ASA I/II/III/IV, n: 39/16/5/0 • Mallampati 1/2/3/4, n: 29/20/10/1 Notes: baseline characteristics combined data for "Airtraq followed by Macintosh" and "Macintosh followed by Airtraq" groups making comparison of the 2 groups impossible.
Interventions	**General details**: anaesthesiology novice residents conducted the laryngoscopies. Prior to the study, they had performed < 200 intubations with the Macintosh laryngoscope and 10 intubations using the Airtraq. **Airtraq followed by Macintosh** • Randomized = 30; no losses; analysed = 30 **Macintosh followed by Airtraq** • Randomized = 30; no losses; analysed = 30 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors:** **Dichotomous outcomes:** • Failed intubation: not explicitly defined • Number of attempts: an unsuccessful intubation attempt was defined as inability to intubate within 90 s or desaturation to SpO_2 < 90%. • CL grade: 1-4 • Airway trauma: dental trauma data only extracted • Oesophageal intubation Notes: all participants were intubated within 2 attempts. There was 1 failure to intubate with the Airtraq due to light failure and subsequent successful intubation with the Macintosh laryngoscope, which meets our study definition of failed intubation for change of device. Note that in the cross-over design of the study, laryngoscopy was performed with both devices although intubation was only performed with the second device.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number generator
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators

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Ferrando 2011 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Novice intubators with < 200 DL intubations and 10 Airtraq intubations. Significant disparity in experience between devices

Foulds 2016a

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 158 **Country:** UK **Setting:** theatre; single-centre **Inclusion criteria:** patients who consented. No additional inclusion criteria were specified **Exclusion criteria:** not reported **Baseline characteristics:** data presented in abstract form only. Baseline characteristics reported as showing no difference. A third arm compared the McGrath used as DL. We excluded that arm from our analysis.
Interventions	**General details**: all participants were anaesthetized by 1 of 5 investigators. Experience not defined. **McGrath MAC Indirect** • Randomized = 52; no losses; analysed = 52 **McGrath MAC Direct** • Randomized = 53; no losses; analysed = 53 **Macintosh** • Randomized = 53; no losses; analysed = 53 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: not explicitly defined in the abstract

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Foulds 2016a *(Continued)*

	Notes: the study authors reported IDS outcomes, but expressed data as median (IQR) and we were therefore unable to extract these data. Outcome data from the McGrath MAC Direct laryngoscopy group was excluded from our analysis.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not possible to ascertain from reported data
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	All participants were anaesthetized by 1 of 5 investigators. Experience not defined

Foulds 2016b

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 50 **Country:** UK **Setting:** theatre; single-centre **Inclusion criteria**: adult patients presenting for elective operative procedures where either the surgical procedure or the anaesthetic technique required tracheal intubation. **Exclusion criteria**: hiatus hernia; symptomatic gastro-oesophageal reflux disease; pharyngeal pathology requiring an alternative laryngoscopic method; raised ICP **Baseline characteristics:**

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Foulds 2016b *(Continued)*

McGrath Series 5

- Age, mean (SD): 55.5 (± 17) years
- Gender M/F, n: 17/7
- BMI, mean (SD): 27.4 (± 4.2) kg/m^2
- ASA I/II/III/IV, n: 13/9/2/0
- Mallampati 1/2/3/4, n: 8/10/6/0

Macintosh

- Age, mean (SD): 48.5 (± 20) years
- Gender M/F, n: 15/10
- BMI, mean (SD): 29.2 (± 4.9) kg/m^2
- ASA I/II/III/IV, n: 10/13/2/0
- Mallampati 1/2/3/4, n: 8/11/6/0

Interventions	**General details**: all participants were intubated by 2 intubators, both of whom were experienced in the use of the McGrath Series 5. All participants had a rigid cervical collar applied. All participants underwent 2 laryngoscopies. They were intubated with the second device. **McGrath Series 5** • Randomized = 25; losses after randomization = 1; analysed = 24 • A malleable stylet preformed with a 60° bend 4 cm from the tip was used for all McGrath intubations **Macintosh** • Randomized = 25; no losses; analysed = 25 • #4 blade **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined, although the outcome was reported • CL grade: 1-4 • Airway trauma: dental injury data only extracted **Continuous outcomes** • Time for tracheal intubation: defined as time from the passage of the tip of the laryngoscope past the participant's teeth to the appearance of the capnograph trace. Notes: TTI reported as median (IQR (range)). There were no suggestions that this deviated significantly from a normal distribution, we therefore converted these values to mean (SD) as per Higgins 2021. Soft tissue airway trauma was reported in addition to dental injury, but was not extracted for use in our analysis. In the cross-over design of the study laryngoscopy was performed with both devices, with intubation performed using the second device. The study authors reported desaturation, defined as SpO_2 < 92%. However, events were reported with denominators from both attempts and we therefore did not extract data for this outcome.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

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Foulds 2016b *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computerized random sequence generation
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant excluded from final analysis because of cancellation of procedure after randomization. Unlikely to affect validity of results
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	2 intubators with prior experience using the McGrath Series 5. Experience in general not defined

Frohlich 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Ireland **Setting**: theatre; single centre **Inclusion criteria:** ASA I-III; scheduled for elective surgical procedure requiring tracheal intubation **Exclusion criteria:** not reported Notes: only abstract published. Baseline characteristics not included in abstract
Interventions	**General details:** 10 anaesthetists performed all intubations. Prior experience with McGrath on ≥ 5 occasions. Optimization manoeuvres used in both groups as required (readjustment of head, use of bougie, use of external laryngeal manipulation and use of second assistant) **McGrath** • Randomized = 30; no losses reported; analysed = 30 **Macintosh**

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Frohlich 2011 *(Continued)*

- Randomized = 30; no losses reported; analysed = 30

VL classification: Macintosh-style

Notes: type of McGrath blade not explicitly defined, Macintosh-style assumed

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts • Airway trauma: dental trauma data only extracted • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: not explicitly defined Notes: TTI reported without SD, therefore data could not be extracted. IDS was reported as mean, not categorical frequencies and therefore could not be extracted for inclusion in the meta-analysis. Intubation difficulty was reported on a subjective VAS.
Notes	**Funding/sponsor/declarations of interest:** 1 McGrath on loan from manufacturer **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants described as "randomly assigned", but no additional details
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Ten anaesthetists, who had received prior instruction and had experienced use of the McGrath videolaryngoscope on at least five previous occasions" Extent of experience with the study devices was not otherwise quantified.

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Gandhi 2019

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre; single-centre **Inclusion criteria**: adult intensive care patients with ASA grade I or II and aged 20-65 years **Exclusion criteria:** patients requesting regional anaesthesia; patients required tracheal intubation due to severe oxygen desaturation (SpO_2 < 80%); history of a difficult intubation **Baseline characteristics** **Airtraq** • Age, mean (SD): 41.25 (± 10.517) years • Gender M/F, n: 19/21 • Weight, mean (SD): 55.35 (± 6.298) kg • ASA I/II/III/IV, n: 27/13/0/0 **Macintosh** • Age, mean (SD): 40.85 (± 11.093) years • Gender M/F, n: 25/15 • Weight, mean (SD): 57.25 (± 7.625) kg • ASA I/II/III/IV, n: 27/13/0/0 Notes: there is a conflicting account provided as to the participant inclusion criteria and specifically the location of intervention. The study authors state that these are intensive care patients requiring emergency intubation, yet it seems that these are patients that are undergoing surgery. There are multiple instances in the text where surgery is mentioned and the narrative describes a perioperative clinical course as opposed to an intensive care patient course. For the purposes of this review we assumed the clinical context to be the operating theatre for surgery to minimize introduction of bias into subgroup analyses of location.
Interventions	**General details**: all participants underwent laryngoscopy with both devices and haemodynamic measurements were collected. They were ultimately intubated with the device assigned at randomization. No data provided on intubator experience **Airtraq** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Patient-reported sore throat (moderate pain) Notes: the authors primarily report haemodynamic outcomes

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Gandhi 2019 *(Continued)*

	Data were also available for mild sore throat pain.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** July 2016–June 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No data provided to assess

Gao 2018

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 167 **Country:** China **Setting:** ICU; single centre **Inclusion criteria:** ICU admission and need for tracheal intubation to allow mechanical ventilation **Exclusion criteria**: contraindications to tracheal intubation (e.g. unstable spinal lesion); age < 18 years; currently pregnant or breastfeeding **Baseline characteristics** **UEScope** • Age, mean (SD): 68.72 (± 16.88) years

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Gao 2018 *(Continued)*

- Gender M/F, n: 58/23
- Weight (estimated), n: < 76 kg: 36; 76-100 kg: 33; 101-150 kg: 10; > 150 kg: 2

Macintosh

- Age, mean (SD): 69.86 (± 15.55) years
- Gender M/F, n: 56/26
- Weight (estimated), n: < 76 kg: 41; 76-100 kg: 32; 101-150 kg: 8; > 150 kg: 1

Notes: reasons for intubation were reported as well. Respiratory failure, circulatory failure, neurological failure and trauma accounted for most cases and they were well balanced between arms.

Interventions	**General details**: all intubations were performed by ICU physicians who had at least 5 years' previous experience working in ICU or had worked in ICU at least 1 year after receiving at least 2 months of anaesthesiology training. Graded sedation without neuromuscular blockade was used to achieve intubating conditions. **UEScope** • Randomized = 84; losses = 3 (not intubated); analysed = 81 **Macintosh** • Randomized = 83; losses = 1 (not intubated); analysed = 82 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: > 3 attempts at intubation • Hypoxia: oxygen saturation < 90% • Number of attempts: each introduction of the laryngoscope into the oral cavity was considered a separate laryngoscopy attempt • Airway trauma: dental injury • CL grade • Mortality: defined as death • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: time from anaesthesia induction initiation to confirmation of good tube position based on partial pressure of end-tidal exhaled CO_2 • POGO score Notes: TTI reported as median (IQR). Due to the fact that the time is reported in min we could not reliably ascertain whether the distribution was normal and opted not to convert and include data into our analysis. POGO was reported as median (IQR). We did not convert to mean (SD) Mortality was defined as death as part of airway management complications with no clear description of when the outcome was assessed
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** August 2014–August 2016

Risk of bias

Bias	Authors' judgement	Support for judgement

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Gao 2018 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	4 participants did not receive intervention as randomized. All of these exclusions were due to the participants not requiring intubation. This is unlikely to affect the results.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"All physicians working at ICU received hands-on training in the use of the video laryngoscope and conventional (direct) laryngoscope. And all the physicians involved had either worked at ICUs for at least 5 years or worked at ICUs for at least 1 year after receiving at least 2 months of anesthesiology training." It is unclear what the extent of training and prior experience with the VL was.

Gavrilovska-Brzanov 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Kuwait **Setting:** theatre; single centre **Inclusion criteria**: adult cardiac surgery patients who underwent CABG operation and required GA with tracheal intubation; normal anatomical predictors for intubation (Mallampati 1 and 2, thyromental distance > 6 cm, mouth opening > 3 cm, normal head and neck movement); ASA I-III **Exclusion criteria**: anatomic features predictive for difficult airway; history of reactive airway disease; morbid obesity (BMI > 35 kg/m^2); gastro-oesophageal reflux; vital organ dysfunction; conduction abnormality; permanent pacemaker and emergency procedures. Patients who failed their first intubation attempt were also excluded. **Baseline characteristics** **Airtraq** • Age, mean (SD): 57 (± 9.6) years • Gender M/F, n: 18/12 • BMI, mean (SD): 27.8 (± 3.9) kg/m^2

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Gavrilovska-Brzanov 2015 *(Continued)*

- ASA I/II/III/IV, n: 0/5/25/0
- Mallampati 1/2/3/4, n: 12/18/0/0

Macintosh

- Age, mean (SD): 59.7 (± 10.9) years
- Gender M/F, n: 19/11
- BMI, mean (SD): 27.1 (± 2.7) kg/m^2
- ASA I/II/III/IV, n: 0/8/22/0
- Mallampati 1/2/3/4, n: 8/22/0/0

Interventions	**General details**: all participants were intubated by an anaesthetist experienced in the use of both laryngoscopes. This is not further quantified. **Airtraq** • Randomized = 30 **Macintosh** • Randomized = 30 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** The study authors report haemodynamic outcomes, but no outcomes of relevance to this review.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported Note: we did not conduct risk of bias assessment for this study because it reported no review-relevant outcomes.

Goksu 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 150 **Country:** Turkey **Setting:** ED; single centre **Inclusion criteria**: those patients over the age of 16, arriving at the ED due to blunt trauma requiring tracheal intubation to secure the airway, were included in the study. **Exclusion criteria:** patients presenting to the ED with penetrating trauma, age under 16 and intubated before ED arrival were excluded from the study. **Baseline characteristics** **C-MAC** • Age, mean (SD): 39 (± 19) years • BMI, median (IQR): 24 (23-29) kg/m^2

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Goksu 2016 *(Continued)*

	Macintosh • Age, mean (SD): 35 (± 15.5) years • BMI, median (IQR): 24 (± 22-26) kg/m^2 Notes: these were all blunt trauma patients. Most patients were intubated due to a head injury, for airway control or for cardiac arrest.
Interventions	**General details:** participants were intubated by residents or attendings with reported frequencies for each year of residency. Most participants were intubated by year 2-5 residents. It is unclear how this was allocated, but the study authors state: "In the DL group, 20 of the ET intubations were left to an experienced operator." This possibly introduces bias. A stylet was used in the tracheal tube for all intubations. All trauma patients had the rigid cervical collar removed during intubation and MILS applied. **C-MAC** • Randomized = 75; no losses; analysed = 75 • #3 or #4 blade **Macintosh** • Randomized = 75; no losses; analysed = 75 • #3 or #4 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation • Hypoxia: oxygen saturation < 90% • Number of attempts: an attempt was defined as an introduction of the laryngoscope into the mouth and its removal regardless of whether an ET tube was inserted • Airway trauma • CL grade • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation • POGO score Notes: ease of intubation was recorded on a subjective VAS. Failed intubation was described with causes and frequencies listed. These did not, however, add up with the total number of cases and the reported number of successful first pass intubations in each group. We contacted the study authors for clarification. Because of limited reporting we only managed to extract the data for hypoxia, first-pass success and TTI.
Notes	**Funding/sponsor/declarations of interest**: this study was supported by Akdeniz University Foundation. No conflicts disclosed **Study dates:** May 2013–October 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomly selected sealed envelopes used

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Goksu 2016 *(Continued)*

Allocation concealment (selection bias)	Low risk	"Either a C-MAC or a DL was randomly selected through the use of sequentially numbered, opaque, sealed envelopes."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Different skill mix with unclear prior experience with intubation in general and specifically with videolaryngoscopy. Allocation of intubations is not clear from the manuscript.

Golboyu 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** Turkey **Setting:** theatre **Inclusion criteria:** ASA I or II; aged 18-45; undergoing elective surgery **Exclusion criteria**: no consent; pregnancy; gastro-oesophageal reflux; history of oral or neck surgery; failed intubation on third attempt **Baseline characteristics** **McGrath Series 5** • Age, mean (SD): 25.4 (± 10.1) years • Gender M/F, n: 24/16 • BMI, n: normal = 24; overweight = 13; obese = 3 • ASA I/II/III/IV, n: 32/8/0/0 • Mallampati 1/2/3/4, n: 23/11/5/1 **Macintosh** • Age, mean (SD): 28.4 (± 9.1) years • Gender M/F, n: 23/17 • BMI, n: normal = 28; overweight = 10; obese = 2 • ASA I/II/III/IV, n: 30/10/0/0

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Golboyu 2016 *(Continued)*

	• Mallampati 1/2/3/4, n: 26/10/3/1 Notes: BMI reported as normal, overweight and obese
Interventions	**General details**: all participants were intubated by a consultant anaesthetist. Experience with devices not specified. A stylet was used in all intubations. **McGrath Series 5** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses, analysed = 40 **VL classification:** hyperangulated Notes: the McGrath Series 5 is a hyperangulated VL
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to perform intubation within 3 attempts • Number of attempts • Airway trauma: reported as a composite outcome of injury to teeth and lips, therefore data could not be extracted • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from the laryngoscope blade insertion into the mouth to passage of the tracheal tube between the vocal cords Notes: failed intubations were not included in the final analysis, it is therefore not possible to assume that there were no failed intubations. TTI reported as median (IQR). We could not assume a normal distribution and therefore did not include this outcome in our analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sealed envelopes used, but random sequence generation not clearly described
Allocation concealment (selection bias)	Low risk	Sealed envelopes used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Golboyu 2016 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	High risk	Participants who were not able to be intubated were excluded from the analysis. The study authors state that all patients included in the study were intubated successfully, but it is unclear whether this is after excluding any failed intubations.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	All participants intubated by a consultant anaesthetist. Intubator experience not further quantified

Griesdale 2012a

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Canada **Setting:** ICU; single centre **Inclusion criteria**: > 16 years of age requiring urgent tracheal intubation in the ICU **Exclusion criteria**: requirement for immediate tracheal intubation (within 5 min) as anticipated by the ICU team; spontaneous breathing intubation technique or C-spine precautions; history of (or anticipated) difficult intubation; previous cardiac arrest or cardiopulmonary instability (oxygen saturation 90% or SBP 80 mmHg despite oxygen or fluid and vasopressor therapy); prior clinical deterioration requiring immediate tracheal intubation while awaiting randomization or deemed inappropriate for enrolment by the attending physician (e.g. patient considered unsuitable for either technique) **Baseline characteristics** **GlideScope** • Age, mean (SD): 68 (± 16) years • Gender M/F, n: 15/5 • BMI, mean (SD): 26 (± 4) kg/m^2 • Mallampati 1/2/3/4, n: 5/6/2/1 **Macintosh** • Age, mean (SD): 61 (± 16) years • Gender M/F, n: 13/7 • BMI, mean (SD): 24 (± 6) kg/m^2 • Mallampati 1/2/3/4, n: 3/4/3/0 Notes: 16 participants were not tested for their Mallampati score
Interventions	**General details**: all inexperienced in tracheal intubation, defined as fewer than 5 intubations in the preceding 6 months (medical students, or PGY 1-4). Supervisor could take over if initial attempt exceeded 1 min. **GlideScope** • Randomized = 20; no losses; analysed = 20

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Griesdale 2012a *(Continued)*

- #4 blade
- Site of intubation ICU (19), ward (1), ED (0)

Macintosh

- Randomized = 20; no losses; analysed = 20
- #3 or #4 blade
- Site of intubation ICU (14), ward (3), ED (3)

VL classification: hyperangulated

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: unsuccessful on first attempt and required use of alternative device • Number of attempts • CL grade: 1-4 (reported for 19 participants in each group only) • Mortality: hospital mortality **Continuous outcomes** • Time for tracheal intubation: defined as time from when tip of laryngoscope entered the participant's mouth until detection of $ETCO_2$ waveform on capnography Notes: data presented for failed first attempts. Although the study authors presented data for second attempts, including attempts with the same device or the alternate device, the success of these second attempts with each device was not clear. The study authors also indicated that the supervisor took over in 8 and 4 failed first attempts in the DL and VL groups respectively, but it was not clear how much these overlapped with a change of device. We felt that it was not possible to reliably extract data for failed intubation (based on our study definition of failure) from the data presented. TTI was presented as median (IQR): GlideScope 221 (103-291), Mac 156 (67-220), P = 0.15. We could not extract these data for inclusion because we could not assume a normal distribution.
Notes	**Funding/sponsor/declarations of interest:** Canadian Anesthesiologists' Society 2009 Research Award; Clinician Scientist Award from Vancouver Coastal Health Research Institute **Study dates:** August 2009–January 2011 **Additional**: pilot study

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random allocation table in permuted blocks of 4
Allocation concealment (selection bias)	Low risk	Numbered opaque sealed envelopes opened by research co-ordinator at time of randomization
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Griesdale 2012a *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	Data for CL scores not reported for 1 participant in each group
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Both groups included inexperienced operators.

Gunes 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 180 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria**: age 22-65 years; ASA I or II; undergoing thyroid or parathyroid surgery under GA **Exclusion criteria**: history of allergy; ASA III or IV; mouth-nose-face deformity; mass in the oropharynx; undergoing surgery for secondary thyroid malignancy **Baseline characteristics** **GlideScope** • Age, mean (SD): 46.1 (± 11.4) years • Gender M/F, n: 18/73 • Weight, mean (SD): 74.0 (± 12.7) kg • Height, mean (SD): 1.62 (± 0.12) m • BMI, mean (SD): 29.2 (± 15.0) kg/m^2 • Mallampati, mean (SD): 1.96 (± 0.79) **Macintosh** • Age, mean (SD): 42.9 (± 11.2) years • Gender M/F, n: 20/69 • Weight, mean (SD): 70.6 (± 11.6) kg • Height, mean (SD): 1.64 (± 0.07) m • BMI, mean (SD): 26.4 (± 4.3) kg/m^2 • Mallampati, mean (SD): 2.01 (± 0.73)
Interventions	**General details**: all participants were intubated either by a 4th year anaesthetist assistant or specialist anaesthetist. It is unclear what the prior level of experience of these intubators was with regards to each device. **GlideScope** • Randomized = 90; no losses; analysed = 90 **Macintosh** • Randomized = 90; no losses; analysed = 90

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Gunes 2020 *(Continued)*

	VL classification: hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation • Hypoxia: recorded as SpO_2 • Successful first attempt • Number of attempts **Continuous outcomes** • Time for tracheal intubation: the duration from the insertion of the laryngoscope blade into the mouth until $ETCO_2$ pressure appears on the monitor Notes: study authors also report haemodynamic outcomes not relevant to this review. Airway trauma reported as blood on tracheal tube post-extubation only
Notes	**Funding/sponsor/declarations of interest**: study authors report that they have no conflicts of interest. **Study dates:** March–September 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomization was performed with a sealed opaque envelope system". No further information provided, randomization method not clear
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"4th year anesthesiologist assistant or specialist anesthesiologist". Extent of experience with the study devices was not otherwise quantified

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Gupta 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** 18-65 years of age; either gender; ASA I or II; undergoing elective C-spine surgery for cervical compressive myelopathy **Exclusion criteria**: risk factors for difficult mask ventilation, gastric aspiration (obesity, pregnancy), difficult airway such as previous neck surgery and mouth opening < 3 cm **Baseline characteristics** **C-MAC with stylet** • Age, mean (SD): 40 (± 12) years • Gender M/F, n: 25/5 • BMI, mean (SD): 23.1 (± 2.6) kg/m^2 • ASA I/II/III/IV, n: 22/8/0/0 • Mallampati 1/2/3/4, n: 4/14/12/0 **Macintosh with stylet** • Age, mean (SD): 39 (± 16) years • Gender M/F, n: 26/4 • BMI, mean (SD): 21.6 (± 2.1) kg/m^2 • ASA I/II/III/IV, n: 21/9/0/0 • Mallampati 1/2/3/4, n: 6/11/13/0 **C-MAC without stylet** • Age, mean (SD): 39 (± 16) years • Gender M/F, n: 24/6 • BMI, mean (SD): 21.6 (± 2.7) kg/m^2 • ASA I/II/III/IV, n: 23/7/0/0 • Mallampati 1/2/3/4, n: 6/15/9/0 **Macintosh without stylet** • Age, mean (SD): 41 (± 16) years • Gender M/F, n: 28/2 • BMI, mean (SD): 22.0 (± 2.4) kg/m^2 • ASA I/II/III/IV, n: 25/5/0/0 • Mallampati 1/2/3/4, n: 4/15/11/0 Notes: all participants had their C-spine immobilized with MILS
Interventions	**General details:** 1 of 2 anaesthetists experienced in the use of both laryngoscopes in patients requiring MILS, having done > 50 intubations with each device before the study. Bougie used if required **C-MAC with stylet** • Randomized = 30; no reported losses; analysed = 30 **C-MAC without stylet**

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Gupta 2013 *(Continued)*

- Randomized = 30; no reported losses; analysed = 30

Macintosh with stylet

- Randomized = 30; no reported losses; analysed = 30

Macintosh without stylet

- Randomized = 30; no reported losses; analysed = 30

VL classification: Macintosh-style

Notes: 4 participants were excluded before randomization due to preference of anaesthetist for alternative intubation techniques.

The neck of all participants was immobilized with MILS by holding the sides of the neck and the mastoid processes, thus preventing flexion/extension or rotational movements of the head and neck.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: a failed attempt was defined as that in which the trachea was not intubated, or that required > 120 s to perform. A maximum of 3 attempts at intubation were permitted.
- Number of attempts
- Hypoxia: defined as desaturation to SpO_2 < 90%
- Airway trauma: reported upper lip trauma, tooth damage, soft tissue bleeding, supraglottic trauma. We only extracted dental trauma data for inclusion into our analysis.
- CL grade: 1-3

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of laryngoscope blade between the teeth until tracheal tube was placed through the vocal cords as evidenced by visual confirmation. Reported as median (IQR) therefore we could not extract these data for inclusion into the meta-analysis, because we could not assume a normal distribution.
- IDS: reported as median (IQR), not categorical frequencies, therefore we could not extract these data.

Notes: for use in the meta-analysis, we added outcome frequencies from the C-MAC with stylet group to C-MAC without stylet group; similarly we added the outcomes from the Macintosh with stylet group to those from the Macintosh without stylet group.

Notes

Funding/sponsor/declarations of interest: none evident

Study dates: August 2011–July 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated randomization"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators

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Gupta 2013 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Four patients were excluded because of alternative intubation techniques preferred by the attending anesthesiologist" Small number excluded prior to randomization
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Two anesthesiologists...experienced in the use of both laryngoscopes in patients requiring MILS, having done more than 50 such intubations with each device before this study"

Gupta 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I or II; 18-60 years of age; mild or moderate contracture of the neck (Onah's classification Type 1 and Type 2); Mallampati 1 or 2; mouth opening > 3 cm; planned for elective surgery under GA **Exclusion criteria**: neck pathology other than scar; BMI > 30 kg/m^2; reactive airway; gastroesophageal reflux disease; neck circumference > 40 cm; pregnancy **Baseline characteristics** **King Vision** • Age, mean (SD): 26.55 (± 8.96) years • Gender M/F, n: 14/26 • Weight, mean (SD): 55.35 (± 11.13) kg • Height, mean (SD): 1.57 (± 0.07) m • BMI, mean (SD): 22.32 (± 3.48) kg/m^2 • Mallampati 1/2/3/4, n: 6/34/0/0 **Macintosh** • Age, mean (SD): 25.75 (± 6.19) years • Gender M/F, n: 15/25 • Weight, mean (SD): 55.02 (± 11.78) kg • Height, mean (SD): 1.58 (± 0.08) m • BMI, mean (SD): 21.81 (± 3.61) kg/m^2 • Mallampati 1/2/3/4, n: 10/30/0/0

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Gupta 2020 *(Continued)*

Interventions	**General details**: the single anaesthetist who intubated was experienced with a minimum of 50 laryngoscopies prior to start of data collection. It is not clear whether this is with the King Vision or in general. Use of accessories not specified, but use of bougie or stylet reported as outcome **King Vision** • Randomized = 40; no losses; analysed = 40 • King Vision device was used with the channelled blade **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** channelled Notes: we contacted the study authors for clarification regarding previous experience. They stated that previous experience was in fact > 50 intubations with each device (personal correspondence; in archive)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: only 2 attempts were allowed with each laryngoscope. After 2 unsuccessful attempts, participants were intubated using Intubating LMA and this was labelled as a failed attempt • Hypoxia: defined as SpO_2 < 95% • Successful first attempt • Number of attempts: each time the laryngoscope entered the oral cavity was counted as an attempt • Airway trauma: only mucosal trauma data were reported. We did not extract data for this outcome. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: calculated from the time of entry of the laryngoscope into the oral cavity to the first capnography waveform on the monitor. In the case of 2 attempts, TTI was taken for the successful attempt. Notes: successful intubation confirmed by `continuous-wave` capnography was the primary endpoint of the study. Ease of intubation was recorded as an objective score with 5 domains, the total score ranging from 0-5, with 0 being very easy and 5 being very difficult. This was not an outcome of interest to the meta-analysis. Failed intubation specified in methods but only reported in the abstract for 1 DL intubation. There is mention of a failed intubation attempt in the DL group in the study abstract. This is at odds with the reported frequencies of intubation attempts in the full manuscript, suggesting that all intubations were successful within 2 attempts in the respective intervention groups. It is possible that the failure mentioned in the manuscript crossed over and the outcome analysed on an ITT basis, but this is not clear. Furthermore, failed intubation is not explicitly reported as an outcome. Therefore, we did not extract data for this outcome in our review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

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Gupta 2020 *(Continued)*

Random sequence generation (selection bias)	Low risk	"Computer-generated random number and the sealed envelope technique"
Allocation concealment (selection bias)	Low risk	"Sealed envelope technique"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2017/06/008822). Study registered retrospectively. All outcomes reported
Experience of intubator	Low risk	Single intubator experienced in laryngoscopy (> 50 intubations). It is unclear from the wording in the manuscript whether this is with the King Vision or with DL. We contacted the study authors for clarification regarding previous experience. They stated that previous experience was in fact > 50 intubations with each device (personal correspondence; in archive)

Hamp 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Austria **Setting:** theatre **Inclusion criteria**: adult patients; ASA I-III; undergoing elective surgery with the need for DLT placement **Exclusion criteria:** patients taking medication with anti-hypertensive or beta-blocking agents on the day of surgery; cardiac arrhythmia; history of previous difficult intubation **Baseline characteristics** **Airtraq** • Age, mean (SD): 56.8 (± 10.6) years • Gender M/F, n: 9/8 • Weight, mean (SD): 73.0 (± 18.9) kg • Height, mean (SD): 1.71 (± 0.09) m • ASA I/II/III/IV, n: 9/7/1/0

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Hamp 2015 *(Continued)*

- Mallampati 1/2/3/4, n: 4/9/4/0

Macintosh

- Age, mean (SD): 63.4 (± 9.3) years
- Gender M/F, n: 11/9
- Weight, mean (SD): 71.3 (± 13.3) kg
- Height, mean (SD): 1.69 (± 0.10) m
- ASA I/II/III/IV, n: 8/10/2/0
- Mallampati 1/2/3/4, n: 7/10/2/1

Interventions	**General details**: all patients were intubated with double lumen tubes (DLT). Intubation was performed by an anaesthetist with experience in DLT placement using the MacIntosh laryngoscope as well as using the DLT-Airtraq laryngoscope. **Airtraq** • Randomized = 20; losses = 3 (1 patient re-intubated with DL due to damaged tracheal tube cuff; 2 patients failed intubation); analysed = 17 • Yellow DLT-Airtraq device used. **Macintosh** • Randomized = 20; losses = 0; analysed = 20 **VL classification:** channelled Notes: if intubation was not possible at the first attempt (within 180 s or if SpO_2 dropped below 92%), participants were excluded from analysis. Reference is made to the CONSORT flow diagram in the manuscript, but the diagram is not published and it is not possible to ascertain with certainty whether the 3 cases excluded from the Airtraq arm were due to failed intubation or not. We contacted study authors for clarification; see exclusions above. Communications with study author stored in archive
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if intubation was not possible at the first attempt (within 180 s or if SpO_2 dropped below 92%), intubation was considered to have failed and participants were excluded from the analysis. This deviates from the definition used in our meta-analysis and we have not extracted data for this outcome. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: from mouth opening for laryngoscopy until the tube position was confirmed by capnography Notes: the study authors also report a range of haemodynamic outcomes.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement

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Hamp 2015 *(Continued)*

Random sequence generation (selection bias)	Low risk	Groups written on labelled cards, put in opaque envelopes, shuffled and drawn at random after entry to theatre by an independent person
Allocation concealment (selection bias)	Low risk	Groups written on labelled cards, put in opaque envelopes, shuffled and drawn at random after entry to theatre by an independent person
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear what happened to 3 participants in the Airtraq arm as authors refer to a CONSORT diagram which was not published with the manuscript. Furthermore, participants were excluded from analysis if first attempt at intubation failed. Study authors contacted for clarification.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubation was performed by an anaesthetist with experience in DLT placement using the MacIntosh laryngoscope as well as using the DLT-Airtraq laryngoscope. Extent of experience with the study devices was not otherwise quantified.

Hindman 2014

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 14 **Country:** USA **Setting:** theatre; single centre **Inclusion criteria**: adults undergoing elective surgery requiring GA and oral intubation; patients who were likely to be easy to intubate; Mallampati 1 or 2; thyromental distance ≥ 6.0 cm; sternomental distance ≥ 12.5 cm; age 18-80 years; height between 1.52 and 1.83 m; BMI ≤ 30 kg/m^2 **Exclusion criteria**: maxillary incisors that were loose or in poor condition; previous difficult intubation; any C-spine anatomical abnormalities such as disc disease, instability, myelopathy and/or any previous C-spine surgery; symptomatic gastro-oesophageal reflux or reactive airway disease; any history of coronary artery disease or cerebral aneurysm; any history of vocal cord and/or glottic disease or dysfunction; preoperative SPB > 180 mmHg or DBP > 80 mmHg; ASA > III **Combined baseline characteristics** • Age, mean (SD): 47 (± 20) years • Gender M/F, n: 9/5 • BMI, mean (SD): 25.9 (± 2.6) kg/m^2 • ASA I/II/III/IV, n: 3/11/0/0

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Hindman 2014 *(Continued)*

- Mallampati 1/2/3/4, n: 8/6/0/0

Notes: cross-over study where each participant was intubated twice, once with each device under investigation.

Interventions	**General details**: all participants were intubated by 1 of 2 study anaesthetists, both with > 27 years' experience of direct laryngoscopy and ≥ 50 successful intubations with Airtraq. **Macintosh then Airtraq** • Analysed = 7 • 1 participant was excluded after randomization due to Airtraq light-source failure. It was not clear which group this participant had been allocated to **Airtraq then Macintosh** • Analysed = 7 • 1 participant was excluded after randomization due to Airtraq light-source failure. It was not clear which group this participant had been allocated to **VL classification:** channelled Notes: all participants had laryngoscopy and intubation with both devices in a sequence determined by randomization. Following the first intubation the tracheal tube was removed and the participant was intubated for a second time with the alternate device.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time between laryngoscope introduction into the mouth and the tracheal tube being advanced 1 cm past the vocal cords • POGO score: 0%-100%, reported separately for video analysis and anaesthetist's verbal report. We extracted data from the anaesthetist's verbal report. Notes: study authors also report minor adverse events and mechanical outcomes relating to force used for intubation. We have not extracted these results for inclusion into the meta-analysis.
Notes	**Funding/sponsor/declarations of interest**: supported by a National Institutes of Health grant **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of an independent biostatistician to develop randomization sequence
Allocation concealment (selection bias)	Low risk	Use of sealed opaque envelopes with matching participant identification number
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators

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Hindman 2014 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 1 loss; reasons for loss reported
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT01369381). Registered prospectively and all outcomes reported in final manuscript
Experience of intubator	Low risk	2 study anaesthetists, each with > 27 years' experience of direct laryngoscopy and ≥ 50 successful intubations with Airtraq

Hirabayashi 2008

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 20 **Country:** Japan **Setting:** theatre; single centre **Inclusion criteria**: ASA I-II; undergoing GA with tracheal intubation for gynaecological procedures **Exclusion criteria**: history of C-spine injury; difficult airway; gastro-oesophageal reflux disease; BMI > 30 kg/m^2 **Baseline characteristics:** "The patients comprised 20 females, with a mean age of 41 (9) years, weight of 56 (6) kg, and height of 159 (4) cm."
Interventions	**General details**: each participant underwent consecutive laryngoscopy using the Airtraq and a DL; tracheal intubation was completed as part of the second laryngoscopy. The order of laryngoscopy was randomized. The same anaesthetist performed all laryngoscopies. The study authors did not specify the number of participants randomized to be intubated with each device. There were 20 participants in the study, all of whom were female. There was no statement indicating any data losses. **Intubated with Airtraq** • Regular blade **Intubated with Macintosh** • #3 blade **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors:** The primary outcomes were changes in cervical motion with intubation. No outcomes relevant to this review reported.
Notes	**Funding/sponsor/declarations of interest**: none declared

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Hirabayashi 2008 *(Continued)*

Study dates: not reported

Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Hirabayashi 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 520 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria**: required GA with tracheal intubation for surgery **Exclusion criteria**: history of previous difficult intubation; C-spine fracture; C-spine instability **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 53 (± 16) years • Weight, mean (SD): 59 (± 12) kg • Height, mean (SD): 1.59 (± 0.09) m • BMI, mean (SD): 23 (± 4) kg/m^2 **Macintosh** • Age, mean (SD): 54 (± 17) years • Weight, mean (SD): 59 (± 11) kg • Height, mean (SD): 1.59 (± 0.09) m • BMI, mean (SD): 23 (± 4) kg/m^2
Interventions	**General details**: all participants were intubated by medical residents with anaesthesia training of 9 (SD ± 6) weeks, 48 operators in total, supervised by an anaesthetist, available for verbal information if necessary **Pentax AWS** • Randomized = 264; no losses reported; analysed = 264 **Macintosh** • Randomized = 256; no losses reported; analysed = 256 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. However, instances of intubation requiring > 3 attempts were reported • Number of attempts: 1-4 • Oesophageal intubation

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Hirabayashi 2009 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as time from interruption of intermittent positive-pressure ventilation to connection of the tracheal tube to an anaesthesia circuit. If the first intubation attempt failed, duration of the subsequent attempt was added to time of the first attempt to secure the airway.
Notes	**Funding/sponsor/declarations of interest**: departmental funding only **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomly assigned via table of random numbers as generated by a personal computer". However, study authors also state: "availability of the Pentax-AWS was slightly limited compared with the standard Macintosh laryngoscope". Unclear if this may have introduced bias
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	"Each participant had taken part in a smaller number of intubations with the Pentax-AWS than the Macintosh laryngoscope" All operators had limited experience overall

Hosalli 2017

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** India **Setting:** theatre

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Hosalli 2017 *(Continued)*

Inclusion criteria: ASA I or II; aged 18-60 years; scheduled for various elective surgeries under GA requiring tracheal intubation

Exclusion criteria: risk factors for difficult intubation (modified Mallampati 3 or 4, thyromental distance < 6 cm, interincisor distance < 3 cm, BMI > 30 kg/m^2); risk for gastric aspiration; relevant drug allergy

Baseline characteristics

Airtraq

- Age, mean (SD): 33.37 (± 12.07) years
- Gender M/F, n: 13/17
- BMI, mean (SD): 22.74 (± 2.17) kg/m^2
- ASA I/II/III/IV, n: 18/12/0/0
- Mallampati 1/2/3/4, n: 9/21/0/0

Macintosh

- Age, mean (SD): 37.37 (± 11.32) years
- Gender M/F, n: 11/19
- BMI, mean (SD): 23.17 (± 2.07) kg/m^2
- ASA I/II/III/IV, n: 16/14/0/0
- Mallampati 1/2/3/4, n: 8/22/0/0

Notes: all participants had MILS applied. A third arm included participants intubated with a McCoy laryngoscope, which was not included in this review.

Interventions

General details: after the onset of neuromuscular block, the neck was immobilized by MILS, performed by a trained assistant. All participants were intubated by the same anaesthetist, experienced with all 3 devices.

Airtraq

- Randomized = 30; no losses; analysed = 30

Macintosh

- Randomized = 30; no losses; analysed = 30

VL classification: channelled

Notes: there was a third arm, using the McCoy laryngoscope, that was not included in our analysis.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: intubation was considered to have failed following 3 unsuccessful attempts at intubation
- Number of attempts
- Airway trauma: dental trauma only extracted
- CL grade: 1-4

Continuous outcomes

- IDS

Notes: IDS used as intended, but reported as patient frequencies for values 0, 1 and > 1; we were therefore not able to extract data for our meta-analysis. The IDS scores were significantly lower in partici-

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Hosalli 2017 *(Continued)*

	pants intubated with the Airtraq (mean 0.43 ± 0.81) than those intubated with the Macintosh (mean 2.23 ± 1.92, P < 0.001).
Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Allocation sequence generated using online randomization software
Allocation concealment (selection bias)	Low risk	Allocation concealed in sealed envelopes, which were opened after patient consent had been obtained
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single anaesthetist experienced in using all 3 laryngoscopes. Experience not further quantified

Hostic 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 140 **Country:** Croatia **Setting:** theatre; single centre **Inclusion criteria:** patients undergoing GA with tracheal intubation **Exclusion criteria:** patients with predicted difficult airway **Baseline characteristics:** abstract only. The study enrolled 140 patients with mean (SD) age 58 (17) years and BMI 27 (4) kg/m^2
Interventions	**General details**: intubator experience not reported

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Hostic 2016 *(Continued)*

	C-MAC D-BLADE • Randomized = 48; no losses; analysed = 48 **C-MAC Mac** • Randomized = 52; no losses; analysed = 52 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated (C-MAC D-BLADE), Macintosh-style (C-MAC)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failure of the procedure was declared if intubation was not successful after 120 s or if arterial oxygen saturation decreased to < 90% **Continuous outcomes** • Time for tracheal intubation • POGO score Notes: IDS reported only as median (IQR)
Notes	**Funding/sponsor/declarations of interest**: not reported **Study dates**: period of 9 months

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear from data available
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not reported

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Hsu 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Taiwan **Setting**: theatre; single centre **Inclusion criteria**: adult patients; ASA I or II; requiring a DLT for thoracic surgery **Exclusion criteria**: risk of regurgitation and pulmonary aspiration; history of gastro-oesophageal reflux; pregnancy; scheduled tracheostomy and planned postoperative ventilation in ICU; a potentially difficult laryngoscopy as suggested by limited neck extension (< 35°); distance between tip of the patient's mandible and thyroid notch < 7 cm; sternomental distance < 12.5 cm with the head fully extended and the mouth closed **Baseline characteristics** **GlideScope** • Age, mean (SD): 40.1 (± 18.7) years • Gender M/F, n: 7/23 • Weight, mean (SD): 60.1 (± 9.5) kg • Height, mean (SD): 1.68 (± 0.07) m • BMI, mean (SD): 21.3 (± 3.4) kg/m^2 • ASA I/II/III/IV, n: 14/16/0/0 • Mallampati 1/2/3/4, n: 1/27/2/0 **Macintosh** • Age, mean (SD): 37.2 (± 15.4) years • Gender M/F, n: 11/19 • Weight, mean (SD): 62.4 (± 12) kg • Height, mean (SD): 1.66 (± 0.08) m • BMI, mean (SD): 23.0 (± 5.6) kg/m^2 • ASA I/II/III/IV, n: 12/18/0/0 • Mallampati 1/2/3/4, n: 3/27/0/0
Interventions	**General details**: all participants were intubated by 2 experienced anaesthetists with experience of ≥ 300 tracheal intubations with each device. All participants were intubated with DLTs. BURP manoeuvre used if required **GlideScope** • Randomized = 30; no losses reported; analysed = 30 **Macintosh** • Randomized = 30; no losses reported; analysed = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Number of attempts: ≥ 1-3

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Hsu 2012 *(Continued)*

- Airway trauma: study reported blood on the device or oral bleeding. Data for dental trauma were not presented, therefore we did not extract this outcome for inclusion in the meta-analysis
- Patient-reported sore throat: combined data for mild/moderate/severe classifications.

Continuous outcomes

- Time for tracheal intubation: time of DLT insertion calculated from time when the laryngoscope passed between participant's lips until 3 complete cycles of $ETCO_2$ displayed on the capnograph.

Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Patients were randomly assigned" No mention of method
Allocation concealment (selection bias)	Low risk	"opening a sealed envelope"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT014249605). Registered prospectively and all prespecified outcomes reported in the final manuscript.
Experience of intubator	Low risk	"two experienced anaesthetists with experience of at least 300 tracheal intubations with each device"

Hu 2017

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** China **Setting:** theatre; single centre **Inclusion criteria:** ASA I or II; aged 18-70 years; undergoing elective laryngeal surgery

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Hu 2017 *(Continued)*

Exclusion criteria: laryngeal hemangioma; laryngeal papilloma; large neoplasm; history of cardiovascular diseases; taken medicine affecting either BP or heart rhythm before surgery; oral ulcers; coagulation abnormalities; difficult intubation

Baseline characteristics

GlideScope

- Age, mean (SD): 50 (± 11) years
- Gender M/F, n: 66/34
- Weight, mean (SD): 64 (± 10) kg
- Height, mean (SD): 1.65 (± 0.06) m
- Mallampati 1/2/3/4, n: 66/31/3/0

Macintosh

- Age, mean (SD): 48 (± 10) years
- Gender M/F, n: 78/22
- Weight, mean (SD): 67 (± 11) kg
- Height, mean (SD): 1.66 (± 0.07) m
- Mallampati 1/2/3/4, n: 62/34/4/0

Notes: baseline characteristics and CL grade data reported for all 100 participants. Outcomes reported only for 196 participants as 4 participants were excluded from the DL arm due to a poor view (CL grade 3).

Interventions

General details: all participants were anaesthetized by a senior anaesthetist who had performed > 100 previous intubations using the GlideScope and Macintosh, respectively.

GlideScope

- Randomized = 100; no losses; analysed = 100
- #3 blade

Macintosh

- Randomized = 100; losses = 4 (excluded due to CL grade 3 view); analysed = 96
- #3 blade

VL classification: hyperangulated

Notes: participants who were found to have a CL grade 3 or 4 view at laryngoscopy were withdrawn from the study and intubated with a flexible fibreoptic bronchoscope.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: an intubation time of > 60 s or SpO_2 < 92% was defined as a failed attempt. If > 2 attempts were required to intubate then the participant was excluded from the study.
- Number of attempts
- Airway trauma: only oropharyngeal mucosal trauma was reported. We did not extract these data into our analysis.
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: timed from the laryngoscope passing the participant's lips until the tracheal tube was deemed to be correctly positioned by the intubator.

Notes: CL grades were reported for all 100 participants prior to exclusion of 4 participants from the DL arm. Failed intubation reported for 1 participant in the DL group, but this participant was intubated

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Hu 2017 *(Continued)*

	successfully with the same device on the second attempt. This did therefore not meet our criteria for failed intubation.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** February–September 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers
Allocation concealment (selection bias)	Low risk	"Random numbers sealed in an envelope and disclosed prior to induction of anaesthesia. Before anaesthesia an anaesthetist who was unaware of the study opened the sealed envelope and performed the intubation."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	4 participants randomized to the DL arm were excluded from the trial and analysis at the point of intubation due to a CL grade 3. This introduces potentially significant bias for our primary outcome assessment.
Selective reporting (reporting bias)	Low risk	Trial registry data examined (CTR-TRC-12002867). Study registered prospectively and all outcomes reported.
Experience of intubator	Low risk	> 100 previous intubations with both devices

Huang 2020

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 89 **Country:** China **Setting:** theatre **Inclusion criteria**: age 18-75 years; ASA I-II; BMI < 35 kg/m^2; Mallampati 1 or 2 **Exclusion criteria**: presence of any predictors of difficult intubation; Mallampati score ≥ 3; interincisor distance < 3 cm; thyromental distance < 6 cm; neck extension < 80° from neck flexion; C-spine instability; history of difficult intubation or difficult mask ventilation; severe pulmonary ventilation dysfunction; risk of pulmonary aspiration **Baseline characteristics**

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Huang 2020 *(Continued)*

GlideScope

- Age, mean (SD): 58.45 (± 8.80) years
- Gender M/F, n: 11/18
- BMI, mean (SD): 23.33 (± 3.29) kg/m^2
- ASA I/II/III/IV, n: 17/12/0/0
- Mallampati 1/2/3/4, n: 17/11/0/0

C-MAC D-BLADE

- Age, mean (SD): 57.20 (± 9.60) years
- Gender M/F, n: 18/12
- BMI, mean (SD): 22.82 (± 2.67) kg/m^2
- ASA I/II/III/IV, n: 18/12/0/0
- Mallampati 1/2/3/4, n: 17/13/0/0

Macintosh

- Age, mean (SD): 54.57 (± 11.78) years
- Gender M/F, n: 20/10
- BMI, mean (SD): 24.32 (± 3.78) kg/m^2
- ASA I/II/III/IV, n: 20/10/0/0
- Mallampati 1/2/3/4, n: 19/11/0/0

Notes: all participants underwent DLT intubation.

Interventions

General details: all participants were intubated by 1 of 5 anaesthetists with > 10 years' working experience skilled in videolaryngoscopy. A stylet was used for all intubations.

GlideScope

- Randomized = 30; losses = 1; analysed = 29

C-MAC D-BLADE

- Randomized = 30; no losses; analysed = 30

Macintosh

- Randomized = 30; no losses; analysed = 30

VL classification: hyperangulated

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Number of attempts/first pass success: intubation success rate at the first attempt was recorded by the same observer.
- Airway trauma: data collected for oral bleeding and dental injury. We only extracted dental trauma data into our analysis.
- Patient-reported sore throat: 1 day after surgery, an independent investigator interviewed participants to assess the presence of sore throat.
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: DLT insertion time was defined as from the time the laryngoscope passed the participant's lips until 3 complete $ETCO_2$ cycles were displayed on the monitor.

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Huang 2020 *(Continued)*

	Notes: the difficulty of DLT insertion and delivery were assessed by the operator, using NRS ranging from 0-10. The NRS results were grouped as 0 = none, 1–3 = mild, 4–6 = moderate, and 7–10 = severe. This was not an outcome of interest to our analysis. TTI was reported as median (IQR) and had a non-normal distribution as evidenced by a box-whisker plot presented in the manuscript; we therefore were unable to extract these data for inclusion in our analysis.
Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A closed envelope technique using a computer-generated block randomization method in blocks of 15 was used. Before the study, the computerized randomization was performed and the allocation results were placed in individual numbered and sealed envelopes. The researcher responsible for recruitment blinded to the allocation result. After a patient was consented for the study, allocation was revealed."
Allocation concealment (selection bias)	Low risk	"A closed envelope technique using a computer-generated block randomization method in blocks of 15 was used. Before the study, the computerized randomization was performed and the allocation results were placed in individual numbered and sealed envelopes. The researcher responsible for recruitment blinded to the allocation result. After a patient was consented for the study, allocation was revealed."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant excluded in the GlideScope arm due to the VL not being available. This is unlikely to have affected the outcomes.
Selective reporting (reporting bias)	Low risk	Trial registry data examined (ChiCTR1900025718). Study registered prospectively and all outcomes reported in the final published manuscript.
Experience of intubator	Unclear risk	"All endotracheal intubations were performed by five anaesthetists with 10 years' working experience skilled in videolaryngoscopy." Extent of experience with the study devices was not otherwise quantified

Ilyas 2014

Study characteristics

Methods	RCT; cross-over design

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Ilyas 2014 *(Continued)*

Participants	**Total number of participants:** 128 **Country:** Australia **Setting**: theatre; 2 centres **Inclusion criteria**: age > 18 years; ASA I-III; full upper dentition at front **Exclusion criteria**: requiring awake fibreoptic intubation; known laryngeal pathology; at risk of pulmonary aspiration **Baseline characteristics:** (reported for device used for intubation) **McGrath Series 5** • Age, mean (SD): 42.3 (± 14.0) years • Gender M/F, n: 35/29 • BMI, mean (SD): 28.5 (± 5.0) kg/m^2 • ASA I/II/III/IV, n: 21/37/6/0 • Mallampati 1/2/3/4, n: 30/26/7/1 **Macintosh** • Age, mean (SD): 42.5 (± 13.1) years • Gender M/F, n: 25/39 • BMI, mean (SD): 27.9 (± 6.0) kg/m^2 • ASA I/II/III/IV, n: 23/39/2/0 • Mallampati 1/2/3/4, n: 24/34/6/0 Notes: all participants had MILS applied
Interventions	**General details**: experienced anaesthetists; all were "clinically familiar with both devices and had undergone training in the use of the McGrath Series 5 before the start of the trial" **McGrath Series 5** • Randomized = 64; no losses; analysed = 64 **Macintosh** • Randomized = 64; no losses; analysed = 64 **VL classification:** hyperangulated Notes: alternative device was used initially to record laryngoscopic view, then was removed. Device to which participants were randomized was then used to re-record laryngoscopic view, then intubation was performed.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Airway trauma: dental damage, blood on blade, mucosal laceration, other airway trauma. We only extracted dental trauma data to avoid unit of analysis issues • Patient-reported sore throat • CL grade: 1-4. Note - 1 participant missing from denominator value in outcome data **Continuous outcomes** • Time for tracheal intubation: defined as time from when laryngoscope entered the mouth until first capnographic square wave

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Ilyas 2014 *(Continued)*

	• IDS: reported as median (IQR (range)). we could not extract these data for inclusion in our analysis. Notes: there were 5 failed intubations in the McGrath Series 5 group. 2 of these occurred due to equipment malfunction and 3 due to difficulties passing the tracheal tube.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Group allocation was achieved using a computer-generated randomisation list and sealed envelopes"
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Experienced anaesthetists with at least 10 years' experience, described as clinically familiar with both devices and trained in use of McGrath before start of the study. No further description of the degree of clinical experience to establish whether experience was sufficient and equivalent for each device

Inal 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Turkey **Setting:** theatre, single centre **Inclusion criteria:** 18-35 years of age and scheduled to undergo caesarean section **Exclusion criteria:** coagulopathy, anticoagulant usage, and head and neck pathology **Baseline characteristics**

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Inal 2016 *(Continued)*

	Truview EVO2 • Age, mean (SD): 27.7 (± 4.5) years • Weight, mean (SD): 86.5 (± 4.63) kg • Mallampati 1/2/3/4, n: 35/15/0/0 **Macintosh** • Age, mean (SD): 27.5 (± 4.3) years • Weight, mean (SD): 86.8 (± 4.67) kg • Mallampati 1/2/3/4, n: 37/13 Notes: all participants were pregnant and were scheduled for caesarian section.
Interventions	**General details**: participants were intubated by 1 of 2 anaesthetists with previous experience of > 100 intubations using the Truview and Macintosh laryngoscopes. **Truview EVO2** • Randomized = 50; no losses; analysed = 50 **Macintosh** • Randomized = 50; no losses; analysed = 50 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as intubation requiring > 3 attempts, or when a different device was used, or if desaturation occurred (peripheral oxygen saturation < 90%) • Hypoxia: oxygen saturation < 90% • Number of attempts • Successful first attempt • Airway trauma: We extracted only data for dental trauma for internal consistency in our review. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time the laryngoscope entered the mouth until the time it was removed from the mouth. Notes: other airway trauma outcomes including blood on laryngoscope blade and minor lacerations were reported but not extracted for use in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors make no financial disclosures and declare no conflicts of interest. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomly divided" No further mention of method of randomization

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Inal 2016 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Participants were intubated by 1 of 2 anaesthetists with previous experience of > 100 intubations using the TruView and Macintosh laryngoscopes.

Inangil 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** Turkey **Setting:** Turkey **Inclusion criteria:** ASA III patients undergoing elective cardiovascular surgery **Exclusion criteria**: history of difficult intubation or anticipated difficult intubation (thyromental distance < 6 cm, interincisor distance < 4 cm, reduced neck mobility, Mallampati 3-4) **Baseline characteristics** **GlideScope** • Age, mean (SD): 64.2 (± 7.8) years • Gender M/F, n: not reported • Weight, mean (SD): 79.5 (± 10.8) kg • Height, mean (SD): 1.70 (± 0.09) m • BMI, mean (SD): 27.8 (± 4.4) kg/m^2 • Mallampati 1/2/3/4, n: 25/10/0/0 **Macintosh** • Age, mean (SD): 65.5 (± 9.7) years • Gender M/F, n: 25/10 • Weight, mean (SD): 79.5 (± 10.9) kg • Height, mean (SD): 1.69 (± 0.07) m

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Inangil 2018 *(Continued)*

	• BMI, mean (SD): 27.8 (± 3.4) kg/m^2 • Mallampati 1/2/3/4, n: 26/9/0/0 Notes: gender not reported for GlideScope arm
Interventions	**General details**: all intubations were performed by the same anaesthetist with experience in using both GlideScope and Macintosh laryngoscopes. **GlideScope** • Randomized = 37; excluded = 2; analysed = 35 • pre-lubricated rigid stylet used **Macintosh** • Randomized = 37; excluded =2; analysed = 35 **VL classification:** hyperangulated Notes: blade sizes described as appropriate, but were not specified. 4 participants excluded from the study analysis after randomization: 2 from the Macintosh group for failed primary intubation and 2 from the GlideScope group for hypotension.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as from the time the blade passed through the lips until the anaesthetist notified the placement of the tracheal tube and the blade removed from participant's mouth. Notes: the study authors excluded 2 participants from the Macintosh arm for failed primary intubation. It was not clear from their methodology if these participants would meet our study definition of failed intubation and we have not extracted data for this outcome. The study authors also report haemodynamic outcomes, which are not of interest to this analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer generated random numbers that were sealed in an envelope"
Allocation concealment (selection bias)	Low risk	Sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias)	High risk	Not possible to fully blind outcome assessors

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Inangil 2018 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	All dropouts reported. 2 participants excluded in Macintosh arm due to failed first attempt, 2 exclusions from the GlideScope arm due to haemodynamic instability
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT02708420). Study registered retrospectively with all outcomes reported
Experience of intubator	Unclear risk	Single intubator experienced in the use of both devices. Extent of experience with the study devices was not otherwise quantified

Ing 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 26 **Country:** France **Setting:** theatre **Inclusion criteria**: aged 18-80 years; undergoing elective surgery requiring orotracheal intubation **Exclusion criteria**: pregnant and breastfeeding patients; predictable risk of difficult mask ventilation or of difficult tracheal intubation; necessity of a RSI; a contra-indication to the use of the automated administration of propofol and of remifentanil; known allergy to propofol or remifentanil; psychiatric illness; supraspinal neurological disorders; cranial neurosurgical procedures; patients equipped with a pacemaker; a contraindication to the use of atracurium; patients scheduled for an otolaryngological, thoracic, or intracranial surgical procedures **Baseline characteristics** **McGrath MAC** • Age, median (IQR): 58.0 (28.0-61.0) years • Gender M/F, n: 3/8 • Weight, median (IQR): 61.0 (56.0-73.0) kg • Height, median (IQR): 1.65 (1.59-1.74) m • ASA I/II/III/IV, n: 7/3/1/0 **Macintosh** • Age, median (IQR): 55.5 (41.8-68.0) years • Gender M/F, n: 5/11 • Weight, median (IQR): 69.0 (54.2-77.2) kg • Height, median (IQR): 1.67 (1.64-1.70) m • ASA I/II/III/IV, n: 5/11/0/0
Interventions	**General details**: experience of intubators not reported. Each time, the physician could decide to use a bougie or stylet, to apply laryngeal pressure, to change technique, to use a LMA or another ventilation device if needed. **McGrath MAC** • Randomized = 22; 11 losses; analysed = 11

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Ing 2017 *(Continued)*

	Macintosh • Randomized = 25; 9 losses; analysed = 16 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Hypoxia: arterial oxygen desaturation, SpO_2 < 92% • Number of attempts • Airway trauma: dental damage data extracted only • Patient-reported sore throat • CL grade: reported as 1-2 and 3-4 dichotomized - no difference between groups **Continuous outcomes** • Time for tracheal intubation: time between entry of the laryngoscope into the mouth until the appearance of the capnography trace • POGO score: reported dichotomized as < 80% and 80%-100% Notes: TTI reported as median (IQR), therefore data not extracted for meta-analysis; DL 35.0 s (22.0–47.0); VL 44.0 s (36.0–61.0). POGO score and CL grade were reported as dichotomized outcomes and could not be extracted for use in the analysis. The primary outcome was the peak plasma remifentanil concentration during the 5-min period that followed the intubation.
Notes	**Funding/sponsor/declarations of interest**: institutional funding by Foch Hospital. Ngai Liu and Thierry Chazot are cofounders of MedSteer, a company dedicated to creating closed-loop systems for the delivery of anaesthetic drugs. Marc Fischler is the President of the Scientific Committee of MedSteer. No conflicts of interest disclosed by authors **Study dates:** September 2014–February 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was performed using an internet connection to the Anesloop site (https://www.anesloop.org/) with a 1:1 scheme and balanced blocks of 10 patients"
Allocation concealment (selection bias)	Low risk	"The allocation was revealed just before laryngoscopy"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	A number of losses noted in both groups after randomization (11 in VL group, 9 in DL group), but all accounted for

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Ing 2017 *(Continued)*

Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT02245789). Registered prospectively and all outcomes reported in the final manuscript.
Experience of intubator	Unclear risk	Not reported

Ithnin 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Singapore **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II; 18-65 years of age; scheduled for elective surgery requiring tracheal intubation **Exclusion criteria**: known or predicted difficult airway; obesity (BMI > 35 kg/m^2); coronary artery or reactive airway disease; history of alcohol or substance abuse or gastro-oesophageal reflux **Baseline characteristics** **GlideScope** • Age, median (IQR): 46 (36-50) years • Weight, mean (SD): 56.9 (± 11.9) kg • Height, mean (SD): 1.58 (± 0.06) m • ASA I/II/III/IV, n: 16/13/0/0 • Mallampati 1/2/3/4, n: 25/4/0/0 **Macintosh** • Age, median (IQR): 38 (34-45) years • Weight, mean (SD): 57.7 (± 11.3) kg • Height, mean (SD): 1.56 (± 0.06) m • ASA I/II/III/IV, n: 16/14/0/0 • Mallampati 1/2/3/4, n: 22/8/0/0
Interventions	**General details**: experience of intubators not reported **GlideScope** • Randomized = 31; losses = 1 (inability to grade the intubating conditions at laryngoscopy); analysed = 30 **Macintosh** • Randomized = 34; losses = 4 (inability to grade the intubating conditions at laryngoscopy); analysed = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes**

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Ithnin 2009 *(Continued)*

- Oesophageal intubation

Notes: this study compared the median effective concentration of anaesthetic required for optimal intubating conditions for each device. Bias was introduced by this study design. Investigators provided data on difficulty of intubation.

Subjective data for difficulty of intubation included 5 variables (jaw relaxation, laryngoscopy, vocal cord, coughing, movement) recorded on scales. Study author quote: "There was no difference in the total intubation scores".

Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"randomized with a computer-generated list"
Allocation concealment (selection bias)	Low risk	"sealed envelope method"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to blind assessment of relevant outcomes
Incomplete outcome data (attrition bias) All outcomes	High risk	5 losses (4 from DL group, 1 from VL group). Reason for exclusion was due to inability to grade intubating conditions in these participants, which may introduce bias to relevant outcomes
Selective reporting (reporting bias)	Unclear risk	There was no prepublished protocol available. Without these documents it is not possible to make an assessment about reporting bias
Experience of intubator	Unclear risk	"An experienced and trained anaesthetist" performed the intubations. Relative experience with each device was not specified.

Jafra 2018

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** India **Setting:** theatre **Inclusion criteria:** patients of either gender; age 18-60 years; ASA I and II; undergoing elective surgery requiring GA with tracheal intubation

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Jafra 2018 *(Continued)*

Exclusion criteria: BMI > 35 kg/m^2; known airway pathology; increased risk of aspiration; pregnancy; coagulopathy or history of anticoagulant use; cardiovascular or cerebrovascular disease; C-spine injury

Baseline characteristics

GlideScope

- Age, mean (SD): 40.03 (± 11.884) years
- Gender M/F, n: 33/67
- Weight, mean (SD): 61.51 (± 10.676) kg
- ASA I/II/III/IV, n: 80/20/0/0

Macintosh

- Age, mean (SD): 39.87 (± 13.419) years
- Gender M/F, n: 40/60
- Weight, mean (SD): 60.4 (± 10.34) kg
- ASA I/II/III/IV, n: 80/20/0/0

Interventions

General details: all participants had an initial laryngoscopy performed with a #3 Macintosh blade, followed by laryngoscopy and intubation as per allocation (either with VL or DL). No external laryngeal manipulation was used. First laryngoscopy was done by trained anaesthetist and second by person trained in both techniques and experience of > 30 intubations with GlideScope.

GlideScope

- Randomized = 100; no losses; analysed = 100
- #3 or #4 blade

Macintosh

- Randomized = 100; no losses; analysed = 100
- #3 blade

VL classification: hyperangulated

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: not explicitly defined. All participants were reported to have been intubated successfully at the first attempt
- Number of attempts
- Airway trauma: we only extracted data for dental damage
- Patient-reported sore throat
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: measured from the insertion of device into the mouth to obtaining a square wave capnogram on monitor
- IDS: reported as mean (SD)
- POGO score: 0%-100%

Notes: an initial CL and POGO score was recorded for all participants using a Macintosh size 3 blade. We extracted CL and POGO data from the second laryngoscopy, performed with the allocated device before intubation. IDS was reported as a continuous outcome and could not be extracted for use in the analysis.

Notes

Funding/sponsor/declarations of interest: none declared

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Jafra 2018 *(Continued)*

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated random number tables and coded sealed envelope method"
Allocation concealment (selection bias)	Low risk	Sealed envelope method
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	No losses evident, and no post-randomization exclusions reported. Participants were excluded if there was > 1 attempt at intubation, which is likely to have an impact on a number of outcomes of interest to this review.
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2013/08/003889). Trial registered retrospectively, all outcomes reported in final manuscript
Experience of intubator	Low risk	First laryngoscopy was done by trained anaesthetist and second by person trained in both techniques and experience of > 30 intubations with GlideScope

Janz 2016

Study characteristics

Methods	RCT; parallel design Note: the study was combined in a factorial design with a comparison of apnoeic oxygenation versus usual care, the results of which are reported separately
Participants	**Total number of participants:** 150 **Country:** USA **Setting:** ICU; single centre **Inclusion criteria**: all patients ≥ 18 years old undergoing tracheal intubation in the Vanderbilt University Medical ICU by a pulmonary and critical care fellow were enrolled **Exclusion criteria**: awake intubation planned; intubation required so emergently that a randomization envelope could not be obtained; the treating clinicians felt a specific approach to intra-procedural oxygenation or a specific laryngoscopy device was mandated for the safe performance of the procedure **Baseline characteristics** **Videolaryngoscopy** • Age, median (IQR): 59 (49-68) years

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Janz 2016 *(Continued)*

- Gender M/F, n: 47/27
- BMI, median (IQR): 28.5 (23.4-32.7) kg/m^2

Direct laryngoscopy

- Age, median (IQR): 60 (51-67) years
- Gender M/F, n: 44/32
- BMI, median (IQR): 28.8 (23.1-33.3) kg/m^2

Notes: in most cases the indication for intubation was respiratory failure (VL: 40, DL: 45), followed by altered mental status or encephalopathy (VL: 20, DL: 19). The study authors also report comorbidities, ICU diagnoses, oxygen saturation prior to intubation, and intubator characteristics.

The groups were well balanced in terms of baseline characteristics.

Interventions

General details: all participants were intubated by pulmonary and critical care medicine (PCCM) fellows. They were supervised by either a PCCM or an anaesthesia attending physician who could offer feedback and guidance at any time during the procedure.

Previous experience with the devices used varied between intubators, but also with time as the study progressed. The study authors report a primary outcome adjusted for the intubator's experience. Prior experience was collected on an event basis, such that with each laryngoscopy within the study, the number of previous intubations with a given device was updated and increased. This effectively means that intubators can progress from inexperienced as per our definition (< 20 intubations with a given device) to experienced during the period of the study. This is likely to have a significant impact on heterogeneity and risk of bias within this domain.

The study authors also report: "As anticipated, fellows had fewer prior intubations with VL (median, 10; interquartile range (IQR), 5–22) compared with DL (47; IQR, 35–58) at the time of each procedure."

Videolaryngoscopy

- Randomized = 74; no losses; analysed = 74

Direct laryngoscopy

- Randomized = 76; no losses; analysed = 76

VL classification: Macintosh-style (see notes below)

Notes: intubators were free to choose their VL for intubation. The study authors report the frequencies of VLs chosen, but outcomes are reported together for all VLs. The most commonly chosen device was the McGrath MAC (74 (98.6%)), followed by GlideScope (1 (1.4%)).

In the direct laryngoscopy group, the blade choice was up to the intubators as well. The most commonly chosen blade was the Macintosh (74 (97.4%)), followed by a Miller (2 (2.6%)).

We contacted the study authors to provide us with device-specific data but they were unable to provide this. We have instead extracted the data into our Macintosh-style blade VL analysis as the results overwhelmingly represent this blade type.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Hypoxia: defined as lowest arterial oxygen saturation (SaO_2) during intubation attempt (IQR), not event rate. Data could not be extracted for this outcome
- Successful first attempt: defined as successful placement of a tracheal tube in the trachea during the first insertion of a laryngoscope into the oral cavity without removing the device from the mouth or using additional airway adjuncts
- Number of attempts: number of attempts reported as median (IQR) and therefore could not be extracted into our analysis

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Janz 2016 *(Continued)*

- Airway trauma: dental trauma data not reported separately from other trauma and could not be extracted
- CL grade: 1-4
- Mortality: in-hospital mortality
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: defined as time from induction to intubation and reported as median (IQR). We did not extract data for this outcome into our analysis.

Notes: the primary outcome was the rate of intubation on first attempt adjusted for the operator's previous experience with the intubating device at the time of the procedure. Their definition excluded the use of airway adjuncts for the first attempt but they report subsequent success rate with addition of tracheal tube introducer (7 participants in the VL group and 4 from the DL group). They report a further 16 participants from the VL group and 22 participants from the DL group who required additional attempts, some including change of device, operator, or use of LMA or fibreoptic scope. It was not clear how many of these would meet our study definition of failed intubation and we were unable to extract this outcome from the study.

Notes

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Study dates: February 2014–February 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Patients were randomly assigned in a 1:1 ratio to use of VL or DL on the first laryngoscopy attempt via random permuted blocks of 4, 8, and 12."
Allocation concealment (selection bias)	Low risk	"Study assignment was concealed until after the decision had been made to intubate and the patient was enrolled in the trial."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Janz 2016 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT02051816). Trial registered prospectively and all prespecified outcomes reported in the final manuscript
Experience of intubator	High risk	All participants were intubated by pulmonary and critical care medicine (PCCM) fellows. They were supervised by either a PCCM or an anaesthesia attending physician who could offer feedback and guidance at any time during the procedure. Previous experience with the devices used varied between intubators, but also with time as the study progressed. The authors report a primary outcome adjusted for the intubator's experience. Prior experience is collected on an event basis, such that with each laryngoscopy within the study, the number of previous intubations with a given device gets updated and increased. This effectively means that intubators can progress from inexperienced as per our definition (< 20 intubations with a given device) to experienced during the period of the study. This is likely to have a significant impact on heterogeneity and risk of bias within this domain. The authors also report: "As anticipated, fellows had fewer prior intubations with VL (median, 10; interquartile range [IQR], 5–22) compared with DL (47; IQR, 35–58) at the time of each procedure."

Jungbauer 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** Germany **Setting**: theatre; single centre **Inclusion criteria**: age > 18 years; modified Mallampati score 3 or 4; history of a difficult intubation and mouth opening ≥ 2 cm **Exclusion criteria:** ASA ≥ IV; undergoing RSI **Baseline characteristics** **V-MAC (Berci-Kaplan)** • Age, mean (range): 56.8 (± 11-88) years • Weight, mean (SD): 83.2 (± 20.8) kg • Height, mean (SD): 1.72 (± 0.10) m • Mallampati 1/2/3/4, n: 0/1/76/23 **Macintosh** • Age, mean (range): 54.2 (± 18-94) years • Weight, mean (SD): 78.7 (± 19.4) kg • Height, mean (SD): 1.72 (± 0.09) m • Mallampati 1/2/3/4, n: 0/2/87/11

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Jungbauer 2009 *(Continued)*

Interventions	**General details**: all intubations were performed by 2 experienced anaesthetists with 13 and 17 years of experience in clinical anaesthesia and at least 3 years of experience in difficult intubations. Optimising manoeuvres used included external manipulation of the larynx (BURP manoeuvre), use of a gum-elastic bougie (Eschmann stylet) and changes in head positioning. **V-MAC (Berci-Kaplan)** • Randomized = 100; no losses reported; analysed = 100 **Macintosh** • Randomized = 100; no losses reported; analysed = 100 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: "In cases where the anaesthetist could not intubate a patient despite all manoeuvres, the intubation attempt was declared as failed". • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from when participant's mouth was opened until cuff of tube was inflated
Notes	**Funding/sponsor/declarations of interest**: departmental funding only. No conflicts declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-based randomization list"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Jungbauer 2009 *(Continued)*

Experience of intubator	Unclear risk	"All intubations were performed by two experienced anaesthetists with 13 and 17 yr of experience in clinical anaesthesia and at least 3 yr of experience in difficult intubations" No information on whether experience was equivalent for each device

Kanchi 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 30 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: scheduled for elective CABG **Exclusion criteria**: risk factors for gastric aspiration, difficult intubation or both (Mallampati 3 or 4; thyromental distance < 6 cm; interincisor distance < 3.5 cm); left main coronary artery disease; poor left ventricular function; conduction abnormality; use of a permanent pacemaker **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 59 (± 8) years • Weight, mean (SD): 62 (± 5) kg • Mallampati, mean (SD): 1.57 (± 0.5) **Macintosh** • Age, mean (SD): 55 (± 8) years • Weight, mean (SD): 65 (± 10) kg • Mallampati, mean (SD): 1.01 (± 0.8)
Interventions	**General details**: all participants were intubated by 1 of 3 consultant anaesthetists who learnt and performed at least 20 intubations with the new device in the clinical setting before the study. **Pentax AWS** • Randomized = 15; no losses reported; analysed = 15 **Macintosh** • Randomized - 15; no losses reported; analysed = 15 • #3 for women, #4 for men **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: defined as time from picking up laryngoscope to when the blade was removed from the mouth after successful intubation.

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Kanchi 2011 *(Continued)*

	Notes: the study authors report haemodynamic changes as primary outcome. These are not outcomes of interest to our meta-analysis and have not been extracted for inclusion.
Notes	**Funding/sponsor/declarations of interest**: none disclosed **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The allocation sequence was generated by random number tables"
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Tracheal intubation was performed in each patient by one of the three consultant anaesthetists who learnt and performed at least 20 intubations with the new device in the clinical setting, prior to the study"

Kapadia 2021

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 110 **Country:** Pakistan **Setting**: theatre; single centre **Inclusion criteria:** adult patients aged between 20-60 years; ASA I or II; scheduled for elective laparoscopic cholecystectomy **Exclusion criteria:** anticipated difficult airway as assessed by limited mouth opening (< 2 finger breadths), limited neck extension, any anatomical/pathological airway abnormality or history of radiotherapy in head and neck region, obese patients having BMI > 30 kg/m^2, history of gastro oesophageal disease requiring RSI with cricoid pressure, and those who were not able to be intubated within 3 laryngoscopy attempts

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Kapadia 2021 *(Continued)*

Baseline characteristics

C-MAC

- Age, mean (SD): 42.13 (± 12.69) years
- Gender M/F, n: 15/40
- Weight, mean (SD): 71.15 (± 12.29) kg
- Height, mean (SD): 1.60 (± 0.09) m
- BMI, mean (SD): 27.46 (± 4.09) kg/m^2
- ASA I/II/III/IV, n: 22/33/0/0
- Mallampati 1/2/3/4, n: 23/26/6/0

Macintosh

- Age, mean (SD): 42.4 (± 13.72) years
- Gender M/F, n: 18/37
- Weight, mean (SD): 67.38 (± 12.52) kg
- Height, mean (SD): 1.61 (± 0.11) m
- BMI, mean (SD): 25.74 (± 3.73) kg/m^2
- ASA I/II/III/IV, n: 21/22/0/0
- Mallampati 1/2/3/4, n: 28/22/5/0

Interventions

General details: all participants were intubated by an anaesthesia resident with > 6 months' experience. This experience is not further quantified by the study authors.

C-MAC

- Randomized = 55; no losses; analysed = 55
- #3 or #4 blade

Macintosh

- Randomized = 55; no losses; analysed = 55
- #3 or #4 blade

VL classification: Macintosh-style

Notes: the VL type is explicitly mentioned only in the introduction section. We assumed the Storz C-MAC (Macintosh blade) was used.

All participants also had an orogastric tube inserted, required for surgery.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Successful first attempt
- Number of attempts: 1-3
- Airway trauma: study authors reported soft tissue damage, dental injury, blood on laryngoscope; we did not extract data for this outcome as the study authors reported events following an orogastric tube insertion. This requires further instrumentation of the airway and it is not possible to ascertain whether the reported trauma resulted from laryngoscopy or from subsequent attempts to facilitate orogastric tube insertion
- Patient-reported sore throat: reported at 1, 12 and 24 h; for the purposes of this review we extracted data for 12 h
- CL grade: 1-2

Continuous outcomes

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Kapadia 2021 *(Continued)*

- Time for tracheal intubation: reported as a dichotomous outcome (< 30 s and > 30 s) and therefore not extracted for use in our analysis

Notes	**Funding/sponsor/declarations of interest**: the study authors make no financial disclosures and report no conflicts of interest. **Study dates:** June 2017–June 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"randomly allocated by a computer-generated number"
Allocation concealment (selection bias)	Low risk	"sealed envelope technique"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT04334616). Trial registered retrospectively, all outcomes reported.
Experience of intubator	Unclear risk	"Anesthesia resident Level I and II having experience of more than six months did all intubations" No further description of experience with given device

Karaman 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** Turkey **Setting:** theatre **Inclusion criteria:** ASA I; scheduled for non-ophthalmic elective surgery **Exclusion criteria**: history of pre-existing glaucoma or previous intraocular surgery; thyromental distance < 6 cm; maximum mouth opening < 3 cm; Mallampati 3 or 4; pre-anaesthetic IOP > 20 mmHg; number of intubation attempts > 2; those at risk for regurgitation; contraindication to use of thiopental sodium and sevoflurane; obstetric or laparoscopic surgery. Patients with eye diseases were ruled out by the ophthalmologist preoperatively.

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Karaman 2016 *(Continued)*

	Baseline characteristics **McGrath Series 5** • Age, mean (SD): 32.52 (± 9.60) years • Gender M/F, n: 19/21 • Weight, mean (SD): 70.30 (± 13.41) kg • Height, mean (SD): 1.68 (± 0.08) m • BMI, mean (SD): 24.93 (± 4.57) kg/m^2 **Macintosh** • Age, mean (SD): 30.10 (± 6.77) years • Gender M/F, n: 23/17 • Weight, mean (SD): 73.32 (± 14.14) kg • Height, mean (SD): 1.70 (± 0.08) m • BMI, mean (SD): 25.25 (± 4.33) kg/m^2
Interventions	**General details**: all orotracheal intubations were performed by the same anaesthetist. A malleable stylet was inserted into the tracheal tube, and the distal tip was angled upwards by 60° to 70°, just proximal to the cuff according to the angle of the blade for the McGrath video laryngoscope and no > 30° for the Macintosh laryngoscope, to achieve successful intubation of the trachea. **McGrath Series 5** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** Outcomes reported include changes in haemodynamic parameters and IOPs. No outcomes relevant to this review reported by the study authors
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Kaur 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** India **Setting**: theatre; single centre **Inclusion criteria:** 20–70 years old, either sex, ASA physical status I or II, scheduled for undergoing elective surgery requiring tracheal intubation **Exclusion criteria:** not reported

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Kaur 2020 *(Continued)*

Baseline characteristics

McGrath MAC

- Age, mean (SD): 36.72 (± 15.26) years
- Gender M/F, ratio: 1.22:1
- ASA I/II/III/IV, n: 31/9/0/0

Truview

- Age, mean (SD): 37.65 (± 10.34) years
- Gender M/F, ratio: 1.35:1
- ASA I/II/III/IV, n: 32/8/0/0

Macintosh

- Age, mean (SD): 40.8 (± 12.91) years
- Gender M/F, ratio: 1.5:1
- ASA I/II/III/IV, n: 33/7/0/0

Interventions	**General details**: all intubations were performed by a senior anaesthetist who had experience of at least 40 intubations in patients using the given VL. **McGrath MAC** • Randomized = 40; no losses; analysed = 40 **Truview** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated (Truview), Macintosh-style (McGrath MAC) Notes: the study authors do not specify what model Truview was used.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as the inability to intubate after 3 attempts • Successful first attempt • Number of attempts: 1 or 2 • Airway trauma: following intubation the laryngoscope blade was checked for blood staining and inspection of teeth and soft tissue was done to rule out trauma • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time interval between placements of tracheal tube between the dental arches to the first deflection on capnograph. SDs not reported with means therefore no data could be extracted. Notes: airway trauma was reported as a composite outcome including blood staining, tooth and soft tissue damage. The specific incidence of dental trauma was not clear therefore we did not extract this outcome for use in our analysis.
Notes	**Funding/sponsor/declarations of interest:** study authors did not receive any financial support and do not disclose any conflicts of interest.

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Kaur 2020 *(Continued)*

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomly assigned" Insufficient detail
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registration data examined (CTRI/2018/05/014150). Trial registered retrospectively, all prespecified outcomes reported in the manuscript
Experience of intubator	Low risk	All intubations were performed by a senior anaesthetist who had experience of at least 40 intubations in patients using the given VL.

Kido 2015

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 50 **Country:** Japan **Setting:** theatre **Inclusion criteria**: age 20-85 years; scheduled to undergo GA with one lung ventilation **Exclusion criteria**: any indication for rapid induction (such as full stomach, gastroesophageal reflux); patients with suspected invasion of cancer in the trachea; anticipated difficult airway (such as difficult head tilting, limited mouth opening) **Baseline characteristics** **McGrath MAC** • Age, mean (SD): 66.6 (± 11.3) years • Gender M/F, n: 15/10 • Weight, mean (SD): 57.8 (± 8.3) kg • Height, mean (SD): 1.61 (± 0.11) m

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Kido 2015 *(Continued)*

- BMI, mean (SD): 22.3 (± 3.2) kg/m^2
- ASA I/II/III/IV, n: 0/13/12/0
- Mallampati 1/2/3/4, n: 9/16/0/0

Macintosh

- Age, mean (SD): 67.9 (± 15.0) years
- Gender M/F, n: 16/9
- Weight, mean (SD): 56.7 (± 16.9) kg
- Height, mean (SD): 1.55 (± 0.21) m
- BMI, mean (SD): 21.9 (± 4.6) kg/m^2
- ASA I/II/III/IV, n: 0/11/14/0
- Mallampati 1/2/3/4, n: 5/18/2/0

Interventions	**General details**: all patients were intubated with DLTs by anaesthesiology residents with 1-3 years of anaesthesia training who had > 50 experiences with DLT intubation. Experience with DL versus VL not reported **McGrath MAC** • Randomized = 25; no losses; analysed = 25 • #3 or #4 blade **Macintosh** • Randomized = 25; no losses; analysed = 25 • #3 or #4 blade **VL classification:** Macintosh-style Notes: anaesthesiology residents performed tracheal intubation with the McGrath with both direct and indirect videolaryngoscopy. It is not clear from the manuscript how many intubations done with the McGrath were done as direct versus indirect.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. Each resident was allowed 3 attempts at intubation, after which another airway management device was used or the leading anaesthetist took over (these were considered failed intubations). • Hypoxia: not explicitly defined • Number of attempts: 1-3 • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as from the time the laryngoscope passed between the participant's lips until the confirmation of $ETCO_2$ on the capnograph. • POGO score: 0%-100% Notes: subjective difficulty of intubation was assessed by intubators on a VAS from 0 mm (extremely easy) to 100 mm (extremely difficult) for laryngoscopy and passage of the tracheal tube through the glottis. We did not extract this outcome for use in our analysis.
Notes	**Funding/sponsor/declarations of interest:** "Financial support for the study was provided by our institution and department." No conflicts declared **Study dates:** July–November 2014

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Kido 2015 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"assigned at random by using the envelope method to 1 of 2 groups" Random sequence generation not clear
Allocation concealment (selection bias)	Low risk	"Assigned at random by using the envelope method to 1 of 2 groups"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (UMIN000014636). Trial registered prospectively and all outcomes reported in final manuscript
Experience of intubator	Unclear risk	"Anesthesia residents with 1 to 3 years of anesthesia training who had more than 50 experiences with DLT intubation performed airway management." Unclear level of experience with VL as compared to DL

Kill 2013

Study characteristics	
Methods	RCT; parallel group
Participants	**Total number of participants:** 60 **Country:** Germany **Setting**: theatre; single centre **Inclusion criteria**: adult patients scheduled for elective surgery requiring GA with tracheal intubation and with ASA I-III **Exclusion criteria**: gastro-oesophageal reflux disease, with abnormal physical status of the upper airway (e.g. after C-spine trauma), C-spine previously operated on, oropharyngeal or hypopharyngeal tumours, macroglossia, mandibular retrusion, other known airway difficulties **Baseline characteristics** **GlideScope** • Age, mean (SD): 61 (± 15) years • Gender M/F, n: 13/17 • Weight, mean (SD): 82 (± 7) kg

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Kill 2013 *(Continued)*

- Height, mean (SD): 1.69 (± 0.09) m
- BMI, mean (SD): 28.8 (± 3.5) kg/m^2
- Mallampati 1/2/3/4, n: 5/19/6/0

Macintosh

- Age, mean (SD): 63 (± 12) years
- Gender M/F, n: 19/11
- Weight, mean (SD): 84 (± 12) kg
- Height, mean (SD): 1.72 (± 0.08) m
- BMI, mean (SD): 28.3 (± 5.8) kg/m^2
- Mallampati 1/2/3/4, n: 9/17/4/0

Interventions

General details: 33 laryngoscopists participated in the study; GlideScope experience of all participating anaesthetists: mean 9.9 (SD ± 8.6) intubations. The GlideScope had been available for 6 months before this investigation. External laryngeal pressure allowed to improve glottic view in both groups

GlideScope

- Randomized = 30; no losses; analysed = 30
- #4 blade

Macintosh

- Randomized = 30; no losses; analysed = 30
- #3 or #4 blade

VL classification: hyperangulated

All anaesthetists were instructed to avoid moving the C-spine to minimize C-spine movements during laryngoscopy, but the head and neck were not immobilized.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: not explicitly defined. However, 3 participants in the study were reported to have "failed [intubation] during several attempts but was then successfully completed using videolaryngoscopy". These cases meet our study definition of failed intubation.

Continuous outcomes

- Time for tracheal intubation: defined as time from beginning of laryngoscopy to successful placement of ET tube. Data provided as median (IQR) and therefore could not be included in the meta-analysis.

Notes

Funding/sponsor/declarations of interest: travel grant from Verathon Europe. Study authors declare no conflicts of interest

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Immediately after induction of anesthesia, the patients were randomly assigned" No details on method of randomization

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Kill 2013 *(Continued)*

Allocation concealment (selection bias)	Low risk	"sealed envelope"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"All enrolled patients were able to be included in further evaluation"
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	"Thirty-three laryngoscopists participated in the study; the GlideScope experience of all participating anesthesiologists was a mean of 9.9 (± 8.6) intubations. The GlideScope had been available for a period of 6 months before this investigation" Large number of participating physicians with differing skill levels. Overall, probable disparity in experience between the 2 devices.

Kim 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 46 **Country:** Republic of Korea **Setting**: theatre; single centre **Inclusion criteria:** aged ≥ 20 years, undergoing uvulopalatopharyngoplasty under GA; diagnosis of obstructive sleep apnoea, confirmed by polysomnography, but otherwise healthy; ASA I or II **Exclusion criteria:** loosened teeth or mouth opening < 18 mm; any pathology in the neck, pharynx or larynx; risk factor for aspiration of gastric contents; history of hypersensitivity to an anaesthetic drug **Baseline characteristics** **Pentax AWS** • Age, mean (range): 45.8 (23-62) years • Gender M/F, n: 16/6 • BMI, mean (SD): 25.6 (± 3.5) kg/m^2 • ASA I/II/III/IV, n: 11/11/0/0 • Mallampati 1/2/3/4, n: 0/5/10/7 **Macintosh**

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Kim 2013 *(Continued)*

- Age, mean (range): 43.7 (19-64) years
- Gender M/F, n: 19/4
- BMI, mean (SD): 25.8 (± 3.2) kg/m^2
- ASA I/II/III/IV, n: 9/14
- Mallampati 1/2/3/4, n: 4/9/6/4

Interventions	**General details**: both anaesthetists experienced; > 3 years of clinical anaesthesia; performed > 500 and ≥ 100 tracheal intubations with the Macintosh laryngoscope and the Pentax AWS respectively. With the Pentax AWS, a well-lubricated tracheal tube was attached to a channel on the right side of the tube before insertion. When the Macintosh laryngoscope was used, a gum-elastic bougie could be used. **Pentax AWS** • Randomized = 23; losses = 1 (change in surgical plan); analysed = 22 **Macintosh** • Randomized = 23; no losses; analysed = 23 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: a failed attempt was defined as 1 in which the trachea was not intubated or an attempt that took > 60 s to complete. Up to 3 attempts at intubation were allowed. • Number of attempts: 1 or 2 • Airway trauma: visible trauma to lip or oral mucosa, bleeding, or dental trauma. Dental trauma data only extracted into meta-analysis. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: not explicitly defined. Reported for both first attempt and for successful attempt. We extracted data from the latter. • IDS: data reported as median (IQR) and could not be included in our analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Patients were randomly allocated into either the Macintosh group or AWS group" No additional details
Allocation concealment (selection bias)	Low risk	"sealed envelope method"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators

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Kim 2013 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"In a total of 46 patients enrolled, one patient in the AWS group was excluded because of a change in surgical plan" Low level of loss, should not affect results
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT01428570). All prespecified outcomes appear to be reported in final manuscript
Experience of intubator	Low risk	"Before this study, both anaesthetists experienced >3 yr of clinical anaesthesia, and had performed >500 and at least 100 tracheal intubations with the Macintosh laryngoscope and the AWS in patients, respectively"

Kim 2016

Study characteristics	
Methods	Cluster RCT; parallel design
Participants	**Total number of participants:** 140 **Country:** Republic of Korea **Setting:** ED **Inclusion criteria**: an experienced intubator performed all intubations during CPR for out-of-hospital or in-hospital cardiac arrest patients at the ED **Exclusion criteria**: intubations performed on traumatic arrest patients wearing a cervical collar to protect a cervical injury, intubations performed by a physician who had performed < 50 previous intubations, and intubations with data loss or poor quality of recording **Baseline characteristics** **GlideScope** • Age, mean (SD): 61.3 (± 18.5) years • Gender M/F, n: 45/26 **Macintosh** • Age, mean (SD): 60.5 (± 18.7) years • Gender M/F, n: 49/20 Notes: participants were all in cardiac arrest with ongoing cardiopulmonary resuscitation. The study authors also report site of arrest (out of hospital, in ED), initial rhythm and data on intubators.
Interventions	**General details**: all participants were intubated by emergency physicians with previous experience of > 30 intubations. Some of the emergency physicians only use DL to intubate, some use VL. Participants were randomized to the intubator (not the device). **GlideScope** • Randomized = 132; 61 losses; analysed = 71 **Macintosh**

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Kim 2016 *(Continued)*

- Randomized = 138; 69 losses; analysed = 69

VL classification: hyperangulated

Notes: the study authors report data separately for 'experienced' and 'highly experienced' physicians performing the intubations. They used cluster randomization to randomize participants to intubators who are DL users and intubators who are VL users. They defined 'experienced intubators' as those who had performed > 50 successful intubations previously.

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as "withdrawal of the intubation and having another physician perform the intubation because of a failure of the attempt or oesophageal intubation" • Number of attempts • Airway trauma: dental damage • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as from the advancement of the blade into the patient's mouth until delivery of bag ventilation Notes: the study authors also report interruption time (duration of time chest compressions were interrupted). TTI reported as median (IQR) and therefore could not be extracted for inclusion in our analysis. The study authors did not account for clustering in the reported manuscript. We therefore did not extract outcomes for this study.
Notes	**Funding/sponsor/declarations of interest**: this paper was supported by Konkuk University. The authors have no declarations. **Study dates:** June 2011–May 2013

Kim 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 220 **Country:** Republic of Korea **Setting:** theatre **Inclusion criteria**: adult patients aged 20-65 years requiring GA **Exclusion criteria:** ASA III or IV; damaged teeth and predicted dental trauma; history of previous difficult intubation or C-spine instability; BMI > 30 kg/m^2; Mallampati 3 or 4; thyromental distance < 7 cm; cervical movement < 45; mouth opening < 3 cm **Baseline characteristics** **Pentax AWS** • Age, mean (range): 42 (20-65) years • Gender M/F, n: 56/54

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Kim 2018 *(Continued)*

- Weight, mean (SD): 65.2 (± 10.9) kg
- Height, mean (SD): 1.66 (± 0.08) m
- BMI, mean (SD): 23.4 (± 2.8) kg/m^2
- ASA I/II/III/IV, n: 93/17/0/0
- Mallampati 1/2/3/4, n: 79/31/0/0

Macintosh

- Age, mean (range): 43 (20-64) years
- Gender M/F, n: 48/62
- Weight, mean (SD): 65.2 (± 11.8) kg
- Height, mean (SD): 1.65 (± 0.10) m
- BMI, mean (SD): 23.6 (± 2.8) kg/m^2
- ASA I/II/III/IV, n: 87/23/0/0
- Mallampati 1/2/3/4, n: 72/38/0/0

Interventions	**General details:** participants were intubated by 1 of 11 novice interns, with no prior clinical experience of intubation. Each intern performed 10 intubations with each device. The interns performed 60 manikin intubations each in the first part of the study prior to commencing the clinical part of the study. **Pentax AWS** • Randomized = 110; no losses; analysed = 110 **Macintosh** • Randomized = 110; no losses; analysed = 110 • #3 blade **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as a 90-s duration of attempted intubation or > 4 intubation attempts • Number of attempts • Airway trauma: dental trauma data only extracted • Patient-reported sore throat **Continuous outcomes** • Time for tracheal intubation: defined as "the time from insertion of the blade tip between the teeth to verification of the location of the [ETT] by confirming the end-tidal CO_2" • POGO score: 0%-100%
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** October 2014–May 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"patients were randomized by opening sealed envelopes which contained randomly assigned groups using a random number generator in the Excel program by author"

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Kim 2018 *(Continued)*

Allocation concealment (selection bias)	Low risk	"patients were randomized by opening sealed envelopes which contained randomly assigned groups using a random number generator in the Excel program by author" and "The sequence of the procedures was allocated by opening the sealed envelopes before monitoring the patients."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses post randomization evident
Selective reporting (reporting bias)	Unclear risk	Attempted review of published protocol on Korean trial registry site (KCT0001334). Not available
Experience of intubator	Low risk	Intubators inexperienced with both devices

Kleine-Brueggeney 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 480 **Country:** Switzerland **Setting:** theatre **Inclusion criteria:** patients of both genders; ASA I-III; scheduled for elective surgery requiring tracheal intubation **Exclusion criteria**: risk of aspiration; known or predicted difficult airway (BMI > 35 kg/m^2, Mallampati > 3, thyromental distance < 6 cm, interincisor distance < 3.5 cm, known difficult mask ventilation/laryngoscopy, planned or previous history of awake tracheal intubation) **Baseline characteristics** **Airtraq** • Age, mean (SD): 53 (± 18) years • Gender M/F, n: 66/54 • BMI, mean (SD): 25 (± 4) kg/m^2 • ASA I/II/III/IV, n: 18/73/29/0 • Mallampati 1/2/3/4, n: 57/56/7/0 **AP Advance MAC** • Age, mean (SD): 51 (± 18) years • Gender M/F, n: 60/60 • BMI, mean (SD): 26 (± 4) kg/m^2

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Kleine-Brueggeney 2017 *(Continued)*

- ASA I/II/III/IV, n: 29/63/28/0
- Mallampati 1/2/3/4, n: 62/49/6/0

King Vision

- Age, mean (SD): 54 (± 17) years
- Gender M/F, n: 63/57
- BMI, mean (SD): 25 (± 4) kg/m^2
- ASA I/II/III/IV, n: 29/63/28/0
- Mallampati 1/2/3/4, n: 71/44/4/1

Macintosh

- Age, mean (SD): 51 (± 19) years
- Gender M/F, n: 74/46
- BMI, mean (SD): 25 (± 4) kg/m^2
- ASA I/II/III/IV, n: 28/65/27/0
- Mallampati 1/2/3/4, n: 66/50/2/0

Notes: all participants had a cervical collar applied to simulate a difficult airway

Interventions	**General details:** participants were electively anaesthetized and a difficult airway was created by tightly adjusting a cervical collar to participants' necks. All VL blades were non-channelled and single-use. Stylets were used for all intubations. "All participating consultant anaesthetists were airway management experts and trained with all VLs on manikins and patients until they felt competent with each device. The level of experience was the same with all VLs and none of the devices had been a standard intubation tool before the study start except for the standard Macintosh laryngoscope." **Airtraq** • Randomized = 120; no losses; analysed = 120 • Blade #2 for women, #3 for men **AP Advance** • Randomized = 120; no losses; analysed = 120 • #3 blade **King Vision** • Randomized = 120; no losses; analysed = 120 • #3 blade **Macintosh** • Randomized = 120; no losses; analysed = 120 • #3 for women, #4 for men **VL classification:** hyperangulated (Airtraq and King Vision), Macintosh-style (AP Advance) Notes: the study authors note that all VLs were used as non-channelled versions of the respective devices. We classified the unchannelled Airtraq and King Vision as hyperangulated devices. The AP advance is specified as a Macintosh-style unchannelled device in the manuscript.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as 2 failed attempts, airway injury, bronchospasm, technical device failure or desaturation < 90%

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Kleine-Brueggeney 2017 *(Continued)*

- Number of attempts: successful attempt defined as placement of the tube in the trachea within 180 s
- Airway trauma: dental trauma only extracted
- Patient-reported sore throat
- CL grade: 1-4
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: defined as from removal of the face mask away from the face until appearance of $ETCO_2$
- IDS
- POGO score: 0%-100%

Notes: as both the Airtraq and King Vision VLs were classified as hyperangulated devices we have extracted outcome data as composite values combined for both devices.

The primary outcome measure was first attempt orotracheal intubation success.

TTI was reported as median (IQR (range)), we therefore did not extract these data into our meta-analyses.

Data for IDS included successful intubations only. Reported as median (IQR (range)) and therefore could not be extracted for inclusion in our dataset.

POGO scores reported as median (IQR (range)) and could not be extracted for inclusion.

Notes

Funding/sponsor/declarations of interest: this work was funded by the Gottfried and Julia Bangerter-Rhyner Foundation, Basel, Switzerland; the Fondation Latine des Voies Aeriennes (FLAVA), Lausanne, Switzerland; the Swiss Society of Anaesthesiology and Resuscitation (SGAR-SSAR), and an institutional research grant of the Department of Anaesthesiology and Pain Therapy, Inselspital, Bern University Hospital, Bern, Switzerland. Airway devices used were provided free of charge by the distributors. None of the investigators or their spouses/partners has any financial interest with any organization that could be perceived as a real or apparent conflict of interest in the context of the subject of this study. No other external funding or competing interests declared.

Study dates: February 2014–June 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"We used computer-generated randomisation with sealed opaque envelopes to randomly assign an intubation tool to a patient. Block randomisation was done separately for each anaesthetist to assure equal numbers of intubations with all devices (block of 80 intubations per anaesthetist with 20 intubations per device)."
Allocation concealment (selection bias)	Low risk	"sealed opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Kleine-Brueggeney 2017 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts after randomization reported
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT02088801). Study registered retrospectively, but within a month of starting data collection. More outcomes reported in final manuscript than in the trial registration
Experience of intubator	Unclear risk	"All participating consultant anaesthetists were airway management experts and trained with all videolaryngoscopes on manikins and patients until they felt competent with each device. The level of experience was the same with all videolaryngoscopes and none of the devices had been a standard intubation tool before the study start except for the standard Macintosh laryngoscope." Extent of experience with the study devices was not otherwise quantified

Koennecke 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 113 **Country:** Switzerland **Setting:** theatre **Inclusion criteria:** patients without predictors for a difficult airway, scheduled for elective surgery **Exclusion criteria:** not reported **Baseline characteristics:** not reported as abstract only. 57 (50%) were women, height 169 ± 8 cm, weight 74 ± 14 kg, BMI 26 ± 4 kg/m^2, mouth opening after extrication collar placement was decreased by 23 ± 6 mm to 24 ± 3 mm (P < 0.001)
Interventions	**General details:** participants were intubated by anaesthetists experienced with the use of the investigated VL devices. Extent of experience not quantified. All participants had a rigid cervical collar applied after induction **Macintosh** • Randomized = 30; no losses reported; analysed = 30 **Airtraq non-channelled blade** • Randomized = 30; no losses reported; analysed = 30 **AP Advance non-channelled blade** • Randomized = 24; no losses reported; analysed = 24 **King Vision non-channelled blade** • Randomized = 29; no losses reported; analysed = 29 **VL classification:** hyperangulated

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Koennecke 2014 *(Continued)*

Notes: for comparison, the study authors published data from a separate study examining outcomes for the channelled-blade versions of the same devices. As this was a different study we have not extracted data from these groups.

For our analysis we classified all the non-channelled devices as hyperangulated as they all have blades that are more anteriorly angulated than the Macintosh blade.

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts **Continuous outcomes** • Time for tracheal intubation: not explicitly defined. In another paper from the same group it was defined as from "time the facemask is taken away from the face until the end-tidal CO_2 curve appears on the monitor" • POGO score: 0%-100% Notes: the primary outcome was intubation success at first attempt. Definitions for outcomes not provided
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported. Preliminary report from a larger trial, but with no data reported following this publication

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	Insufficient data to assess. Preliminary report
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Anaesthesiologists experienced with the VLS evaluated the clinical performance of 3 VLS without a guiding channel for intubation (see table) and compared that with the standard Macintosh blade and the results from SWIVIT 1."

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Koennecke 2014 *(Continued)*

	Not enough data to assess

Koh 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 50 **Country:** Korea **Setting:** theatre **Inclusion criteria**: age 20-60 years; ASA I or II; scheduled to undergo surgical procedures necessitating tracheal intubation **Exclusion criteria**: risk factors for increased dental injury; pulmonary aspiration; functional or anatomical deformities in the airway (e.g. asthma, burns, tumour); anticipated airway difficulties (e.g. Mallampati 4 or having prior history of difficult airway); BMI > 30 kg/m^2; requiring one lung ventilation or a different tracheal tube other than the conventional tracheal tube used **Baseline characteristics** **Airtraq** • Age, mean (SD): 45.5 (± 7.9) years • Gender M/F, n: 9/16 • Weight, mean (SD): 64.9 (± 9.3) kg • Height, mean (SD): 1.65 (± 0.08) m • ASA I/II/III/IV, n: 22/3/0/0 • Mallampati 1/2/3/4, n: 4/16/5/0 **Macintosh** • Age, mean (SD): 44.0 (± 9.4) years • Gender M/F, n: 9/16 • Weight, mean (SD): 61.8 (± 10.6) kg • Height, mean (SD): 1.61 (± 0.09) m • ASA I/II/III/IV, n: 18/7/0/0 • Mallampati 1/2/3/4, n: 6/15/4/0 Notes: all participants had a rigid Philadelphia cervical collar applied to simulate difficult airway conditions.
Interventions	**General details**: tracheal intubation was performed by 1 experienced anaesthetist who had performed > 30 intubations with the Airtraq previously. **Airtraq** • Randomized = 25; no losses; analysed = 25 **Macintosh** • Randomsied = 25; no losses; analysed = 25 • #3 blade for women, #4 blade for men **VL classification:** channelled

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Koh 2010 *(Continued)*

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: in the event of failed second intubation attempt, the Philadelphia collar was removed and the participants were intubated under direct vision using a conventional laryngoscope with a pillow. • Number of attempts: a tracheal intubation attempt was considered to have failed if it could not be accomplished within 90 s. When the first intubation attempt failed, the intubation attempt was terminated and a second attempt was made after mask ventilation of 1 min. **Continuous outcomes** • Time for tracheal intubation: defined as the time from picking up the device until the first appearance of the capnograph wave form. Total time and time at first attempt reported separately. We extracted data for time at first attempt. • POGO score: 0%-100% POGO scores were combined for subsequent attempts and reported separately for first attempt and overall/at second attempt. We did not include the comparisons for these 2 measures in the meta-analysis. Lip and dental injuries specified as outcome in methods, but not reported. Haemodynamic outcomes including changes in HR and BP were reported, but are not of interest to this meta-analysis.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated codes that were maintained in sequentially numbered opaque envelopes"
Allocation concealment (selection bias)	Low risk	"Opaque envelopes". It was assumed that envelopes were sealed
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Tracheal intubation was performed by one experienced anesthesiologist who had experienced more than 30 intubations with the Airtraq."

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Komatsu 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria**: scheduled for various surgical procedures requiring tracheal intubation as part of anaesthesia; ≥ 18 years of age; ASA I-III **Exclusion criteria**: increased risk of pulmonary aspiration; C-spine pathology or anticipated airway difficulties (e.g. Mallampati 4 or thyromental distance < 6 cm) **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 60 (± 19) years • Gender M/F, n: 20/30 • Weight, mean (SD): 56 (± 10) kg • Height, mean (SD): 1.58 (± 0.09) m • Mallampati 1/2/3/4, n: 26/17/7/0 **Macintosh** • Age, mean (SD): 53 (± 18) years • Gender M/F, n: 28/22 • Weight, mean (SD): 58 (± 10) kg • Height, mean (SD): 1.62 (± 0.10) m • Mallampati 1/2/3/4, n: 28/14/8/0
Interventions	**General details**: the investigator had had previous experience of > 150 intubations with the Pentax AWS before this study. **Pentax AWS** • Randomized = 50; no losses reported; analysed = 50 **Macintosh** • Randomized = 50; no losses reported; analysed = 50 • #3 blade **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as unsuccessful after 3 attempts, then change of device used. Any single insertion of Pentax AWS or Macintosh laryngoscope into the participant's mouth was considered an intubation attempt. • Hypoxia: defined as SpO_2 < 95% • Number of attempts: 1-3 • Airway trauma: mucosal trauma, blood detected on the devices, dental injury. We only extracted dental trauma data. • Oesophageal intubation

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Komatsu 2010 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as time from picking up the laryngoscope to confirmation of tracheal intubation by capnography. In the event that tracheal intubation was accomplished after 1 or 2 failed attempts, times for all individual intubation attempts were totaled to calculate intubation time. Notes: CL and POGO scores were recorded in both 'normal' position and at ground level, all performed with a Macintosh #3 blade and not as per group allocation. These data could not therefore be extracted as there were no laryngeal view data from the Pentax AWS group.
Notes	**Funding/sponsor/declarations of interest**: instruments loaned from manufacturers. No financial support. No conflicts of interest declared **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was based on computer-generated codes"
Allocation concealment (selection bias)	Low risk	"maintained in sequentially numbered, opaque envelopes until just before experimental intubation"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Both investigators were blinded to the laryngeal view obtained by the other, and to the results of laryngoscopy performed under optimal conditions before group assignment" Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	"Both investigators were blinded to the laryngeal view obtained by the other, and to the results of laryngoscopy performed under optimal conditions before group assignment." Not possible to blind other outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"The investigator [...] had previously performed 150 intubations using the Airway Scope in an optimal intubation condition, but none at the ground level"

Kreutziger 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 514 **Country:** Austria

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Kreutziger 2019 *(Continued)*

Setting: prehospital

Inclusion criteria: adult emergency patients requiring prehospital tracheal intubation

Exclusion criteria: age < 18 years; futility of further measures if survival was unlikely

Baseline characteristics

McGrath MAC

- Age, median (IQR): 65 (18-95) years
- Gender M/F, n: 179/88
- BMI, median (IQR): 26.1 (13.1-47.8) kg/m^2

Macintosh

- Age, median (IQR): 64 (18-95) years
- Gender M/F, n: 176/71
- BMI, median (IQR): 27.2 (15.6-55.6) kg/m^2

Notes: 54 participants in each group had their C-spine immobilized.

The study authors report the modified National Advisory Committee for Aeronautics Index (NACA) frequencies for participants. A large proportion of participants (136 (55.1%) in DL group and 150 (56.2%) in VL group) were NACA 6/7, which corresponds to cardiac arrest or death.

Interventions

General details: all participants were intubated either by a HEMS or EMS physician. HEMS physicians were either board-certified anaesthetists or EMS physicians with at least 4 years of postgraduate training including inpatient anaesthesia. All intubators had prior experience using VL, which was implemented in this service in 2015. It is not clear what the exact prior experience with videolaryngoscopy was.

A semi-rigid stylet was used for all intubations.

McGrath MAC

- Randomized = 267; no losses; analysed = 267

Macintosh

- Randomized = 247; no losses; analysed = 247

VL classification: hyperangulated, Macintosh-style, channelled

Notes: the CONSORT flow diagram showed that of the 247 participants allocated to the Macintosh device, 27 participants were switched to the McGrath Mac device during attempts at intubation. Conversely, of the 267 participants allocated to the McGrath Mac device, 38 participants were switched to the Macintosh laryngoscope. They performed an ITT analysis, reporting their outcome data based on the originally allocated groups.

Switching the device following the failed first intubation attempt, but not later than after the second attempt for each device was allowed.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation
- Number of attempts: intubators were instructed to prompt interruption of intubation attempts when saturation levels neared 90% or minus 10% of the basic level. Switching the device following the failed first intubation attempt, but not later than after the second attempt for each device was allowed.
- Oesophageal intubation

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Kreutziger 2019 *(Continued)*

Continuous outcomes

- Time for tracheal intubation: reported as time until passage of the tracheal tube through the glottis and to first $ETCO_2$ separately. We extracted data from the latter for our analysis.

Notes: we could not extract data for failed intubation as the protocol allowed switching the device after a single failed intubation. Furthermore, a change in device was mandated after 2 failed attempts with a given device. This is significantly different to the definition of overall failure we adopted for our review. The study authors report success rates up to the 4th attempt for each device, with the success rate at 98.5% for DL and 98.1% for VL, after 38 device switches from the VL group to the DL group and 27 device switches from the DL group to the VL group.

Notes

Funding/sponsor/declarations of interest: supported, in part, by OEAMTC Helicopter Emergency Medical Service, who paid patient insurance premiums. Dr. Trimmel disclosed that the study was funded in part by Oesterreichischer Automobil und Touring Club, the motorist association of Austria (OEAMTC) Helicopter Emergency Medical Service (patient insurance fees). The remaining study authors have disclosed that they do not have any potential conflicts of interest.

Study dates: April 2017–July 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The web-based documentation (EDV Trimmel, Ternitz, Austria), including a computed random generator (1:1 ratio) and the electronic case report form determined the device assigned to each patient at each HEMS base."
Allocation concealment (selection bias)	Low risk	"A printout of the assignment was archived at each participating HEMS base and opened by the HEMS technician on occasion. HEMS physicians subsequently performed airway management as herein defined."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"There was only one protocol violation: one patient underwent three attempts with the McGrath VL. All results were evaluated by intention-to-treat analysis." Cross-overs were allowed by the protocol after the first intubation attempt. There were no losses unreported and the single reported protocol violation is unlikely to have had a significant impact on the final analysis.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Although the authors state that all physicians had previous clinical and simulation experience with the VLs, it is unclear from the manuscript whether there is a degree of heterogeneity in the experience of all staff.

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Kriege 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 2171 **Country:** Germany **Setting:** theatre **Inclusion criteria**: elective surgery requiring tracheal intubation **Exclusion criteria**: difficult intubation expected; age < 18 years; ASA IV; high risk of aspiration **Baseline characteristics:** no baseline characteristics reported. Abstract only
Interventions	**General details**: no details on intubator experience reported **McGrath** • Analysed = 1084 **Macintosh** • Analysed = 1087 **VL classification:** Macintosh-style Notes: there was insufficient detail in the abstract to determine the number of participants initially randomized and number lost following randomization.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Hypoxia: not explicitly defined • Number of attempts **Continuous outcomes** • Time for tracheal intubation: not explicitly defined • IDS Notes: TTI reported as median (IQR) and therefore could not be extracted for inclusion into our analysis. Time for intubation was significantly shorter with Macintosh (34 sec; IQR, 26-45) compared with McGrath (36 sec; IQR, 26-47; P < 0.0005) IDS reported as a frequency only for scores of > 5 and could not be extracted into our analysis due to insufficient detail.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported **Additional: c**ontacted study authors in March and August 2021 for details on full manuscript and further data. At the time of finalising this review in September 2021, the authors have not produced further data to allow a more detailed assessment and no publication has been found in database searches.

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**

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Kriege 2020 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient details provided
Selective reporting (reporting bias)	Unclear risk	Clinical trial registry (NCT02611986) and full published protocol (doi.org/10.1136/bmjopen-2017-016907) examined. Not all outcomes reported, but awaiting full manuscript publication
Experience of intubator	Unclear risk	Not reported

Kucukosman 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** Turkey **Setting:** theatre **Inclusion criteria**: age 18-65 years; ASA I-II; scheduled for non-ophthalmic elective surgery **Exclusion criteria:** patients with Mallampati and ASA status ≥ III, a history or suspicion of a difficult airway, those who had undergone intubation attempts > 2 times, a history of intracranial/ocular surgery, cerebral edema or high ICP, glaucoma, uncontrolled hypertension, diabetic retinopathy and those who declined to participate were excluded **Baseline characteristics** **C-MAC** • Age, mean (SD): 39.53 (± 12.99) years • Gender M/F, n: 8/22 • Weight, mean (SD): 73.30 (± 13.64) kg • ASA I/II/III/IV, n: 15/15/0/0 • Mallampati 1/2/3/4, n: 18/12/0/0 **Macintosh** • Age, mean (SD): 41.53 (± 11.31) years • Gender M/F, n: 10/20

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Kucukosman 2020 *(Continued)*

- Weight, mean (SD): 72.93 (± 14.16) kg
- ASA I/II/III/IV, n: 11/19/0/0
- Mallampati 1/2/3/4, n: 14/16/0/0

Notes: a third arm randomized to the McCoy laryngoscope was reported, but was not of relevance to this review.

Interventions	**General details**: all intubation procedures were performed by the same experienced anaesthesia assistant who was familiar and trained (performed at least 50 intubations prior to the study) with all 3 laryngoscopes. Stylets were used for all intubations. **C-MAC** • Randomized = 30; no losses; analysed = 30 • #3 blade **Macintosh** • Randomized = 30; no losses; analysed = 30 • #3 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts **Continuous outcomes** • Time for tracheal intubation: defined as time from the insertion of the laryngoscope to the passage of the tracheal tube through the glottis. Notes: the study authors also report haemodynamic outcomes and measurements of optic nerve sheath diameter. These are not outcomes of interest to this meta-analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** July 2019–January 2020

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	"Sealed envelope technique"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Kucukosman 2020 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All intubation procedures were performed by the same experienced anaesthesia assistant who was familiar and trained (performed at least 50 intubations prior to the study) with all 3 laryngoscopes."

Kumar 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre **Inclusion criteria**: C-spine injury; age 18-65 years; ASA I-III; scheduled for C-spine fixation; requiring tracheal intubation with manual in-line axial stabilization for induction of anaesthesia **Exclusion criteria**: difficult airway due to reduced mouth opening < 5 cm; anatomical abnormalities such as congenital anomalies; trauma to airway; broken teeth; blood in airway making direct laryngoscopy difficult; requiring RSI; inotropic or vasopressor support **Baseline characteristics** **King Vision** • Age, mean (SD): 41.97 (± 13.98) years • Gender M/F, n: 23/7 • ASA I/II/III/IV, n: 7/15/8/0 **Macintosh** • Age, mean (SD): 45.7 (± 14.96) years • Gender M/F, n: 26/4 • ASA I/II/III/IV, n: 3/18/9/0 Notes: all participants included in the study had C-spine injury and underwent laryngoscopy and intubation with MILS.
Interventions	**General details**: the procedure was performed by a trained operator who had an experience of at least 100 intubations with King Vision video laryngoscope. **King Vision** • Randomized = 35; 5 losses; analysed = 30 **Macintosh** • Randomized = 35; 5 losses; analysed = 30

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Kumar 2019 *(Continued)*

	VL classification: channelled Notes: the King Vision VL is available with and without a guiding channel. This study specified the use of a channelled blade.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failure was defined as laryngoscopy time exceeding 120 s • Airway trauma: dental trauma data only extracted **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from insertion of the laryngoscope blade in the oral cavity till the placement of the tracheal tube through the vocal cords was visually confirmed by the anaesthetist performing the intubation. In situations where visual confirmation of the tube passing through the cords was not done, the attempt was not considered complete till the tube was connected to the breathing circuit and successful placement was confirmed by capnography/end-tidal CO_2. • IDS: 0 = easy; 1-5 = slight difficulty; >5 = moderate or major difficulty Notes: the study authors also report haemodynamic comparisons between groups. Failed intubation is not reported, but is defined
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** August 2015–September 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Computer-generated random number table."
Allocation concealment (selection bias)	Low risk	"Sequentially-numbered opaque-sealed envelopes which had the intervention written in them. The envelopes were opened after the patient was inside the operation theatre."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to blind outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	5 participants excluded from each arm due to observations not being recorded. Unlikely to impact analysis
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2017/10/010242). Registered retrospectively, all outcomes reported in final manuscript
Experience of intubator	Low risk	"The procedure was performed by a trained operator who had an experience of at least 100 intubations with King Vision video laryngoscope."

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Kurnaz 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Turkey **Setting**: theatre; single centre **Inclusion criteria:** patients undergoing elective surgery, aged ≥ 65 years, ASA I-IV **Exclusion criteria:** ASA > IV, severe chronic obstructive pulmonary disease, preoperative HR < 50 per min or > 100 per min, arterial BP < 90/60 mmHg or > 180/ 100 mmHg, history of allergic reaction, intracranial vascular pathology (aneurysm, arteriovenous malformation, etc), and chin ankylosis, those with a high risk of aspiration of gastric contents **Baseline characteristics** **Truview PCD** • Age, mean (SD): 73.5 (± 7) years • Gender M/F, n: 28/22 • ASA I/II/III/IV, n: 0/27/19/4 • Mallampati 1-2/3-4, n: 47/3 **Macintosh** • Age, mean (SD): 73 (± 4.8) years • Gender M/F, n: 22/28 • ASA I/II/III/IV, n: 0/31/16/3 • Mallampati 1-2/3-4, n: 47/3 Notes: geriatric patients
Interventions	**General details**: all orotracheal intubations were performed by the same anaesthetist, previously trained with the use of VL and with at least 2 years' experience. The extent of VL experience is not further quantified. **Truview PCD** • Randomized = 50; no losses; analysed = 50 **Macintosh** • Randomized = 50; no losses; analysed = 50 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Number of attempts: 1 or > 1 • CL grade: 1-2 and 3-4; we did not extract data for this outcome for our analysis. **Continuous outcomes**

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Kurnaz 2016 *(Continued)*

- Time for tracheal intubation: the time from placing the laryngoscope blade in the mouth until seeing the $ETCO_2$ value on the monitor

Notes	**Funding/sponsor/declarations of interest:** the study authors declare no conflicts of interest and make no financial disclosures **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomized by sealed envelope system" Insufficient detail
Allocation concealment (selection bias)	Low risk	"Sealed envelope system"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available for this study.
Experience of intubator	Unclear risk	All intubations performed by single intubator with > 2 years' anaesthetic experience and previous experience with Truview, but this experience is not further quantified.

Laosuwan 2015

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 22 **Country:** Thailand **Setting:** theatre; single centre **Inclusion criteria:** patients undergoing orthopaedic surgery that did not involve C-spine procedures; requiring orotracheal intubation; age 20-65 years; ASA I-II; modified Mallampati 1 or 2 **Exclusion criteria:** BMI > 30 kg/m^2; presence of difficult intubation predictors; abnormal upper airway or cervical vertebrae; pregnancy **Baseline characteristics**

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Laosuwan 2015 *(Continued)*

	McGrath Series 5 • Age, mean (SD): 43.18 (± 11.37) years • Gender M/F, n: 5/6 • Weight, mean (SD): 63.68 (± 9.46) kg • Height, mean (SD): 1.64 (± 0.06) m • ASA I/II/III/IV, n: 6/5/0/0 • Mallampati 1/2/3/4, n: 9/2/0/0 **Macintosh** • Age, mean (SD): 35.18 (± 10.08) years • Gender M/F, n: 9/2 • Weight, mean (SD): 67.02 (± 6.91) kg • Height, mean (SD): 1.66 (± 0.09) m • ASA I/II/III/IV, n: 8/3/0/0 • Mallampati 1/2/3/4, n: 6/5/0/0 Notes: all participants had MILS applied
Interventions	**General details**: all intubations were performed by a single investigator, well experienced in the use of both devices. Before laryngoscopy, the forehead of each participant was fixed with medical tapes in the neutral position, resembling MILS. **McGrath Series 5** • Randomized = 11; no losses; analysed = 11 **Macintosh** • Randomized = 11; no losses; analysed = 11 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if the first attempt failed within 60 s or the participant developed SpO_2 < 90%, laryngoscopy would be stopped and the participant would be ventilated with 100% oxygen via anaesthetic bag-mask. Failure of intubation was considered when > 2 attempts were required. • Number of attempts: data not extracted due to probable reporting error • Airway trauma: dental injury data only extracted • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: not explicitly defined in the manuscript, but outcome was reported Notes: the frequency of number of attempts for Macintosh was reported in the manuscript as 1 for 1 attempt and 1 for 2 attempts, which was felt most likely to be a reporting error. We excluded this outcome from our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported
Risk of bias	

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Laosuwan 2015 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Random number table"
Allocation concealment (selection bias)	High risk	Open random allocation schedule
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	All intubations were performed by a single investigator, experienced in the use of both devices. Extent of experience was not further quantified.

Lascarrou 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 371 **Country:** France **Setting:** ICU; multi-centre **Inclusion criteria:** ICU admission and need for orotracheal intubation to allow mechanical ventilation **Exclusion criteria**: contraindications to orotracheal intubation (e.g. unstable spinal lesion); insufficient time to include and randomize the patient (e.g. because of cardiac arrest); age < 18 years; currently pregnant or breastfeeding; correctional facility inmate; under guardianship; without health insurance; refusal by patient or next of kin; previous enrolment in a trial with intubation as the primary end point **Baseline characteristics** **McGrath MAC** • Age, mean (SD): 62.7 (± 15.3) years • Gender M/F, n: 122/64 • BMI, mean (SD): 26.2 (± 6.7) kg/m^2 **Macintosh** • Age, mean (SD): 62.8 (± 16.3) years

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Lascarrou 2017 *(Continued)*

- Gender M/F, n: 113/72
- BMI, mean (SD): 26.6 (± 7.2) kg/m^2

Notes: other characteristics, such as reason for ICU admission and criteria for difficult intubation/ventilation were reported as well.

Interventions	**General details**: all intubators received manikin training with both devices (at least 5 intubations). Orotracheal intubation performed by a non-expert was always supervised by an expert. An expert was defined as a physician who had either worked at ICUs for at least 5 years or worked at ICUs for at least 1 year after receiving at least 2 years of anaesthesiology training. Physicians who did not meet these criteria were classified as non-experts. No stylet was used for the first intubation attempt as per French intubation guidelines. **McGrath MAC** • Randomized = 186; no losses; analysed = 186 **Macintosh** • Randomized = 185; no losses; analysed = 185 **VL classification:** Macintosh-style Notes: 3 participants from each group did not receive the intervention as allocated. These participants were retained in the analysis on an ITT basis. A separate per-protocol analysis was also published in the manuscript that excluded these participants. We extracted data from this study based on the ITT analysis.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not reported explicitly, but intubations with missing data on number of attempts imputed by authors to be failed • Hypoxia: reported separately as hypoxaemia (SpO_2 < 90%) and severe hypoxaemia (SpO_2 < 80%). We extracted data based on an SpO_2 < 90%. • Successful first attempt • Number of attempts: reported for 1-5 attempts. If the first-pass intubation attempt failed, the individual performing intubation chose between repeat laryngoscopy and an alternative intubation technique. Each introduction of the laryngoscope into the oral cavity was considered a separate laryngoscopy attempt. • Airway trauma: tooth injury data only extracted • CL grade: 1-4 • Mortality: at 28 days • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as time from anaesthesia induction initiation to confirmation of good tube position based on partial pressure of end-tidal exhaled CO_2 • POGO score: 0%-100% Notes: primary outcome was first-pass success. Data for 5 participants (2 in DL arm, 3 in VL arm) were missing for the primary outcome. They were classified as failed intubations in the ITT analysis. POGO score reported as median (IQR) and therefore could not be extracted for inclusion in our analysis. TTI reported in minutes as median (IQR) and therefore could not be extracted for inclusion.

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Lascarrou 2017 *(Continued)*

	The study authors reported death, 28-day mortality and ICU mortality separately. Death was not further defined but was described as a direct complication of intubation. We extracted data for 28-day mortality for the outcome of mortality.
Notes	**Funding/sponsor/declarations of interest**: the authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.Dr Ricard reported receiving travel reimbursement from Fisher & Paykel. Dr Mira reported receiving personal fees from LFB and Merck Sharp & Dohme for serving on advisory boards; and nonfinancial support from Astellas. Dr Messika reported receiving consulting fees from Basilea Pharmaceutica. Dr Azoulay reported receiving personal fees from Gilead, Astellas, and Alexion; and grants from Cubist and Alexion. No other disclosures were reported. The nonprofit healthcare institution Centre Hospitalier Département de la Vendée was the study funder and sponsor. Centre Hospitalier Département de la Vendée had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. **Study dates:** May 2015–January 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization was performed in blocks of 4. The randomization scheme was balanced and stratified by center and expert or nonexpert status of the individual performing intubation."
Allocation concealment (selection bias)	Low risk	"The software used to collect the data from the electronic report form automatically allocated the patients, thereby ensuring concealment."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident from manuscript
Selective reporting (reporting bias)	Low risk	Prospectively published protocol examined (clinicaltrials.gov identifier: NCT02413723). All prespecified outcomes reported in final manuscript
Experience of intubator	High risk	All participants were intubated either by experts or non-experts. As per the authors: "An expert was defined as a physician who had either worked at ICUs for at least 5 years or worked at ICUs for at least 1 year after receiving at least 2 years of anesthesiology training. Physicians who did not meet these criteria were classified as nonexperts." The study authors performed separate prespecified subgroup analyses

Lee 2009

Study characteristics

Methods	RCT; cross-over design

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Lee 2009 *(Continued)*

Participants	**Total number of participants:** 44 **Country:** The Netherlands **Setting**: theatre; single centre **Inclusion criteria**: no details given **Exclusion criteria**: < 18 years of age; requiring other than blade #3 of laryngoscope; ASA ≥ IV; requiring surgery of the face or throat **Baseline characteristics:** cross-over design. Baseline characteristics not divided by type of scope but by gender **Female** • Age, mean (SD): 50 (± 16) years • BMI, mean (SD): 26.8 (± 5.5) kg/m^2 • ASA I/II/III/IV, n: 11/12/1/0 • Mallampati 1/2/3/4, n: 7/14/2/1 **Male** • Age, mean (SD): 56 (± 13) years • BMI, mean (SD): 30.2 (± 8.5) kg/m^2 • ASA I/II/III/IV, n: 3/14/3/0 • Mallampati 1/2/3/4, n: 10/8/2/0
Interventions	**General details:** cross-over design; each participant underwent laryngoscopy with both devices in the order determined by randomization (by 2 different anaesthetists). Intubation was performed with the second device following laryngoscopy. The study did not specify the sequence to which participants had been randomized. 44 participants were included; it was not clear whether any participants were lost from their analysis. **Storz VL** **Macintosh** **VL classification:** Macintosh-style Notes: type of VL not specified, but description and images from the manuscript indicated a Macintosh-style blade design.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. A statement indicated that all participants were successfully intubated with the allocated device. • Airway trauma: the study authors reported that no injuries or dental damage occurred during the study. • CL grade: 1-4. Data could not be extracted for this outcome Notes: the main outcomes studied in this paper were the forces applied to the maxillary incisors during laryngoscopy; these are not outcomes of interest to our review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

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Lee 2009 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Patients randomly selected to participate. Order of blades randomly decided. No additional details provided
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No reported losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Ten anesthesiolgists (4 specialists, 6 residents), all familiar with the videolaryngoscope (minimum 30 uses) and classical intubation practices, participated in the study"

Lee 2012

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 50 **Country:** The Netherlands **Setting:** theatre; single centre **Inclusion criteria**: selected from a population of elective surgical patients. No additional details provided **Exclusion criteria**: < 18 years of age; requiring other than a #3 blade Macintosh laryngoscope; ASA ≥ IV; without both upper and lower teeth; requiring surgery of the face and/or throat **Baseline characteristics** **Macintosh** • Age, mean (SD): 54 (± 16) years • Gender M/F, n: 10/15 • BMI, mean (SD): 26 (± 4) kg/m^2 • ASA I/II/III/IV, n: 9/14/2/0

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Lee 2012 *(Continued)*

GlideScope

- Age, mean (SD): 56 (± 17) years
- Gender M/F, n: 6/19
- BMI, mean (SD): 25 (± 4) kg/m^2
- ASA I/II/III/IV, n: 10/15/0/0

McGrath Series 5

- Age, mean (SD): 55 (± 16) years
- Gender M/F, n: 4/21
- BMI, mean (SD): 26 (± 5) kg/m^2
- ASA I/II/III/IV, n: 9/14/2/0

V-MAC

- Age, mean (SD): 52 (± 16) years
- Gender M/F, n: 10/15
- BMI, mean (SD): 25 (± 3) kg/m^2
- ASA I/II/III/IV, n: 9/14/2/0

Interventions

General details: all laryngoscopies were performed by available staff members (only senior residents and specialists), all of whom were experienced in anaesthesia and use of the devices studied. All staff members received an introductory videolaryngoscopy course in the hospital's airway skills lab and had used each VL a minimum of 50 times before this study.

A stylet was used with the GlideScope and the McGrath. No stylet was used with the V-MAC nor the Macintosh.

Macintosh

- Analysed = 25

GlideScope

- Analysed = 25

McGrath Series 5

- Analysed = 25

V-MAC

- Analysed = 25

VL classification: hyperangulated, Macintosh-style

Notes: participants randomly assigned to receive a laryngoscopy with a pair of scopes in random order. The exact sequences to which participants were randomized was not specified. There were no reported participant losses.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined in this study as > 4 attempts or > 120 s. For our analysis, > 3 attempts was taken as failed intubation.
- Successful first attempt
- Number of attempts: 1-4. An attempt was counted as an "approach of the ETT to the glottic entrance", as participants were only actually intubated following the second laryngoscopy.
- Airway trauma: minor lacerations, but dental trauma not explicitly reported. No data were extracted for this outcome.

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Lee 2012 *(Continued)*

- CL grade: 1-3

Continuous outcomes

- Time for tracheal intubation: measured as time between picking up the tracheal tube and positioning the tube directly anterior to the vocal cords. Categorized as < 30 s, 30-60 s, > 60 s. Not reported as a continuous outcome and could not be extracted for inclusion in the review.

Notes: regarding the TTI, the authors quote: "The time taken to complete the placement of the tracheal tube with the McGrath™ scope (Aircraft Medical) was significantly different from the other blades, with a greater proportion of the attempts requiring > 30 s. There was also a statistically significant difference in time taken for the procedure between the Macintosh (Karl Storz) and GlideScope® blades (Verathon Inc), with the GlideScope® blade (Verathon Inc) having more attempts requiring between 30 and 60 s. No further differences in insertion time were significant"

Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants randomly assigned to set of 2 blades, which were used in randomized order. No details of randomization method provided
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Large number of anaesthetists in the study; all described as having equivalent training. Experience with each VL was > 50 intubations for all intubators.

Lee 2013

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 40

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Lee 2013 *(Continued)*

Country: Korea

Setting: theatre; single centre

Inclusion criteria: 18-60 years old; ASA I or II; scheduled for elective surgery that was expected to take 1-2 h

Exclusion criteria: known cardiovascular disease; diabetes; endocrine disease; allergies to any medications; anatomical characteristics associated with a difficult airway, such as unstable teeth, mouth opening < 3 cm, limited neck extension

Baseline characteristics

Pentax AWS

- Age, mean (SD): 38.9 (± 13.3) years
- Gender M/F, n: 12/8
- Weight, mean (SD): 64.9 (± 8.2) kg
- Height, mean (SD): 1.68 (± 0.09) m
- BMI, mean (SD): 23.0 (± 2.6) kg/m^2

Macintosh

- Age, mean (SD): 35.5 (± 10.5) years
- Gender M/F, n: 11/9
- Weight, mean (SD): 66.0 (± 14.9) kg
- Height, mean (SD): 1.67 (± 0.10) m
- BMI, mean (SD): 23.6 (± 3.9) kg/m^2

Interventions

General details: all participants were intubated by a single anaesthetist experienced with both devices.

Pentax AWS

- Randomized = 20; no losses reported; analysed = 20

Macintosh

- Randomized = 20; no losses reported; analysed = 20

VL classification: channelled

Notes: if tracheal intubation failed at the first attempt or if a participant's CL grade was > 3, the participant was excluded from the study.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Patient-reported sore throat: measured at different time points; mild to moderate sore throat measured 30 min after extubation. Not possible to interpret data presented for sore throat at 30 min. No sore throat observed 24 h after extubation in either group.

Continuous outcomes

- Time for tracheal intubation: defined as time from when the tip of the blade passes the incisors until the tip of the blade passes out of the incisors after insertion of the tracheal tube.

Notes: the main outcomes studied were haemodynamic parameters that are not of interest to our review.

Notes

Funding/sponsor/declarations of interest: the study authors declare no conflicts of interest and make no financial disclosures.

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Lee 2013 *(Continued)*

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"patients were randomly assigned to the two groups" No additional details
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"Single anesthesiologist who was an expert in both intubation procedures". Experience with study devices was not further quantified

Lim 2005

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Singapore **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II admitted for elective gynaecological procedures; Mallampati grades 1 and 2 **Exclusion criteria**: risk of aspiration; evidence of a potentially difficult airway **Baseline characteristics** **GlideScope** • Age, mean (SD): 39 (± 13) years • Weight, mean (SD): 57.8 (± 10.5) kg • Height, mean (SD): 1.58 (± 0.04) m

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Lim 2005 *(Continued)*

- ASA I/II/III/IV, n: 23/7/0/0
- Mallampati 1/2/3/4, n: 25/5/0/0

Macintosh

- Age, mean (SD): 40 (± 10) years
- Weight, mean (SD): 58.2 (± 8.9) kg
- Height, mean (SD): 1.58 (± 0.05) m
- ASA I/II/III/IV, n: 28/2/0/0
- Mallampati 1/2/3/4, n: 26/4/0/0

Notes: all participants had MILS applied to simulate a difficult airway

Interventions	**General details**: all participants were intubated by 1 of 20 anaesthetists in the department with varying degrees of experience with GlideScope (from complete novice to > 10 successful experiences). A stylet was used in both groups. A statement indicated, "external laryngeal pressure, adjustment of the angle of the tracheal tube with adjustment or partial withdrawal of the stylet, increased lifting force of the intubating device and slight withdrawal of the blade were allowed to facilitate the tracheal intubation". **GlideScope** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to secure airway in 3 attempts • Successful first attempt • Number of attempts: 1-2 • Airway trauma: bloodstained secretions. Dental trauma was not reported, therefore no data were extracted for this outcome • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from anaesthetist picking up device to when capnography confirmed correct placement of the tube. Intubation time was broken down by level of experience of the intubator. Notes: study authors reported intubation difficulty, but used a non-standardized scale
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomized with sealed envelopes. Insufficient detail

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Lim 2005 *(Continued)*

Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Differing levels of experience of intubators, all detailed by study authors. Not clear whether experience of intubators was evenly distributed for each device.

Lin 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 170 **Country:** China **Setting**: theatre; single centre **Inclusion criteria**: adults scheduled for elective open thoracic surgery requiring DLT insertion for single lung ventilation **Exclusion criteria**: limited mouth opening; ASA III or IV; age < 18 years; history of known difficult airway **Baseline characteristics** **CEL-100** • Age, mean (SD): 58.2 (± 9.6) years • Gender M/F, n: 55/28 • Weight, mean (SD): 60.9 (± 8.9) kg • Height, mean (SD): 1.63 (± 0.07) m • BMI, mean (SD): 22.9 (± 2.7) kg/m^2 • ASA I/II/III/IV, n: 60/16/7/0 • Mallampati 1/2/3/4, n: 40/36/7/0 **Macintosh** • Age, mean (SD): 57.6 (± 9.4) years • Gender M/F, n: 52/30 • Weight, mean (SD): 61.2 (± 8.3) kg

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Lin 2012 *(Continued)*

- Height, mean (SD): 1.63 (± 0.07) m
- BMI, mean (SD): 23.1 (± 2.8) kg/m^2
- ASA I/II/III/IV, n: 59/17/6/0
- Mallampati 1/2/3/4, n: 45/31/6/0

Notes: all participants were undergoing thoracic surgery requiring intubation with DLT.

Interventions	**General details**: all intubations were performed by 3 experienced anaesthetists who had each performed at least 30 successful DLT insertions using the CEL-100 device. Use of stylet, and external laryngeal pressure allowed if required **CEL-100** • Randomized = 85; losses = 2 (failed intubation); analysed = 83 **Macintosh** • Randomized = 85; losses = 3 (failed intubation); analysed = 82 **VL classification:** Macintosh-style Notes: the study authors state, "the blade of the CEL-100 retains the Macintosh blade shape, except for a slightly anterior curve at the distal tip". There was some debate regarding its classification as either hyperangulated or Macintosh-style. The consensus opinion was the CEL-100 VL should be classified as a Macintosh-style VL for the purposes of this review. A total of 5 participants were excluded from the study analysis for failed intubation. We have extracted these as instances of failed intubation in the meta-analysis.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure after 3 attempts for either device with trachea intubated with a single-lumen tube or managed according to ASA difficult airway guidelines. Participants were then excluded from the study • Hypoxia: oxygen saturation < 95% - reported as hypoxaemia • Successful first attempt • Number of attempts: 1 or > 2 • Airway trauma: oral mucosal bleeding. Dental trauma was not reported and data for this outcome have not been extracted • Patient-reported sore throat: reported for first postoperative day • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as time from insertion of laryngoscope blade into the mouth until first upstroke of the capnograph trace; If > 1 intubation attempt was required, successful intubation time was the sum of the times for each attempt and did not include the time interval between attempts. • IDS Notes: TTI data were reported as median (IQR (range)) and could not be extracted because we could not assume a normal distrubution. Intubation difficulty was subjectively assessed on a non-standardized scale from 0 (easy) to 100 (difficult). Scores reported as median (IQR)
Notes	**Funding/sponsor/declarations of interest**: none declared

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Lin 2012 *(Continued)*

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated codes"
Allocation concealment (selection bias)	Low risk	"maintained in sequentially numbered opaque envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	5 participants excluded from further analysis owing to failure of intubation. Low number, therefore low risk of bias
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All the intubations were performed by three experienced anaesthetists who had each performed at least 30 successful double-lumen tube insertions using the CEL-100 device"

Liu 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 180 **Country:** China **Setting:** theatre; single centre **Inclusion criteria**: age > 18 years; ASA I-II; undergoing elective surgery under GA requiring routine orotracheal intubation. **Exclusion criteria**: predictors of potential difficult airway; BMI > 35 kg/m^2; modified Mallampati 3-4; limited mouth opening < 3 cm, thyromental distance < 6 cm; loose cutting teeth or extreme long superior teeth; restricted neck motion (< 80° from full flexion); history of difficult airway; obstructive sleep apnoea-hypopnoea syndrome; risk of regurgitation or aspiration; patients with C-spine instability **Baseline characteristics** **McGrath Series 3** • Age, mean (SD): 43.0 (± 12.4) years

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Liu 2016 *(Continued)*

- Gender M/F, n: 18/72
- BMI, mean (SD): 23.7 (± 3.4) kg/m^2
- ASA I/II/III/IV, n: 76/24/0/0
- Mallampati 1/2/3/4, n: 47/53/0/0

Macintosh

- Age, mean (SD): 44.1 (± 12.3) years
- Gender M/F, n: 13/77
- BMI, mean (SD): 23.4 (± 3.4) kg/m^2
- ASA I/II/III/IV, n: 68/32/0/0
- Mallampati 1/2/3/4, n: 49/51/0/0

Interventions	**General details**: all participants were intubated by 1 of 9 first year trainee anaesthetists supervised by a senior anaesthetist. Trainees had prior experience of 10-30 intubations with Macintosh. They had received standardized training on manikins with the McGrath laryngoscope and had to achieve 5 successful intubations before starting the study. The use of a stylet was at the discretion of the anaesthetist. **McGrath Series 3** • Randomized = 90; losses = 2 (for failed intubations); analysed = 88 • #3 or #4 blade **Macintosh** • Randomized= 90; losses = 1 (for failed intubation); analysed = 89 • #3 or #4 blade **VL classification:** hyperangulated Notes: the study uses a McGrath Series 3 VL, which is not used in clinical practice anymore and limited data on its design are available in open source. The study authors note the angle of the blade is 45°. We recognize this is less than the 60° used in more hyperangulated devices, but more than the curvature of a standard Macintosh blade. For the purposes of this review we classified it as a hyperangulated device.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure to achieve tracheal intubation after 2 attempts or prolonged intubation taking > 120 s • Successful first attempt • Number of attempts: if the operator removed the laryngoscope from the participant's mouth, this was counted as an additional attempt at intubation. • Airway trauma: dental trauma data only extracted • Patient-reported sore throat • CL grade: 1-3 **Continuous outcomes** • Time for tracheal intubation: defined as the time from when the laryngoscope was placed into the mouth until $ETCO_2$ detected, including time between attempts Notes: time to intubation was the primary outcome. Ease of intubation was reported on a NRS from 1 (easiest) to 5 (most difficult)
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures.

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Liu 2016 *(Continued)*

Study dates: November–December 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated block randomization"
Allocation concealment (selection bias)	Low risk	"Sealed opaque envelopes were used to conceal the assignment and were opened only on arrival of the patient in the anesthetic room, shortly before tracheal intubation"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	There were 15 dropouts prior to randomization, which is unlikely to have affected the outcomes.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	All intubators were inexperienced with both laryngoscopes and this was felt to be balanced between the 2 groups.

Liu 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 360 **Country:** China **Setting:** theatre; single centre **Inclusion criteria**: age ≥ 18 years; scheduled for elective abdominal surgery and; required tracheal intubation under GA **Exclusion criteria**: history of neck injury; difficult airway; participation in other clinical trials within the previous 3 months; other contraindications to intubation; thyromental distance < 6 cm; mouth opening < 3 cm; cervical ankylosis; Mallampati 4 **Baseline characteristics** **Tosight** • Age, mean (SD): 40.7 (± 10.9) years • Gender M/F, n: 39/140

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Liu 2019 *(Continued)*

- Weight, mean (SD): 59.7 (± 10.7) kg
- Height, mean (SD): 1.60 (± 0.07) m
- BMI, mean (SD): 23.3 (± 3.3) kg/m^2
- ASA I/II/III/IV, n: 87/92/0/0
- Mallampati 1/2/3/4, n: 49/117/13/0

Macintosh

- Age, mean (SD): 41.7 (± 10.2) years
- Gender M/F, n: 31/150
- Weight, mean (SD): 61.0 (± 10.6) kg
- Height, mean (SD): 1.60 (± 0.07) m
- BMI, mean (SD): 23.9 (± 3.5) kg/m^2
- ASA I/II/III/IV, n: 87/94/0/0
- Mallampati 1/2/3/4, n: 40/128/13/0

Interventions	**General details**: all participants were intubated by 1 of 4 anaesthetists, who were divided into senior and junior based on years of clinical experience. All had > 5 years' clinical experience and in excess of 1000 direct laryngoscopy intubations, with at least 30 prior VL intubations performed. **Tosight** • Randomized = 179; no losses from intubation analysis; analysed = 179 • 2 losses to follow-up in complications analysis **Macintosh** • Randomized = 181; no losses from intubation analysis; analysed = 181 • 3 losses to follow-up in complications analysis **VL classification:** hyperangulated Notes: 4 additional participants were excluded from the analysis after randomization due to cancellation of surgery. The study authors did not specify the group to which these participants had been allocated.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: if the number of consecutive intubation failures exceeded 2, a change to an alternative intubation method was performed or was attempted by other qualified intubation personnel • Successful first attempt • Number of attempts • Patient-reported sore throat • Airway trauma: defined as immediate mouth, pharynx and larynx injury, or incisor injury after intubation • CL grade: grades reported grouped for 1-2 and 3-4 **Continuous outcomes** • Time for tracheal intubation: time between the cessation of oxygen supply until the waveform is confirmed with $ETCO_2$ monitoring Notes: TTI reported as median (IQR). We did not assume a normal distribution and therefore did not include this outcome in our analysis.

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Liu 2019 *(Continued)*

	Due to the way that CL grades were dichotomized in this study we were unable to extract these data for use in the meta-analysis. Airway trauma was reported as a composite outcome that did not differentiate dental injury from other airway trauma, therefore we could not extract these data.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates:** April–December 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"random numbers were generated by an individual other than the operator, and an opaque random envelope was prepared. After the patients were formally included and the statistics of their baseline data collated, the researchers, who did not participate in the operation, randomly grouped the patients according to the random number within the envelope."
Allocation concealment (selection bias)	Low risk	"random numbers were generated by an individual other than the operator, and an opaque random envelope was prepared. After the patients were formally included and the statistics of their baseline data collated, the researchers, who did not participate in the operation, randomly grouped the patients according to the random number within the envelope."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	9 participants were excluded post-randomization (4 cases surgery cancellation, 3 lost to follow-up in DL arm, 2 lost to follow-up in VL arm). This was unlikely to have affected the analysis.
Selective reporting (reporting bias)	Low risk	Trial registry data examined (ChiCTR-IOR-16009023). Registered prospectively and all prespecified outcomes reported in final manuscript.
Experience of intubator	Low risk	All participants were intubated by 1 of 4 anaesthetists, who were divided into senior or junior based on years of experience. All had > 5 years' clinical experience and had performed > 30 intubations with the VL and in excess of 1000 intubations with the DL.

Lopez 2017

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 34 **Country:** Panama **Setting:** theatre

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Lopez 2017 *(Continued)*

	Inclusion criteria: age > 18 years; ASA I-II; undergoing surgical procedures requiring GA and orotracheal intubation **Exclusion criteria**: C-spine alterations; predictors of difficult airway; pregnancy **Baseline characteristics:** abstract only, no baseline characteristics reported. The study authors specified the use of the King Vision device with the channelled blade.
Interventions	**General details**: no further details reported **King Vision** • Randomized = 17; no reported losses; analysed = 17 **Macintosh** • Randomized = 17; no reported losses; analysed = 17 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as from the introduction of the device until capnographic confirmation of successful intubation • IDS: grouped as easy (IDS = 0), minor difficulty (IDS = 0-5), moderate to major difficulty (IDS > 5)
Notes	**Funding/sponsor/declarations of interest**: not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient data to assess

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Lopez 2017 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Not reported

Loughnan 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** New Zealand **Setting**: theatre **Inclusion criteria**: age > 18 years; requiring tracheal intubation; no contraindication to DL or VL **Exclusion criteria**: requiring an awake approach, RSI or flexible bronchoscopic intubation; known difficult intubation; language or cognitive barriers that precluded adequate informed consent; operating anaesthetist did not have enough clinical experience in the use of DL or VL without in-theatre supervision **Baseline characteristics** **Videolaryngoscopy** • Age, median (IQR): 54 (40-67) years • Gender M/F, n: 25/26 • BMI, mean (SD): 28.8 (25.0-31.8) kg/m^2 • ASA I/II/III/IV, n: 9/29/13/0 **Direct laryngoscopy** • Age, median (IQR): 52 (41-64) years • Gender M/F, n: 30/19 • BMI, median (IQR): 27.8 (24.7-32.4) kg/m^2 • ASA I/II/III/IV, n: 8/28/13/0 Notes: baseline characteristics reported for all VLs combined. As per the manuscript, there were 27 participants intubated with the McGrath, 20 with the GlideScope, and 6 with an unspecified VL. The airway difficulty score was reported instead of Mallampati, and was matched in both groups. There were more obese patients in the VL group (12 versus 7). This was a feasibility pilot trial.
Interventions	**General details**: all participants were intubated by an anaesthetist with > 20 previous intubations with the given device. Stylets and bougies were available, but not mandated. Use was recorded **Videolaryngoscopy** • Number randomized = 53; losses = 2 (missing data = 2); analysed = 51 • McGrath = 28 • GlideScope = 20 • Other VL = 3 • #3 or #4 blade

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Loughnan 2019 *(Continued)*

Macintosh

- Number randomized = 53; losses = 4 (missing data = 4); analysed = 49
- #3 or #4 blade

VL classification: hyperangulated, Macintosh-style

Notes: data for VL device type taken from raw data tables provided by the study authors. There is some discrepancy in the number of VL device types used (see above for comparison).

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Number of attempts: successful first-pass intubation was defined as 1 fluid movement from the tracheal tube entering the mouth to being positioned in the trachea, during a single apnoeic episode.
- Airway trauma: we only extracted data for dental damage

Continuous outcomes

- Time for tracheal intubation: defined as the time from laryngoscope in hand to when intubation was confirmed by end-tidal capnography
- IDS

Notes: in the published manuscript, outcomes for videolaryngoscopy with the McGrath Mac and GlideScope devices were combined. For our analysis the study authors kindly shared their raw data, which allowed us to extract outcomes from these devices separately.

Airway trauma was reported in the study as a composite outcome, which included airway bleeding, mucosal injury or dental damage. From the raw data, we have extracted data relating only to dental injury.

Notes

Funding/sponsor/declarations of interest: funding provided from pooled funds of Auckland District Health Board Anaesthetic research department. No external funding provided. No conflicts of interest declared by study authors

Study dates: March 2016–June 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Patients were permuted blocked randomized in groups of 8 to either DL or VL. Randomisation was performed by a research coordinator who disclosed group assignation to the investigator."
Allocation concealment (selection bias)	Low risk	"Details were contained in sealed opaque envelopes until enrolment into the study was completed."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	There were 4 missing cases in the DL and 2 missing cases in the VL arm after randomization. This is unlikely to affect outcomes significantly.

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Loughnan 2019 *(Continued)*

Selective reporting (reporting bias)	Low risk	Trial registry data examined (ACTRN12615001267549). Registered prospectively with all prespecified outcomes reported in the final manuscript.
Experience of intubator	Low risk	Participating intubators had the experience of > 20 intubations with all devices.

Maassen 2012

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 80 **Countries:** Belgium and The Netherlands **Setting**: theatre; single centre **Inclusion criteria**: adult patients; ASA II or III; scheduled for elective coronary artery bypass surgery requiring intubation and intra-arterial BP monitoring **Exclusion criteria**: obesity (BMI > 35 kg/m^2); chronic obstructive pulmonary disease; history of difficult intubation; mouth opening < 3 cm; inadequate neck mobility; left ventricular ejection fraction < 45% **Baseline characteristics** **Cross-over design, all reported together** • Age, mean (SD): 66.2 (± 10.2) years • Gender M/F, n: 55/25 • Height, mean (SD): 172 (± 9) cm • Weight, mean (SD): 80.9 (± 15.5) kg • BMI, mean (SD): 27.0 (± 4) kg/m^2 • ASA I/II/III/IV, n: 0/67/13/0 • Mallampati 1/2/3/4, n: 34/41/5/0
Interventions	**General details**: no information provided on intubator experience. Extra manoeuvres to optimize visualization of the glottis entrance (BURP). A stylet or a gum-elastic bougie was used to facilitate intubation. Participants underwent both laryngoscopy and intubation with each device in an order determined by randomization. The tracheal tube was withdrawn after the first intubation without cuff inflation. **C-MAC** • Randomized = 40; losses = 0; analysed = 40 **Macintosh** • Randomized = 40; losses = 0; analysed = 40 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined, but a statement indicated that all participants were successfully intubated with both devices

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Maassen 2012 *(Continued)*

- Number of attempts: counted as each approach of the tracheal tube to the glottis entrance. If after 2 attempts the participant could not be intubated, a stylet or a gum-elastic bougie was used to facilitate intubation. No data were reported by study authors for this outcome.
- Airway trauma: reported for palatoglossal arch or dental injury. We only extracted dental trauma data for inclusion into the meta-analysis.
- Patient-reported sore throat: only 3 participants, who had an effective airway time > 50 s, reported postoperative minor, self-limiting sore throat, which did not require treatment. Study authors did not state to which group these participants were assigned.

Continuous outcome

- Time for tracheal intubation: defined as time between picking up the tracheal tube and visual passage of the tube until vocal cords were between the 2 black line markings on the distal end of the tracheal tube.

Note: only data on failed intubation, trauma and TTI could be extracted for this study. All other outcomes were not relevant or were wrongly reported for our review.

Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** January-June 2010

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"We performed a randomized cross-over study, in which each patient received sequential treatments in a random order" Insufficient detail to make a judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient detail provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details of intubator experience

Macke 2020

Study characteristics

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Macke 2020 *(Continued)*

Methods	RCT; parallel design
Participants	**Total number of participants:** 152 **Country:** Germany **Setting**: pre-hospital; single centre **Inclusion criteria**: requiring tracheal intubation, > 18 years **Exclusion criteria:** < 18 years **Baseline characteristics** **C-MAC** **Macintosh** The data comparing the baseline characteristics between groups were unavailable. There was a statement indicating no significant differences in baseline characteristics between groups.
Interventions	**General details**: the number of intubators used was not specified. They divided intubators into 2 groups, with 'experienced' intubators defined as those with > 100 intubations. The use of additional airway equipment was not specified. **C-MAC** • Randomized = 76; no losses; analysed = 76 • The C-MAC D-BLADE (hyperangulated) was also available to intubators. For the purpose of the review we have classified this as a Macintosh-style VL. **Macintosh** • Randomized = 76; no losses; analysed = 76 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Successful first attempt • Number of attempts • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as from removal of facemask to detectable $ETCO_2$ trace. TTI reported as median (IQR) • POGO score Notes: there were 3 instances where a change of device was necessary in the direct laryngoscopy group, which are considered as failed intubations for the purpose of this review. The study presented outcome data for CL grade and POGO, which could not be included in our analysis, because the data were quoted as median (IQR) for both outcomes.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** April 2017–January 2019

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Macke 2020 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not explicitly stated
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Some outcomes not reported (e.g. hypoxia) due to incomplete data
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to make a judgement about reporting bias without these documents.
Experience of intubator	Unclear risk	An "experienced" and "less experienced" group were studied, however outcomes were not reported separately for these groups. The study included a statement indicating, "no difference was found between the group of experienced physicians and less experienced physicians for all parameters."

Maharaj 2006

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Ireland **Setting**: theatre; single centre **Inclusion criteria:** ASA I–III patients, aged ≥ 18 years of age, scheduled for surgical procedures requiring tracheal intubation **Exclusion criteria**: risk factors for gastric aspiration and/or risk factors for difficult intubation (Mallampati class 3 or 4; thyromental distance < 6 cm; interincisor distance < 4.0 cm) were present or where there was a history of relevant drug allergy **Baseline characteristics** **Macintosh** • Age, mean (SD): 41.1 (± 16.9) years • Gender M/F, n: 11/19 • Weight, mean (SD): 73.8 (± 9.8) kg

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Maharaj 2006 *(Continued)*

- BMI, mean (SD): 27.7 (±5.7) kg/m^2
- Mallampati 1/2/3/4, n: 17/13/0/0

Airtraq

- Age, mean (SD): 43.8 (± 16.8) years
- Gender M/F, n: 11/19
- Weight, mean (SD): 71.7 (± 11.3) kg
- BMI, mean (SD): 27.1 (±6.1) kg/m^2
- Mallampati 1/2/3/4, n: 13/17/0/0

Interventions	**General details:** 4 anaesthetists, experienced in the use of both devices. Experience not quantified **Macintosh** • Randomized = 30; no losses; analysed = 30 **Airtraq** • Randomized = 30; no losses; analysed = 30 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt in which the trachea was not intubated, or which required > 120 s to perform • Number of attempts • Airway trauma: dental trauma only reported • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from insertion of the blade between the teeth until the tracheal tube was placed through the vocal cords, as confirmed visually by the anaesthetist • IDS Notes: lowest SpO_2 recorded during intubation was recorded and reported for each group as mean (± SD). The incidence of hypoxia in each group was not clear and therefore we have not included this outcome in our review. Haemodynamic outcomes also reported, but not relevant to this review
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes

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Maharaj 2006 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible. An unblinded independent observer was used
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to make a judgement about reporting bias without access to these documents.
Experience of intubator	Unclear risk	4 anaesthetists, all experienced in the use of both devices. Extent of experience not specified

Maharaj 2007

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Ireland **Setting:** theatre; single centre **Inclusion criteria:** ASA I–III, aged ≥ 18 years, scheduled to undergo surgical procedures necessitating tracheal intubation **Exclusion criteria**: risk factors for gastric aspiration and/or difficult intubation (Mallampati class 3 or 4, thyromental distance < 6 cm, interincisor distance < 4.0 cm) were present, or where there was a history of relevant drug allergy **Baseline characteristics** **Macintosh** • Age, mean (SD): 45.7 (±16.4) years • Gender M/F, n: 9/11 • BMI, mean (SD): 26.4 (± 4.4) kg/m^2 • Mallampati 1/2/3/4, n: 13/7/0/0 **Airtraq** • Age, mean (SD): 43.6 (±19.4) years • Gender M/F, n: 8/12 • BMI, mean (SD): 24.4 (±3.1) kg/m^2 • Mallampati 1/2/3/4, n: 12/8/0/0 Notes: study simulated difficult airway conditions using manual in-line axial stabilization of C-spine. ASA grade quoted as median (IQR), not included in this review

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Maharaj 2007 *(Continued)*

Interventions	**General details:** 4 intubators used in study, all experienced anaesthetists. Quantitative experience with each device not specified. Additional airway equipment and manoeuvres, such as a bougie and laryngeal manipulation, were available to intubators to assist intubation. **Macintosh** • Randomized = 20; no losses; analysed = 20 **Airtraq** • Randomized = 20; no losses; analysed = 20 **VL classification:** channelled Notes: technique for intubation with Airtraq described in the study involved the use of the optical viewfinder (not a videolaryngoscopy screen)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt in which the trachea was not intubated or an attempt that required > 120 s to perform • Number of attempts: 1-3 • Airway trauma: not explicitly defined • CL grade **Continuous outcomes** • Time for tracheal intubation: the duration of the intubation attempt was defined as the time taken from insertion of the blade between the teeth until the tracheal tube was placed through the vocal cords, as evidenced by visual confirmation by the anaesthetist. • IDS Notes: the study compared the lowest SaO_2 in each group, quoted as mean (± SD), but did not report the incidence of hypoxia. The study also described some haemodynamic outcomes such as change in HR and mean arterial pressure around the time of laryngoscopy, which have not been included in this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of sequence generation not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias)	High risk	Not possible to fully blind outcome assessors

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Maharaj 2007 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Study used 4 anaesthetists who were experienced in the use of both devices, but a quantitative indication of relative experience was not provided.

Maharaj 2008

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Ireland **Setting:** theatre; single centre **Inclusion criteria:** ASA physical status I-III patients, aged ≥ 18 years of age, who were deemed on preoperative assessment by their primary anaesthetist to be at increased risk for difficult tracheal intubation (based on possession of at least 3 of the following criteria: thyromental distance < 6 cm; Mallampati classification 3 or 4; interincisor distance < 4 cm; previously documented difficult intubation), and scheduled for surgical procedures requiring tracheal intubation **Exclusion criteria**: risk factors for gastric aspiration or history of relevant drug allergy **Baseline characteristics** **Macintosh** • Age, mean (SD): 50.2 (±18.2) years • Gender M/F, n: 10/10 • BMI, mean (SD): 29.9 (±6.8) kg/m^2 • Mallampati 1/2/3/4, n: 0/1/15/4 **Airtraq** • Age, mean (SD): 51.7 (±14.6) years • Gender M/F, n: 8/12 • BMI, mean (SD): 29.4 (±4.7) kg/m^2 • Mallampati 1/2/3/4, n: 1/2/13/4 Notes: included patients were deemed to all possess characteristics indicating they were high risk for difficult intubation, based on at least 3 of the following criteria: thyromental distance < 6 cm; Mallampati classification 3 or 4; interincisor distance < 4 cm; previously documented difficult intubation. The study reported that median ASA for both groups was II (IQR I-III).
Interventions	**General details:** 3 anaesthetist intubators, all experienced in the use of both devices. All had > 500 intubations using the Macintosh laryngoscope, at least 50 intubations with the Airtraq in manikins and 50 intubations with the Airtraq in patients prior to this study.

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Maharaj 2008 *(Continued)*

Macintosh

- Randomized = 20; no losses; analysed = 20

Airtraq

- Randomized = 20; no losses; analysed = 20

VL classification: channelled

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt in which the trachea was not intubated, or where tracheal intubation attempts were terminated after 120 s had elapsed • Successful first attempt • Number of attempts • Hypoxia: the study included data on the incidence of SaO_2 of ≤ 93% during intubation • Airway trauma: dental trauma • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from insertion of the blade between the teeth until the tracheal tube was placed through the vocal cords. Notes: the study reported IDS scores, but categorized IDS scores into the following groups: 0, 1-3, 4-6, 7-9, 10-12. These are different to the category cut-offs used in our review and we were therefore unable to extract these data. The study also reported number of optimization manoeuvres used (such as laryngeal manipulation and use of bougie). Reported haemodynamic outcomes including changes in BP and HR are not relevant to this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of outcome data evident

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Maharaj 2008 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No prepublished protocol or clinical trials registration was available. It is not feasible to make a judgement about reporting bias without access to these documents.
Experience of intubator	Low risk	3 anaesthetist intubators, all with > 500 Macintosh intubations and > 50 clinical intubations with Airtraq

Mahmood 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA class I and II, of age group between 18-65 years who required surgery under GA **Exclusion criteria**: obese individuals, patients with anticipated difficult airway, patients with head injury, respiratory tract (oropharynx, larynx) pathology, hiatus hernia, and pregnancy **Baseline characteristics:** no specific list of baseline characteristics was published. The study authors included a statement indicating that preoperative characteristics between groups were "similar".
Interventions	**General details**: the study provided no details on the number of intubators used or their relative skill and experience with each device. **Airtraq** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** channelled Notes: it was unclear from the study whether intubators used the optical viewfinder or video screen with the Airtraq.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade **Continuous outcomes** • Time for tracheal intubation: defined as the time elapsed from insertion of the blade between the dental arches until the tracheal tube was placed through the vocal cords and confirmed by auscultation Notes: the study also reported outcomes relating to changes in HR and BP, which are not relevant to this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures.

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Mahmood 2015 *(Continued)*

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	No data for baseline characteristics were available
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	The number of intubators and relative experience with each device was not specified.

Malik 2008

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Ireland **Setting**: theatre; single centre **Inclusion criteria:** ASA I-III; aged ≥ 16 years; undergoing surgical procedures requiring tracheal intubation **Exclusion criteria:** risk factors for gastric aspiration, difficult intubation or both (Mallampati 3 or 4; thyromental distance < 6 cm; interincisor distance < 3.5 cm); history of relevant drug allergy **Baseline characteristics** **GlideScope** • Age, mean (range): 45.03 (23-80) years • Gender M/F, n: 8/22 • BMI, mean (SD): 26.5 (± 3.3) kg/m^2 • ASA, median (IQR): II (I-II)

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Malik 2008 *(Continued)*

- Mallampati 1/2/3/4, n: 10/20/0/0

Pentax AWS

- Age, mean (range): 43.9 (20-68) years
- Gender M/F, n: 11/19
- BMI, mean (SD): 26.0 (± 6.0) kg/m^2
- ASA, median (IQR): II (I-II)
- Mallampati 1/2/3/4, n: 12/18/0/0

Truview EVO2

- Age, mean (range): 43.2 (21-83) years
- Gender M/F, n: 20/10
- BMI, mean (SD): 25.3 (± 3.5) kg/m^2
- ASA, median (IQR): II (I-II)
- Mallampati 1/2/3/4, n: 14/16/0/0

Macintosh

- Age, mean (range): 50.8 (18-82) years
- Gender M/F, n: 11/19
- BMI, mean (SD): 25.7 (± 4.1) kg/m^2
- ASA, median (IQR): II (I-II)
- Mallampati 1/2/3/4, n: 13/17/0/0

Notes: MILS used in all participants.

Interventions	**General details**: each investigator had performed at least 50 intubations with each device in manikins, and at least 20 intubations with each device in the clinical setting. Bougie, cricoid pressure, and second assistant were used for all scopes. **GlideScope** • Randomized = 30; losses = 0; analysed = 30 • Stylet used **Pentax AWS** • Randomized = 30; losses = 0; analysed = 30 • Tracheal tube placed into side channel before intubation **Truview EVO2** • Randomized = 30; losses = 0; analysed = 30 • Used with camera attachment. Stylet used **Macintosh** • Randomized = 30; losses = 0; analysed = 30 • #3 blade used in women, #4 blade used in men **VL classification:** hyperangulated (GlideScope, Truview EVO2), channelled (Pentax AWS)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as trachea not intubated, or took > 60 s; maximum of 3 attempts, then manual in-line axial stabilization discontinued and Macintosh blade used • Successful first attempt

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Malik 2008 *(Continued)*

- Number of attempts: 1-3
- Airway trauma: blood on blade, minor laceration, dental or other airway trauma. We only extracted dental trauma data.
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of the blade between the teeth until the tracheal tube was placed through the vocal cords
- IDS score: 0-7

Notes	**Funding/sponsor/declarations of interest**: both Pentax and Truview were provided by manufacturers. Departmental funding only **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Allocation sequence was generated by random number tables"
Allocation concealment (selection bias)	Low risk	"Allocation concealed in sealed envelopes, which were not opened until patient consent had been obtained"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No evident losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Tracheal intubation was performed in each patient by one of the three anaesthetists ... Each investigator had performed at least 50 intubations with each device in manikins, and at least 20 intubations in the clinical setting with each device"

Malik 2009a

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Ireland

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Malik 2009a *(Continued)*

Setting: theatre; single centre

Inclusion criteria: ASA I-III, aged ≥ 16 years, undergoing GA for surgery and requiring tracheal intubation

Exclusion criteria: risk factors for gastric aspiration, difficult intubation (Mallampati class 3 or 4; thyromental distance < 6 cm; interincisor distance < 3.5 cm) or both, history of relevant drug allergy

Baseline characteristics

Pentax AWS

- Age, mean (range): 50.4 (23-82) years
- Gender M/F, n: 13/17
- BMI, mean (SD): 26.9 (± 4.1) kg/m^2

Macintosh

- Age, mean (range): 47.4 (18-78) years
- Gender M/F, n: 18/12
- BMI, mean (SD): 26.3 (± 4.9) kg/m^2

Interventions

General details: 1 of 3 anaesthetists who were familiar with each of the devices. Each investigator had performed, with each device, at least 50 intubations in manikins and at least 20 intubations in the clinical setting.

Pentax AWS

- Randomized = 30; losses = 0; analysed = 30

Macintosh

- Randomized = 30; losses = 0; analysed = 30
- #3 blade in women, #4 blade in men

VL classification: channelled

Notes: the study included a third arm comparing the LMA CTrach, which is not within the scope of this review. Data were therefore not extracted.

All participants received MILS

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as an attempt in which the trachea was not intubated, or that required > 120 s to perform
- Successful first attempt
- Number of attempts: 1-3
- Airway trauma: blood on laryngoscope blade, minor laceration, dental or other airway trauma. We only extracted dental trauma data for internal consistency and to avoid unit of analysis error.
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of blade between the teeth until tracheal tube was placed through the vocal cords. Data reported as median (IQR), so could not be extracted as a normal distrubution could not be assumed.
- IDS: 0-7

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Malik 2009a *(Continued)*

Notes	**Funding/sponsor/declarations of interest:** Pentax AWS supplied by manufacturer. Departmental funding only **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"allocation sequence was generated by random number tables"
Allocation concealment (selection bias)	Low risk	"allocation concealed in sealed envelopes, which were not opened until patient consent had been obtained"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data for CL scores not available for 3 participants in the Macintosh group, but overall few losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"one of the three anaesthetists ... who were familiar with each of the devices. Each investigator had performed, with each device, at least 50 intubations in manikins and at least 20 intubations in the clinical setting"

Malik 2009b

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 75 **Country:** Ireland **Setting**: theatre; single centre **Inclusion criteria:** ASA I-III, aged ≥ 16 years, deemed on preoperative assessment by the primary anaesthetist to be at increased risk for difficult laryngoscopy, undergoing surgical procedures requiring tracheal intubation **Exclusion criteria:** risk factors for gastric aspiration, history of relevant drug allergy **Baseline characteristics** **GlideScope**

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Malik 2009b *(Continued)*

- Age, mean (range): 55 (22-85) years
- Gender M/F, n: 13/12
- BMI, mean (SD): 34.4 (± 10.7) kg/m^2
- Mallampati 1/2/3/4, n: 0/0/20/5

Pentax AWS

- Age, mean (range): 60 (29-84) years
- Gender M/F, n: 14/11
- BMI, mean (SD): 33.4 (± 7.2) kg/m^2
- Mallampati 1/2/3/4, n: 0/1/21/3

Macintosh

- Age, mean (range): 54 (26-85) years
- Gender M/F, n: 16/9
- BMI, mean (SD): 33.6 (± 9.4) kg/m^2
- Mallampati 1/2/3/4, n: 0/0/19/6

Notes: significant number of obese participants in all 3 groups

Interventions

General details: each anaesthetist had performed > 500 intubations with the Macintosh laryngoscope and at least 100 intubations with the Pentax AWS and GlideScope in manikins, and 50 intubations with the Pentax AWS and GlideScope in the clinical setting before this study.

Use of bougie, external laryngeal manipulation, second assistant for all 3 scopes

GlideScope

- Randomized = 25; losses = 0; analysed = 25
- Stylet used, bent into hockey stick curve

Pentax AWS

- Randomized = 25; losses = 0; analysed = 25

Macintosh

- Randomized = 25; losses = 0; analysed = 25
- #3 blade women, #4 blade men

VL classification: hyperangulated (GlideScope), channelled (Pentax AWS)

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: the study authors state, "a maximum of three intubation attempts with the study device were permitted. However, in situations where the investigator deemed that there was a low likelihood of success with a third attempt, this attempt was not performed and laryngoscopy was deemed to have failed."
- Successful first attempt
- Number of attempts: 1-3. "A failed intubation attempt was defined as an attempt in which the trachea was not intubated or which required > 60 s to perform"
- Airway trauma: dental trauma, visible trauma to lip or oral mucosa or blood on the laryngoscope. We extracted only data for dental trauma to avoid unit of analysis error.
- CL grade: 1-4

Continuous outcomes

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Malik 2009b *(Continued)*

- Time for tracheal intubation: defined as time from insertion of the blade between the teeth until the TT was placed through the vocal cords. Time for successful attempt in seconds: median (IQR): AWS 15 (8-31); GlideScope 17 (12-31); Macintosh 13 (8-23). Data presented as median (IQR) and therefore not extracted because we could not assume a normal distrubution.
- IDS: presented in histogram format, with numbers. Extracted into our review based on our categorization: IDS = 0 ("easy"); IDS = 1-5 ("minor difficulty"); IDS > 5 ("moderate to severe difficulty")

Notes	**Funding/sponsor/declarations of interest:** Pentax provided by manufacturers. Departmental funding only **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"random number tables"
Allocation concealment (selection bias)	Low risk	"allocation concealed in sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Each anaesthetist had performed more than 500 intubations with the Macintosh laryngoscope and at least 100 intubations with the Pentax AWS and GlideScope in manikins, and 50 intubations with the Pentax AWS and GlideScope in patients"

Marco 2011

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 108 **Country:** Italy **Setting:** theatre; single centre

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Marco 2011 *(Continued)*

	Inclusion criteria: ASA physical status I-III patients, aged ≥ 18 years, scheduled for urological surgical procedures requiring GA and tracheal intubation **Exclusion criteria**: history of difficult airway and/or the presence of risk factors for pulmonary aspiration **Baseline characteristics** **Macintosh** • Mallampati 1/2/3/4, n: 20/18/13/3 **Airtraq** • Mallampati 1/2/3/4, n: 22/17/12/3 Notes: the study also reported baseline thyromental distance and interincisor distance with no significant difference between groups. No other demographic data were available
Interventions	**General details**: intubators were all novice anaesthesia residents in their first year of training. None had any clinical experience with the use of either device. The study randomly allocated residents to either the Airtraq or the Macintosh group and used only the allocated device for the duration of the study. The residents had performed 5 intubations with both devices on a Laerdal Airway Management Trainer. They were supervised by an experienced anaesthetist and were allowed the use of optimization manoeuvres including external laryngeal manipulation and assistance with "slight movements of the blade once placed into the vallecula in an attempt to lift the epiglottis". **Macintosh** • Randomized = 54; no losses; analysed = 54 **Airtraq** • Randomized = 54; no losses; analysed = 54 **VL classification:** channelled Notes: the study did not specify whether a video screen or the optical viewfinder was used when using the Airtraq
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Number of attempts: first pass success only reported • Airway trauma: dental trauma only reported • Patient-reported sore throat **Continuous outcomes** • Time for tracheal intubation: defined as the time elapsed from insertion of the blade between the dental arches until the tracheal tube was placed through the vocal cords, as confirmed visually by the operator Notes: methods reported that failed intubation would be studied but no outcome data were available. IDS scores and CL grade were studied but insufficient detail on these outcomes was available in the publication therefore we have not extracted these data for use in this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

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Marco 2011 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization method
Allocation concealment (selection bias)	Unclear risk	Intubators randomized directly to a single device therefore concealment not possible
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible. Data recording performed by independent observer
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Failed intubation rate studied but not reported. Insufficient detail reported for CL grade and IDS score comparison
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	All intubators had no clinical experience with either device

Marrel 2007

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 80 **Country:** Switzerland **Setting:** theatre; single centre **Inclusion criteria**: morbidly obese patients; ASA II or III; age 23-76 years; scheduled for bariatric surgery **Exclusion criteria**: previous ENT surgery; radiotherapy; unstable C-spine requiring stabilization before intubation **Baseline characteristics** **X-Lite** • Age, mean (SD): 45 (± 13) years • Gender M/F, n: 15/25 • Weight, mean (SD): 118.6 (± 27.7) kg • Height, mean (SD): 1.65 (± 0.10) m • BMI, mean (SD): 42.8 (± 6.9) kg/m^2 • Mallampati 1/2/3/4, n: 14/13/10/3

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Marrel 2007 *(Continued)*

X-Lite without screen (direct)

- Age, mean (SD): 45 (± 12) years
- Gender M/F, n: 17/23
- Weight, mean (SD): 122.3 (± 22.8) kg
- Height, mean (SD): 1.67 (± 0.10) m
- BMI, mean (SD): 43.5 (± 5.4) kg/m^2
- Mallampati 1/2/3/4, n: 12/15/9/4

Interventions	**General details**: all participants were intubated by a single intubator with previous experience with videolaryngoscopy. This experience is not further quantified. All intubations were performed with the X-Lite VL, a Macintosh-style device, with the screen turned away from the intubator in participants randomized to the direct arm after grading the direct and VL CL view. **X-Lite** • Randomized = 40; losses = 0; analysed = 40 • #3 blade **X-Lite without screen (direct)** • Randomized = 40; losses = 0; analysed = 40 • #3 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: the timer was started when the intubating anaesthetist stopped manual ventilation to take the laryngoscope blade and stopped when the tube was confirmed as being intratracheal ($ETCO_2$). Notes: in the cross-over design of the study, all 80 participants had a CL grade recorded for both direct and indirect laryngoscopy, before being intubated as per the group allocation. These were recorded in a table. It was not clear from the table which intervention was performed in what order. We were therefore unable to extract data for this outcome.
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias)	High risk	Not possible to blind intubators

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Marrel 2007 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"The same senior anaesthetist, with experience in the use of the videolaryngoscope and who was not involved in the study, always performed the intubation." Extent of experience not further described

Marsaban 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 139 **Country:** Indonesia **Setting:** theatre; single centre **Inclusion criteria:** 18–65 years old, BMI 18.5–30 kg/m^2 , ASA I or II **Exclusion criteria**: pregnancy, history of cardiac disease, cerebrovascular disease history, hypertension, hypotension, tachycardia, bradycardia, patients consuming cardiovascular drugs, difficult airway suspicion, increased ICP, converted GA patients from regional anaesthesia. If a patient did not have a CL grade of 1 or 2 on initial laryngoscopy they were further excluded from the study **Baseline characteristics** **Macintosh** • Age, mean (SD): 38.8 (±13.3) years • Gender M/F, n: 23/44 • Weight, mean (SD): 58 (±10.6) kg • Height, mean (SD): 1.58 (±0.7) m • BMI, mean (SD): 22.9 (±3.1) kg/m^2 • ASA I/II/III/IV, n: 20/47/0/0 **C-MAC** • Age, mean (SD): 38.6 (±13.2) years • Gender M/F, n: 24/43 • Weight, mean (SD): 59.1 (±7.6) kg • Height, mean (SD): 1.61 (±0.7) m • BMI, mean (SD): 22.5 (±2.2) kg/m^2

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Marsaban 2017 *(Continued)*

	• ASA I/II/III/IV, n: 18/49/0/0 Notes: patients with a a CL grade of > 2 on initial laryngoscopy were excluded from the study after randomization. The device used may affect the probability of achieving a CL grade of 1 or 2, therefore may cause attrition bias.
Interventions	**General details**: the number of intubators and their skill and experience with both devices was not specified in the study. Intubators were allowed the use of external laryngeal manipulation to achieve a good view at laryngoscopy. **Macintosh** • Randomized = 70; losses = 3 (reason not specified); analysed = 67 **C-MAC** • Randomized = 69; losses = 2 (reason not specified); analysed = 67 **VL classification:** Macintosh-style Notes: use of conventional C-MAC Macintosh-style blade presumed, although blade type used not specified in the study
Outcomes	**Outcomes relevant to the review reported by study authors** Notes: no outcomes of interest for this review were reported by the study. The focus of the study was changes in HR and BP at time points around laryngoscopy and intubation and the use of external laryngeal manipulation.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** October–December 2015 Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Maruyama 2008a

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 13 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria:** aged 41-68 years, ASA I or II, scheduled to undergo elective surgery requiring GA with tracheal intubation **Exclusion criteria:** previous neck surgery, possible pregnancy, difficult intubation anticipated, without incisor teeth **Baseline characteristics** Cross-over design with baseline characteristics reported together for all participants. • Age, mean (range): 50 (41-68) years • Gender M/F, n: 7/4

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Maruyama 2008a *(Continued)*

- Weight, median (range): 55 (41-75) kg
- Height, median (range): 1.61 (1.50-1.75) m
- Mallampati 1/2/3/4, n: 10/1/0/0

Interventions	**General details**: study authors stated, "The operator was familiar with both devices, and his technique was consistent"; however, no further information was provided to reveal level of experience. Participants underwent laryngoscopy and introduction of the tracheal tube with both devices according to the cross-over design of this study. The order in which the devices were used was determined by randomization, but the number of participants allocated to each sequence was not specified. The study authors stated, "For the first device, the patient's mouth was opened by the cross-finger method, and the tip of the tracheal tube was introduced into the glottis. The second device was studied in an identical manner, and intubation was completed with the second device." **Pentax AWS and Macintosh** • Recruited = 13; losses = 2 (issues with positioning equipment); analysed = 11 **VL classification:** channelled Notes: head immobilized with blocks and restraining bands
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: defined as time when the Macintosh laryngoscope or the AWS passed the central incisors to time when the tip of the tracheal tube passed through the glottis. Notes: the main outcomes studied were C-spine movements during laryngoscopy; these are not outcomes of interest to this review.
Notes	**Funding/sponsor/declarations of interest:** Pentax AWS provided by manufacturer **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomized, no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	"Two of the 13 patients were excluded from the study because of technical difficulties" Moderate loss

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Maruyama 2008a *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details on amount of experience with Pentax AWS

Maruyama 2008b

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 24 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria:** aged 18-82 years, ASA I or II, scheduled to undergo elective surgery requiring GA with tracheal intubation **Exclusion criteria:** previous neck surgery, possible pregnancy, unstable C-spine, difficult intubation anticipated, without incisors **Baseline characteristics** **Pentax AWS** • Age, mean (range): 50.8 (27-82) years • Gender M/F, n: 6/6 • Weight, mean (SD): 58.0 (± 6.5) kg • Height, mean (SD): 1.62 (± 0.07) m • Mallampati 1/2/3/4, n: 8/4/0/0 **Macintosh** • Age, mean (range): 48.1 (24-63) years • Gender M/F, n: 6/6 • Weight, mean (SD): 56.5 (± 13.6) kg • Height, mean (SD): 1.62 (± 0.10) m • Mallampati 1/2/3/4, n: 8/4/0/0
Interventions	**General details**: laryngoscopy was performed by an anaesthetist. Experience with devices not reported **Pentax AWS** • Randomized = 14; losses = 2 (cervical movement not recorded); analysed = 12 **Macintosh** • Randomized = 15; losses = 3 (cervical movement not recorded); analysed = 12 **VL classification:** channelled Notes: the study also included a group using a McCoy laryngoscope, which was not eligible for inclusion in this review; we did not extract data for this group.
Outcomes	**Outcomes relevant to the review reported by study authors**

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Maruyama 2008b *(Continued)*

	Dichotomous outcomes • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time when the laryngoscope or the AWS passed the central incisors to time when the anaesthetist withdrew the device from the participant's mouth after tracheal intubation Notes: the main outcomes studied related to C-spine movement during laryngoscopy; these are not outcomes of interest to this review.
Notes	**Funding/sponsor/declarations of interest:** Pentax AWS supplied by manufacturer **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Described as randomized with no additional details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	5 withdrawals. Most resulted from problems with recording data during laryngoscopies. High attrition rate
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details

Masoumifar 2020

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Iran **Setting**: theatre; single centre

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Masoumifar 2020 *(Continued)*

	Inclusion criteria: patients aged 20-40 undergoing elective surgery **Exclusion criteria:** not reported **Baseline characteristics:** not reported specifically, but the study authors note that there was no significant difference between the 3 groups in terms of gender, age, BMI and Mallampati scores. Notes: study authors report a third arm comparing outcomes for a LMA, which we did not include in this review.
Interventions	**General details**: all participants were intubated by an anaesthetist with > 30 previous successful intubations with each device. **GlideScope** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; losses = 1 (case missing from number of attempts); analysed = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Number of attempts: 1-2 • Patient-reported sore throat: reported at 6-8 hand 24 h postop time points **Continuous outcomes** • Time for tracheal intubation: not explicitly defined Notes: the study reports both duration of intubation and duration of laryngoscopy, neither of which was defined in the manuscript. Duration of intubation was reported in minutes. We did not extract data for TTI from this study due to uncertainty about which outcome to include. There is 1 case missing in the reported number of attempts in the Macintosh group; the authors do not explicitly report on the outcome of this case.
Notes	**Funding/sponsor/declarations of interest**: study authors do not report receiving any funding and declare no conflicts of interest. **Study dates:** not reported **Additional:** manuscript presented in English and Persian. Data extracted from English manuscript

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomly divided into three groups" Insufficient detail
Allocation concealment (selection bias)	Unclear risk	Allocation concealment method not specified
Blinding of participants and personnel (performance bias)	High risk	Blinding not possible

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Masoumifar 2020 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	There is 1 case unaccounted for in the Macintosh group for number of attempts Low attrition
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available for this study
Experience of intubator	Low risk	Anaesthesia resident with > 30 intubations using each device

Mathew 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: aged 18-60 years, BMI < 30 kg/m^2, ASA I or II, scheduled for elective surgery under GA requiring tracheal intubation **Exclusion criteria**: history of hypertension/hypotension, ischaemic heart disease, anticipated difficult airway, signs and symptoms of raised ICP, patients on drugs affecting BP or HR **Baseline characteristics** **Macintosh** • Age, mean (SD): 39.33 (±13.24) years • Gender M/F, n: 13/18 • Weight, mean (SD): 61.4 (±1.33) kg • Height, mean (SD): 160.9 (±8.22) cm • BMI, mean (SD): 23.55 (±2.72) kg/m^2 • ASA I/II/III/IV, n: 28/5/0/0 • Mallampati 1/2/3/4, n: 18/15/0/0 **Airtraq** • Age, mean (SD): 39.40 (±10.92) years • Gender M/F, n: 12/21 • Weight, mean (SD): 58.03 (±9.52) kg • Height, mean (SD): 158.5 (±10.54) cm • BMI, mean (SD): 23.03 (±2.53) kg/m^2 • ASA I/II/III/IV, n: 31/2/0/0 • Mallampati 1/2/3/4, n: 14/19/0/0

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Mathew 2018 *(Continued)*

	Notes: group sizes indicated by baseline totals in gender, ASA and Mallampati categories does not match the claimed group sizes for outcomes (reportedly 30 in each group). The study authors noted that, "three patients from Airtraq group and 1 from Macintosh group were excluded from the analysis of haemodynamic parameters and duration of intubation as they required a second attempt for intubation".
Interventions	**General details**: number of intubators not specified. All anaesthetists had > 2 years' experience with both Macintosh and Airtraq devices, although a quantitative estimate of experience with each device was not available. MILS was used during intubation attempts. **Macintosh** • Randomized = 33; losses not clear, at least 1 (required repeat attempt); analysed = 30 • #3 and #4 blade used for women and men, respectively. **Airtraq** • Randomized = 33; losses = 3 (required > 1 at intubation, excluded from TTI analysis, but not from other analyses); analysed = 30 • #3 size used for 8.0 and 8.5 tracheal tubes used, #2 size used for 7.0 and 7.5 tracheal tubes **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure to get capnographic trace within 120 s of introduction of laryngoscope blade or a decrease in O2 saturation ≤ 94% • Number of attempts: 1/2 • Patient-reported sore throat **Continuous outcomes** • Time for tracheal intubation: defined as as the time in s from the time point the anaesthetist inserts laryngoscope into the mouth, to the appearance of capnographic trace. Notes: the main focus of the study was comparing haemodynamic outcomes such as changes in HR and BP in the context of MILS between each group. These outcomes are not relevant to our review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated table of random numbers
Allocation concealment (selection bias)	Low risk	Sequentially numbered, opaque sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible

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Mathew 2018 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	3 participants from Airtraq group and 1 from Macintosh group were excluded from the analysis of duration of intubation as they required a second intubation attempt. The denominators for analysis and randomization not clear from manuscript for given outcomes
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2017/10/010157). All prespecified outcomes reported in final manuscript. Trial registered retrospectively.
Experience of intubator	Unclear risk	Intubators had > 2 years' experience with each device but quantitative estimates of experience were not provided.

McElwain 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** Ireland **Setting**: theatre; single centre **Inclusion criteria:** ASA I-III, aged ≥ 16 years, undergoing surgical procedures requiring tracheal intubation **Exclusion criteria:** risk factors for gastric aspiration, difficult intubation or both (Mallampati class 3 or 4; thyromental distance < 6 cm; interincisor distance < 3.5 cm), history of relevant drug allergy **Baseline characteristics** **C-MAC** • Age, mean (SD): 54 (± 20) years • Gender M/F, n: 10/20 • BMI, mean (SD): 29 (± 5) kg/m^2 • Mallampati 1/2/>2, n: 11/19/0 **Airtraq** • Age, mean (SD): 52 (± 19) years • Gender M/F, n: 14/15 • BMI, mean (SD): 28 (± 4) kg/m^2 • Mallampati 1/2/>2, n: 13/16/0 **Macintosh** • Age, mean (SD): 58 (± 20) years • Gender M/F, n: 19/12 • BMI, mean (SD): 28 (± 7) kg/m^2 • Mallampati 1/2/>2, n: 12/18/1

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McElwain 2011 *(Continued)*

Interventions	**General details**: all participants were intubated by a single anaesthetist experienced in the use of all 3 devices. **Storz C-MAC** • Randomized = 30; losses = 1 (change of anaesthetic technique); analysed = 29 **Airtraq** • Randomized = 29; losses = 0; analysed = 29 **Macintosh** • Randomized = 31; losses = 0; analysed = 31 **VL classification:** Macintosh-style (Storz C-MAC), channelled (Airtraq) Notes: all participants had MILS applied to simulate a difficult airway
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt in which the trachea was not intubated, or in which the device was abandoned and another device was used • Successful first attempt • Number of attempts: 1-3 • Airway trauma: blood on laryngoscope blade/minor laceration/dental or other airway trauma. We only extracted dental trauma data for inclusion in the review. • CL grade: 1-3 **Continuous outcomes** • Time for tracheal intubation: defined as time from insertion of the blade between the teeth until the anaesthetist had obtained the best possible view of the vocal cords. • IDS: reported on a scale from 0-8+ Notes: time for tracheal intubation reported as median (IQR), therefore not extracted into meta-analysis. POGO scores were presented in the format of a box-and-whisker plot and therefore could not be extracted for inclusion in the review.
Notes	**Funding/sponsor/declarations of interest:** Storz C-MAC and Airtraq supplied by manufacturers. Departmental funding only. No conflicts of interest declared by study authors **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"allocation sequence was generated using online randomization software"
Allocation concealment (selection bias)	Low risk	"sealed envelopes, which were not opened until patient consent had been obtained"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator

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McElwain 2011 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"A total of 90 patients consented to participate in the study. One patient, who had been randomized to the C-MAC group, was not subsequently entered into the study due to a change in the choice of anaesthetic technique." Low level of loss
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	"The trachea was then intubated by one anaesthetist [...] experienced in the use of all three laryngoscopes" Extent of experience with study devices was not further quantified

Misirlioglu 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria:** 18–65 years of age, ASA I or II, undergoing elective surgery **Exclusion criteria:** ASA III risk category and above, with respiratory, cardiovascular and central nervous system disorders, haemorrhagic diathesis, morbid obesity, diabetes, alcohol and substance use disorder **Baseline characteristics**: not reported Notes: no published baseline data were available. The study authors included a statement indicating, "there were no statistically significant differences between the M and the G group patients with respect to age, gender, ASA classification, Mallampati scores, Cormack–Lehane scoring"
Interventions	**General details** **Macintosh** • Number of patients randomized and analysed not reported **GlideScope** • Number of patients randomized and analysed not reported **VL classification:** hyperangulated Notes: no data for group size in either Macintosh or GlideScope group were available.
Outcomes	**Outcomes relevant to the review reported by study authors**

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Misirlioglu 2016 *(Continued)*

	Notes: the study primarily examined changes in HR and BP around the time of intubation, which are not of interest to this review. They did examine CL grade and number of intubation attempts but these data were not published. The authors made a statement in the results indicating there were no statistically significant differences between groups in respect of these outcomes. Data for time to intubation were available but could not be extracted because group size and standard deviation data were not available.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Najafi 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 300 **Country:** Iran **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II, MET > 4, scheduled for elective surgery under GA in the supine position **Exclusion criteria:** age < 18 years or > 60 years; any anatomical abnormality in the head, neck or face; any ENT, neck or thoracic surgery; smoking history; edentulous patients; estimated surgery time > 4 h; any clinical evidence of active pulmonary disease; common cold during recent 2 weeks; limited mouth opening or neck extension **Baseline characteristics** **GlideScope** • Age, mean (SD): 39.1 (± 7.6) years • Gender M/F, n: 67/83 • ASA I/II/III/IV, n: 125/25/0/0 • Mallampati 1/2/3/4, n: 71/48/18/13 **Macintosh** • Age, mean (SD): 40.2 (± 7.2) years • Gender M/F, n: 70/80 • ASA I/II/III/IV, n: 127/23/0/0 • Mallampati 1/2/3/4, n: 85/40/17/8
Interventions	**General details**: single anaesthetist in both groups, experience with either device not reported **GlideScope** • Randomized = 150; losses = 0; analysed = 150 • #4 blade **Macintosh** • Randomized = 150; losses = 0; analysed = 150

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Najafi 2014 *(Continued)*

	• #3 blade for women, #4 blade for men **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as intubation requiring > 3 attempts, after which an alternate device was used for intubation. Outcome was defined but not reported • Patient-reported sore throat: several postoperative time points were reported (1 h, 6 h, 24 h, 48 h). We extracted data from the 6-h timepoint into our review. **Continuous outcomes** • Time for tracheal intubation: no definition reported
Notes	**Funding/sponsor/declarations of interest**: university funding. The study authors disclose no financial interests. **Study dates:** December 2012–May 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"block randomization method"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents. Study authors did not report data for failed intubation.
Experience of intubator	Unclear risk	Single anaesthetist in both groups, but no details of experience

Nakayama 2010

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 240

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Nakayama 2010 *(Continued)*

	Country: Japan **Setting:** theatre; single centre **Inclusion criteria:** ASA I-III patients scheduled for elective video-assisted thoracoscopic surgery (VATS) for pulmonary resection requiring left-sided DLT intubation **Exclusion criteria:** not reported **Baseline characteristics:** not reported Notes: abstract only. Comparing GlideScope vs Pentax AWS vs Macintosh
Interventions	**General details**: the number of intubators and their experience with each device was not specified. **GlideScope** • Randomized = 80; no losses reported; analysed = 80 **Pentax AWS** • Randomized = 80; no losses reported; analysed = 80 **Macintosh** • Randomized = 80; no losses reported; analysed = 80 **VL classification:** hyperangulated (GlideScope); channelled (Pentax AWS) Notes: for placement of left-sided DLT
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as lack of successful intubation after 3 attempts • Successful first attempt **Continuous outcomes** • Time for tracheal intubation: defined as the time from insertion of the device into the oropharynx to the time when accuracy of the DLT placement was confirmed with fibreoptic bronchoscopy. Notes: insufficient detail to extract dental trauma data
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias)	High risk	Not possible

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Nakayama 2010 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Outcome data for dental trauma not reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubator experience not specified

Nandakumar 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 30 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I–III, age 18–60 years, with a BMI of ≥ 35 kg/m^2 scheduled for elective bariatric surgery **Exclusion criteria:** ASA IV–V patients, patients undergoing emergency surgery, patients with respiratory, oral and pharyngeal pathology, craniofacial abnormalities, restricted neck movement or known C-spine disease, restricted mouth opening < 1.5 cm, bucked teeth, macroglossia, and patients scheduled for oral surgery **Baseline characteristics** **Macintosh** • Age, mean (SD): 40.6 (± 11.6) years • Gender M/F, n: 3/12 • Weight, mean (SD): 116.8 (± 18.76) kg • Height, mean (SD): 151.17 (± 42.25) cm • BMI, mean (SD): 44.67 (± 6.64) kg/m^2 • ASA I/II/III/IV, n: 5/9/1/0 **GlideScope** • Age, mean (SD): 42.06 (± 13.25) years • Gender M/F, n: 3/12 • Weight, mean (SD): 117.16 (± 0.86) kg • Height, mean (SD): 158.52 (± 9.65) cm • BMI, mean (SD): 46.91 (± 6.92) kg/m^2 • ASA I/II/III/IV, n: 3/12/0/0

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Nandakumar 2018 *(Continued)*

	Notes: bariatric population. A third arm comparing the McCoy laryngoscope was reported. We did not extract data for that arm.
Interventions	**General details**: the single intubator was a trainee with experience of > 25 intubations with each device. **Macintosh** • Randomized = 15; no losses; analysed = 15 **GlideScope** • Randomized = 15; no losses; analysed = 15 **VL classification:** hyperangulated Notes: apnoeic oxygenation provided for all intubation attempts. Participants were intubated in ramped position
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure to intubate after 2 discrete attempts, with second anaesthetist performing subsequent attempts • Successful first attempt • Number of attempts • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from the time when the blade of the laryngoscope crosses the incisors to the first upstroke of the capnograph • IDS: 0, 1-5, > 5 Notes: airway trauma reported as blood on laryngoscope blade, dental injury not reported
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible

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Nandakumar 2018 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	High risk	Outcomes for airway trauma and incidence of hypoxia were not reported despite being described in methods
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (CTRI/2016/02/006662). All prespecified outcomes reported in published manuscript. Trial registered retrospectively
Experience of intubator	Low risk	Single intubator only. Reportedly > 25 intubations with each of the study devices

Ndoko 2008

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 106 **Country:** France **Setting:** theatre; single centre **Inclusion criteria**: morbidly obese (BMI > 35 kg/m^2) adult patients undergoing general, gynaecological and bariatric surgery **Exclusion criteria**: history of hiatus hernia, symptomatic gastric reflux, gastric banding, allergy to succinylcholine, and those with mouth opening < 30 mm (interincisor distance) **Baseline characteristics** **Macintosh** • Age, mean (range): 42 (26-58) years • Gender M/F, n: 13/27 • BMI, mean (SD): 43 (± 5) kg/m^2 • ASA I/II/III/IV, n: 25/20/8/0 • Mallampati 1/2/3/4, n: 17/20/11/5 **Airtraq** • Age, mean (range): 45 (21-66) years • Gender M/F, n: 10/30 • BMI, mean (SD): 44 (± 6) kg/m^2 • ASA I/II/III/IV, n: 30/18/5/0 • Mallampati 1/2/3/4, n: 15/22/10/6 Notes: the focus of the study was the use of these devices in a bariatric population.
Interventions	**General details**: the number of intubators was not specified. All intubators were anaesthetists "skilled in the use of the Airtraq and Macintosh laryngoscopes". The study authors recommended the use of a gum elastic bougie for intubations where a CL grade of ≥ 3 was found at laryngoscopy. **Macintosh** • Randomized = 53; no losses; analysed = 53 • #3 or #4 blade **Airtraq**

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Ndoko 2008 *(Continued)*

- Randomized = 53; no losses; analysed = 53

VL classification: channelled

Notes: the intubation technique presented showed the Airtraq being used with the optical viewfinder, not the video screen. Following a failed attempt with 1 device (defined as an attempt taking > 120 s), the protocol recommended switching to the alternate device for the next attempt.

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as tracheal intubation not achieved within 120 s • Hypoxia: defined as incidence of SpO_2 < 92% • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time elapsing between the insertion of the laryngoscope into the oral cavity and the visualization (or the sensation in the case of blind tracheal intubation) of the tube crossing the glottis • IDS Notes: number of attempts and CL grade recorded as part of IDS scores. Dental trauma not reported There is a discrepancy between the reported rate of successful first attempt, reported as "Number of patients in whom intubation required > 1 attempt" and counted as 4 in the DL group, and failed intubation, reported as 6 in the DL group. We therefore only extracted data for failed intubation and excluded data on number of attempts and successful first attempt from our analysis.
Notes	**Funding/sponsor/declarations of interest**: funded from within the anaesthetic department of the su tdy author's institution. No conflicts of interest declared by the study authors. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant data attrition evident

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Ndoko 2008 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubators were reportedly skilled in the use of both devices. Extent of experience with each of the study devices was not further quantified

Ninan 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** Mallampati 2 and 3 patients, ASA I and II, undergoing elective surgery under GA with tracheal intubation **Exclusion criteria**: uncontrolled hypertension, age < 18 years, recent respiratory tract infection, morbid obesity, pregnant, edentulous **Baseline characteristics** **Macintosh** • Age, mean: 38.03 years • Gender M/F, n: 22/8 • BMI, mean: 25.3 kg/m^2 • Mallampati 1/2/3/4, n: 0/20/10/0 **C-MAC** • Age, mean: 41.03 years • Gender M/F, n: 20/10 • BMI, mean: 25.8 kg/m^2 • Mallampati 1/2/3/4, n: 0/18/12/0 Notes: the study authors did not specify SD or other indicators of data spread for age or BMI.
Interventions	**General details**: single intubator used in the study, experience with each device not specified. The anaesthetist was permitted the use of external laryngeal manipulation or additional equipment such as a bougie. These manoeuvres were recorded. **Macintosh** • Randomized = 30; no losses reported; analysed = 30 • #4 blade **C-MAC** • Randomized = 30; no losses reported; analysed = 30 • #4 blade **VL classification:** Macintosh-style

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Ninan 2016 *(Continued)*

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failure: defined as an intubation attempt exceeding 120 s • CL grade: 1-4 Notes: the study reported time to intubation, but we could not extract these data because SD was not reported. Overall success at intubation was reported but not the number of intubation attempts. They also reported haemodynamic outcomes including changes in HR and BP, which are not of interest to this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** 2015–2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Concealment method not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	None reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single intubator, experience with each device not specified. Insufficient detail to make judgement

Nishikawa 2009

Study characteristics

Methods	RCT; Parallel design
Participants	**Total number of participants:** 40 **Country:** Japan

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Nishikawa 2009 *(Continued)*

Setting: hospital

Inclusion criteria: ASA I or II, adult patients 20-65 years old, undergoing elective mastectomy or minor orthopaedic surgery in supine position

Exclusion criteria: hypertension, hypotension, cardiovascular disease, or arteriosclerosis; known history of a previous difficult tracheal intubation

Baseline characteristics

Pentax AWS

- Age, mean (SD): 41.0 (± 13.8) years
- Gender M/F, n: 5/15
- Weight, mean (SD): 55.3 (± 11.6) kg
- Height, mean (SD): 1.57 (± 0.12) m

Macintosh

- Age, mean (SD): 41.7 (± 13.8) years
- Gender M/F, n: 4/16
- Weight, mean (SD): 54.1 (± 10.6) kg
- Height, mean (SD): 1.59 (± 0.12) m

Interventions

General details: all intubations were performed by a single anaesthetist who had 2 years' experience with Macintosh blades and at least 50 previous intubations with the Pentax AWS.

Pentax AWS

- Randomized = 20; no losses reported; analysed = 20

Macintosh

- Randomized = 20; no losses reported; analysed = 20
- #3 blade for women, #4 or #5 for men

VL classification: channelled

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as inability to place the tracheal tube into the trachea on the first attempt. Patients were excluded from the study in the event of intubation failure or if intubation took > 30 s to complete.
- Patient-reported sore throat: reported at 24 h postoperatively. Graded on a 4-point scale; no sore throat, mild, moderate or severe

Continuous outcomes

- Time for tracheal intubation: defined as interval from the time the device was inserted into the oropharynx to the time when the device was removed from the oral cavity.

Notes: the main outcomes studied were haemodynamic and bispectral index changes associated with intubation; these are not outcomes of interest to our review.

Notes

Funding/sponsor/declarations of interest: Grants-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science, and Technology of Japan to Koichi Nishikawa (No. 20390412).

Study dates: not reported

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Nishikawa 2009 *(Continued)*

Additional: note potential for bias introduced by exclusion criteria; study author quote: "Patients in whom there was failure to intubate and those requiring > 30 seconds to achieve tracheal intubation were excluded from this study". No participants, however, were excluded.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated random numbers"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"No patient was excluded from analysis according to the exclusion criteria"
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All intubating procedures were performed by a single anesthesiologist who had 2 years' experience with Macintosh blades and at least 50 previous intubations with the Pentax AWS"

Paik 2020

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 20 **Country:** South Korea **Setting**: radiology suite; single centre **Inclusion criteria:** patients undergoing an elective endovascular cerebral aneurysm coiling under GA **Exclusion criteria**: history of upper airway surgery due to polyp, tumour, inflammation, or trauma; risk factors for aspiration, such as gastro-oesophageal reflux disease or gastrointestinal obstruction; coagulopathy; BMI > 30 kg/m2 ; history of C-spine disease **Baseline characteristics:** **Macintosh laryngoscope first** • Age, mean (SD): 59.1 (± 3.9) years

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Paik 2020 *(Continued)*

- Gender M/F, n: 3/7
- Weight, mean (SD): 61.6 (± 9.1) kg
- Height, mean (SD): 159.6 (± 6.7) cm
- BMI, mean (SD): 24.1 (± 2.5) kg/m^2
- Mallampati 1/2/3/4, n: 8/2/0/0

C-MAC D-BLADE laryngoscope first

- Age, mean (SD): 61.0 (± 11.6) years
- Gender M/F, n: 2/8
- Weight, mean (SD): 58.6 (± 9.7) kg
- Height, mean (SD): 156.8 (± 9.4) cm
- BMI, mean (SD): 23.8 (± 2.5) kg/m^2
- Mallampati 1/2/3/4, n: 6/3/1/0

Notes: cross-over design. Study participants had simulated immobilization of the C-spine with a collar for intubation.

Interventions	**General details**: single intubator, described as a skilled anaesthetist but no other information about relative experience with each device **Macintosh laryngoscope first** • Randomized = 10; no losses; analysed = 10 • #3 or #4 blade **C-MAC D-BLADE first** • Randomized = 10; no losses; analysed = 10 **VL classification:** hyperangulated Notes: participants were all intubated with the device they were initially randomized to before being extubated and reintubated with the alternate device.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure of tracheal intubation in spite of 3 consecutive attempts • Successful first attempt Notes: the primary focus of the study examined C-spine motion with these devices when the C-spine is immobilized with a collar. This outcome is not relevant to our review. The study authors did examine time to intubation but it was not possible to extract these data because we were unable to calculate an accurate SD. Airway trauma reported as blood on laryngoscope, dental trauma not reported and therefore not extracted
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** July 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization

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Paik 2020 *(Continued)*

Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	None evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Single intubator. Insufficient information regarding intubator experience to make judgement

Pappu 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I–III requiring elective surgery under GA with tracheal intubation having at least 1 of the following predictors of difficult intubation: history of difficult intubation in previous anaesthetic experience, thyromental distance ≤ 6 cm, sternomental distance ≤ 12 cm, limited neck extension and a modified Mallampati grade of 3 or 4 **Exclusion criteria:** interincisor distance < 3 cm, respiratory tract infection, C-spine injury, or risk factors for gastric aspiration were present **Baseline characteristics** **Truview EVO2** • Age, mean (SD): 46.6 (± 14.16) years • Weight, mean (SD): 78.27 (± 26.28) kg • Height, mean (SD): 1.62 (± 0.079) m • BMI, mean (SD): 29.75 (± 10.38) kg/m^2 • ASA I/II/III/IV: 9/12/9/0 • Mallampati 1/2/3/4: 0/0/18/12 **C-MAC D-BLADE** • Age, mean (SD): 46.97 (± 15.06) years

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Pappu 2020 *(Continued)*

- Weight, mean (SD): 84.2 (± 34.11) kg
- Height, mean (SD): 1.64 (± 0.093) m
- BMI, mean (SD): 30.91 (± 11.12) kg/m^2
- ASA I/II/III/IV: 13/10/7/0
- Mallampati 1/2/3/4: 0/1/18/11

Macintosh

- Age, mean (SD): 46.22 (± 14.63) years
- Weight, mean (SD): 82.27 (± 27.1) kg
- Height, mean (SD): 1.63 (± 0.078) m
- BMI, mean (SD): 29.54 (± 9.33) kg/m^2
- ASA I/II/III/IV: 15/6/9/0
- Mallampati 1/2/3/4: 1/0/21/8

Notes: the study population all had predictors of difficult airway, including history of previous difficult intubation or features on clinical examination suggestive of difficult intubation. A 4th arm comparing a videoendoscope, which is not a VL, was excluded.

Interventions	**General details**: 2 anaesthetists performed all intubations. Their relative experience with each device was not specified. **Truview EVO2** • Randomized = 30; no losses; analysed = 30 • Tracheal tube pre-loaded onto manufacturer-provided preformed stylet **C-MAC D-BLADE** • Randomized = 30; no losses; analysed = 30 • A stylet bent into a "J" shape was used **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** hyperangulated (Truview EVO2, C-MAC D-BLADE) Notes: outcomes from the videoendoscope group were excluded from our analysis because it is not a VL.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Number of attempts: 1, > 1 • Airway trauma: dental trauma data only extracted • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from the insertion of the laryngoscope blade between the teeth till the appearance of the capnography trace Notes: the primary outcome of interest was the IDS score, but we were unable to extract these data from the study because it was not clear how many participants had IDS scores of 0, 1-5 and > 5 in each group.

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Pappu 2020 *(Continued)*

	There was a significant difference between time for tracheal intubation between Truview EVO2 and C-MAC D-BLADE arms; we therefore did not combine these outcomes and did not include them in the analysis.
Notes	**Funding/sponsor/declarations of interest:** study authors received no funding and declare no conflicts of interest. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number tables
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible. Recording was performed by an independent observer.
Incomplete outcome data (attrition bias) All outcomes	Low risk	None evident
Selective reporting (reporting bias)	Unclear risk	No prepublished protocol or clinical trials registration reported. It is not feasible to assess risk of reporting bias without these documents.
Experience of intubator	Unclear risk	2 anaesthetist intubators. Their relative experience with each device was not specified.

Parasa 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 61 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I or II; aged 18–65 years of either sex, posted for surgeries under GA **Exclusion criteria:** patients with known coronary artery disease, airway pathology, and patients who needed RSI **Baseline characteristics** **Macintosh**

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Parasa 2016 *(Continued)*

- Age, mean (SD): 45.6 (± 12.34) years
- Gender M/F, n: 17/13
- Weight, mean (SD): 61.27 (± 13.22) kg
- ASA I/II/III/IV, n: 16/14/0/0
- Mallampati 1/2/3/4, n: 19/8/2/1

GlideScope

- Age, mean (SD): 43.63 (± 11.64) years
- Gender M/F, n: 18/12
- Weight, mean (SD): 58.97 (± 10.98) kg
- ASA I/II/III/IV, n: 19/11/0/0
- Mallampati 1/2/3/4, n: 16/11/3/0

Interventions	**General details**: single intubator, an anaesthesiology resident with experience > 50 intubations with Macintosh blade and 10 intubations with GlideScope **Macintosh** • Randomized = 30; no losses; analysed = 30 **GlideScope** • Randomized = 31; excluded = 1 (failed intubation); analysed = 30 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Airway trauma: presence of blood on the laryngoscope tip; dental injury not reported • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from introduction of the laryngoscope blade into the mouth to the visual appearance of $ETCO_2$ trace Notes: a single participant was excluded from the study following 3 failed intubation attempts with the GlideScope. The study also reported haemodynamic outcomes, which are not the subject of this review and therefore we have not extracted these data.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** July 2015–September 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number tables used
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes

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Parasa 2016 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	A single participant was excluded from the study following 3 failed intubation attempts with the GlideScope.
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Single intubator, > 50 intubations with Macintosh, 10 intubations with GlideScope. Balance of experience likely to favour Macintosh group

Park 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 74 **Country:** South Korea **Setting:** theatre; single centre **Inclusion criteria**: aged 18-60 years, ASA I or II, scheduled to undergo surgery under GA **Exclusion criteria**: cardiopulmonary disease such as hypertension, angina pectoris, or asthma, who had potential risk of pulmonary aspiration in tracheal intubation due to pregnancy or ascites, who had no teeth or loose teeth, or who were expected to have difficulty with tracheal tube. Also excluded were those patients who were assessed as CL ≥ 3 when, after induction of anaesthesia, an anaesthetist examined the exposure view of the glottis and the epiglottis with the Macintosh DL **Baseline characteristics** **Airtraq** • Age, mean (SD): 39.5 (± 12.3) years • Gender M/F, n: 15/22 • Weight, mean (SD): 62.4 (± 12.3) kg • Height, mean (SD): 163.4 (± 8.6) cm • Mallampati 1/2/3/4, n: 28/9 **Macintosh** • Age, mean (SD): 38.3(± 11.9) years • Gender M/F, n: 15/22 • Weight, mean (SD): 64.1 (± 10.3) kg • Height, mean (SD): 165.4 (± 8.6) cm • Mallampati 1/2/3/4, n: 30/7

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Park 2010 *(Continued)*

	Notes: the purpose of the study was to examine the relative performance of each device for inexperienced intubators early in their training. Intubators were randomly allocated to either the Airtraq or Macintosh device after simulation training on a manikin followed by 2 clinical intubations with each device on real patients.
Interventions	**General details:** 37 medical student intubators with minimal experience. All had undertaken training with both devices on a manikin (10 intubations) and 2 intubations using both devices on real patients. All intubations were supervised by an experienced anaesthetist who performed direct laryngoscopy with a Macintosh blade on all participants before the student attempted intubation with the study device. Participants who the supervising anaesthetist decided had a CL view of 3 or 4 were excluded from the study. **Airtraq** • Randomized = 37; no losses; analysed = 37 **Macintosh** • Randomized = 37; no losses; analysed = 37 **VL classification:** channelled Notes: the Airtraq intubation technique described in the study methods used the optical viewfinder, not the video screen for laryngoscopy.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as 3 subsequent unsuccessful intubation attempts; oesophageal intubation followed by a further unsuccessful attempt; inability to intubate within 90 s; desaturation to < 90% SpO_2 • Hypoxia: defined as incidence of SpO_2 < 90% during an intubation attempt • Successful first attempt • Number of attempts: 1, > 1 • Airway trauma: dental or mucosal injury. Dental injury reported separately • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as time from opening of the mouth to the first appearance of normal wave capnography Notes: CL grades were recorded as part of the demographic data when initial laryngoscopy was performed by the expert supervising anaesthetist.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	High risk	Concealment not possible in study design

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Park 2010 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Intubators inexperienced novices in the use of both devices

Pazur 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 52 **Country:** Croatia **Setting:** theatre; single centre **Inclusion criteria**: age > 18, ASA I-III **Exclusion criteria**: presence of ≥ 3 predictors for difficult intubation: Mallampati score, interincisor gap, thyromental distance, upper lip bite test, raised BMI and known previous difficult airway management **Baseline characteristics** **C-MAC D-BLADE** • Age, mean (SD): 59 (± 17) years • Gender M/F, n: 13/13 • BMI, mean (SD): 27.4 (± 3.9) kg/m^2 • ASA I/II/III/IV, n: 1/19/6/0 • Mallampati 1/2/3/4, n: 17/8/1/0 **Macintosh** • Age, mean (SD): 61 (± 12) years • Gender M/F, n: 15/11 • BMI, mean (SD): 25.3 (± 6.8) kg/m^2 • ASA I/II/III/IV, n: 2/19/5/0 • Mallampati 1/2/3/4, n: 18/6/2/0
Interventions	**General details**: the number of intubators and their relative experience with each device was not specified. A stylet was used for intubations with both devices.

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Pazur 2016 *(Continued)*

	C-MAC D-BLADE • Randomized = 26; no losses; analysed = 26 • #4 blade used, manufacturer-provided preformed stylet **Macintosh** • Randomized = 26; no losses; analysed = 26 • #3 or #4 blade, used with a standard stylet **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from when the laryngoscope was taken into the hand until the ($ETCO_2$) curve was displayed on the monitor • IDS: 0, 1-5, > 5 Notes: the study also reported changes in HR and BP before and after intubation, which have not been extracted for use in this review.
Notes	**Funding/sponsor/declarations of interest**: the study authors do not declare any conflicts of interest or make any financial disclosures. **Study dates:** June 2013–April 2014

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Pazur 2016 *(Continued)*

Experience of intubator	Unclear risk	Number of intubators and relative experience with each device was not specified

Peck 2009

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 54 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II, undergoing elective surgical procedures **Exclusion criteria:** no details **Baseline characteristics** • Age, mean (SD): 53.4 (± 15.4) years • Gender M/F, n: 27/27 • Weight, mean (SD): 82.6 (± 18.2) kg • Height, mean (SD): 1.68 (± 0.1) m • BMI, mean (SD): 29.3 (± 6.0) kg/m^2 Notes: cross-over design with baseline characteristics reported together, not by device
Interventions	**General details**: intubator experience not reported. "The first assigned device was used solely to grade the glottic view and the second device was used for both grading the glottic view and tracheal intubation." **McGrath** • Randomized = 27; losses = 0; analysed = 27 **Macintosh** • Randomized = 27; losses = 0; analysed = 27 **VL classification:** Macintosh-style Notes: simulated difficult laryngoscopy with MILS Type of McGrath device not specified, Macintosh-style blade assumed
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. Unsuccessful intubation requiring a change of device was reported, which meets our review definition of failure. • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: not explicitly defined

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Peck 2009 *(Continued)*

	• POGO score: 0%-100%
Notes	**Funding/sponsor/declarations of interest**: none apparent **Study dates**: not reported **Additional**: abstract only. Not possible to contact study author, as no contact information provided in abstract. Sufficient information in Methods and Results sections for inclusion in the review.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient detail
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Abstract only. No details, although no obvious losses noted
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details

Postaci 2015

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 84 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria:** ASA I-III, 18-65 age, BMI ≥ 30 kg/m^2 **Exclusion criteria:** patients with a mouth opening of < 3 cm, patients with cervical instability, patients at risk of aspiration **Baseline characteristics** **Macintosh**

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Postaci 2015 *(Continued)*

	• Age, mean (SD): 44 (± 10.4) years • BMI, mean (SD): 44.6 (± 7.5) kg/m^2 • Mallampati 1/2/3/4, n: 20/11/9/2 **McGrath Series 5** • Age, mean (SD): 49.8 (± 10.3) years • BMI, mean (SD): 46.5 (± 7.2) kg/m^2 • Mallampati 1/2/3/4, n: 16/14/10/0 Notes: obese study population. Turkish language full text, translated using Google Translate
Interventions	**General details:** 5 anaesthetist intubators were used in their study. Their relative experience with each device was not clear. **Macintosh** • Randomized = 42; no losses; analysed = 42 • #4 blade **McGrath Series 5** • Randomized = 42; no losses; analysed = 42 • Preformed stylet used **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as from insertion of the laryngoscope into the mouth until the insertion of the tube through the vocal cords • IDS: 0, 1-5, > 5
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Closed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias)	High risk	Blinding not possible

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Postaci 2015 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not clear from data reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	5 intubators. Their relative experience with each device was not specified.

Pournajafian 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 95 **Country:** Iran **Setting**: theatre; single centre **Inclusion criteria:** scheduled for elective surgery under GA, ASA I or II, aged 18-60 years **Exclusion criteria:** hypertension, lung disease, cardiovascular disease, C-spine disease, gastro-oesophageal reflux disease, predicted difficult intubation/laryngoscopy, history of regular drug intake, allergy to anaesthetic medications, oxygen desaturation during intubation ≤ 94%, intubation failures **Baseline characteristics** **GlideScope** • Age, mean (SD): 36.1 (± 11.6) years • Gender M/F, n: 20/26 • Weight, mean (SD): 69.7 (± 9.1) kg • Height, mean (SD): 1.68 (± 0.09) m • BMI, mean (SD): 24.9 (± 3.5) kg/m^2 **Macintosh** • Age, mean (SD): 33.7 (± 10.6) years • Gender M/F, n: 18/31 • Weight, mean (SD): 66.2 (± 9.8) kg • Height, mean (SD): 1.66 (± 0.08) m • BMI, mean (SD): 24.1 (± 3.3) kg/m^2
Interventions	**General details**: intubators had about 4 years' experience with Macintosh and 20 successful intubations with GlideScope **GlideScope** • Randomized = 53; losses = 7 (1 did not receive allocated intervention due to difficulty with mask ventilation, 6 excluded from analysis due to failure of intubation); analysed = 46 **Macintosh**

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Pournajafian 2014 *(Continued)*

- Randomized = 53; losses = 4 (1 did not receive allocated intervention due to fall in HR and BP during induction, 3 excluded from analysis due to failure to intubate); analysed = 49
- #3 blade for women, #4 blade for men

VL classification: hyperangulated

Notes: although the study authors excluded instances of failed intubation from their analysis, we have extracted these into our review in the failed intubation outcome.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as > 1 attempt needed to achieve successful intubation, intubations needing > 30 s, need for another person to complete the procedure
- Successful first attempt

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of scope until tracheal tube positioned between vocal cords

Notes: study aimed to consider haemodynamic changes, but also reported on relevant outcomes.

Notes

Funding/sponsor/declarations of interest: supported in part by grant from Iran University of Medical Sciences

Study dates: February–September 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Generated by random allocation table in permutated blocks of 4
Allocation concealment (selection bias)	Low risk	"The numbered opaque sealed envelopes that contained patient allocation were opened at the time of randomization"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Study exclusion criteria were such that some participants were excluded because of intubation failure. For this review, we included in our outcome data the number of excluded participants due to intubation failure.
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (IRCT201111264969N4). Trial registered prospectively, but some prespecified outcomes not reported in final manuscript (e.g. sore throat)
Experience of intubator	Low risk	About 4 years' experience with Macintosh and 20 successful intubations with GlideScope

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Rabbani 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: elective surgeries under GA requiring oral intubation **Exclusion criteria**: not specified **Baseline characteristics:** no baseline characteristics were published in the abstract. The authors included a statement indicating balanced demographic data and airway pre-assessment characteristics between groups. Notes: abstract only. The study examined the utility of the study devices when intubating patients in the lateral position.
Interventions	**General details**: the number of intubators, their relative experience and use of additional equipment such as stylet or bougie was not specified. **Macintosh** • Randomized = 40; no losses; analysed = 40 **C-MAC** • Randomized = 40; no losses; analysed = 40 **Airtraq** • Randomized = 40; no losses; analysed = 40 **VL classification:** channelled (Airtraq), Macintosh-style (C-MAC) Notes: the use of the C-MAC with Macintosh-style blades was assumed for our analysis
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: the study authors did not specify how they defined this outcome, but did report data. Notes: there was insufficient detail present in the results to extract any further outcome data from this abstract
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates**: not specified

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Sequence generation method unspecified

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Rabbani 2020 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Incomplete reporting of several outcomes
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubator experience was not specified

Rajasekhar 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** patients aged 18-60 years, ASA I and II, undergoing elective surgery under GA **Exclusion criteria:** patients aged < 18 or > 60 years, patient refusal, morbid obesity, pregnancy, history of hypertension and coronary artery disease, history of beta blocker therapy, anti-hypertensive therapy, major renal, hepatic, cardiovascular, respiratory ailments and cerebral aneurysms, allergy to any of the drugs used in the study and anticipated difficult airway **Baseline characteristics** **Macintosh** • ASA I/II/III/IV, n: 16/14/0/0 • Mallampati 1/2/3/4, n: 10/20/0/0 **C-MAC** • ASA I/II/III/IV, n: 19/11/0/0 • Mallampati 1/2/3/4, n: 14/16/0/0 Notes: no other demographic data were published, but did include a statement indicating no significant differences in age, sex, height or weight between groups. The study authors reported a third group of participants intubated with a McCoy blade, which we did not include in this review.

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Rajasekhar 2020 *(Continued)*

Interventions	**General details**: a single skilled anaesthetist performed all intubations. Relative experience with each device was not specified. **Macintosh** • Randomized = 30; no losses; analysed = 30 **C-MAC** • Randomized = 30; no losses; analysed = 30 **VL classification:** Macintosh-style Notes: outcomes from the McCoy group were not included in our analysis. For the purpose of our analysis we have assumed the C-MAC was used with Macintosh-style blades, however a hyperangulated "D" blade was also available.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-4 Notes: the main outcomes studied were haemodynamic and entropy differences, which are not outcomes of interest to our review. They did report an intention to compare duration of laryngoscopy and intubation outcomes, however these data were not apparent in their results.
Notes	**Funding/sponsor/declarations of interest**: the study authors do not declare any conflicts of interest or make any financial disclosures. **Study dates:** May–August 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	Duration of intubation data not reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Rajasekhar 2020 *(Continued)*

Experience of intubator	Unclear risk	Single intubator, experienced at laryngoscopy, but relative experience with different devices not detailed

Ranieri 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 132 **Country:** Brazil **Setting:** theatre; single centre **Inclusion criteria:** patients undergoing bariatric surgery, aged 18– 60 years, ASA I–III, BMI ≥ 35 kg/m^2 **Exclusion criteria**: history of untreated gastro-oesophageal reflux, suxamethonium intolerance, or previous difficult or failed intubation **Baseline characteristics** **Macintosh** • Age, mean (SD): 34.9 (± 9.4) years • Gender M/F, n: 16/48 • BMI, mean (SD): 42.7 (± 4.4) kg/m^2 • ASA I/II/III/IV, n: 26/25/13/0 • Mallampati 1/2/3/4, n: 6/32/21/5 **Airtraq** • Age, mean (SD): 35.4 (± 8.8) years • Gender M/F, n: 15/53 • BMI, mean (SD): 43.5 (± 6.3) kg/m^2 • ASA I/II/III/IV, n: 28/32/8/0 • Mallampati 1/2/3/4, n: 9/33/22/4 Notes: obese study population. Broadly similar baseline characteristics including additional demographic data based on airway examination
Interventions	**General details:** 4 anaesthetist intubators, all had > 5 years' experience performing direct laryngoscopy and > 50 intubations with an Airtraq device. Use of external laryngeal manipulation and bougie was allowed **Macintosh** • Randomized = 64; no losses (2 cases of failed intubation, treated on an ITT basis, assumed worst case); analysed = 64 • #3, #4 or #5 blade **Airtraq** • Randomized = 68; no losses; analysed = 68 • #3 blade **VL classification:** channelled

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Ranieri 2012 *(Continued)*

	Notes: all participants were intubated in the ramped position.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure to intubate within 120 s • Hypoxia: SpO_2 < 92% during intubation attempt • Successful first attempt • Number of attempts: 1-3 • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time in seconds from the moment the anaesthetist picked up the device until cuff inflation Notes: intubation failed in 2 participants in the Macintosh group. These participants were subsequently intubated successfully with the Airtraq device but were retained in the Macintosh group on an ITT basis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates:** March 2010–July 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation method not clear
Allocation concealment (selection bias)	Low risk	Sealed opaque envelope
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible. A single observer recorded the outcome data
Incomplete outcome data (attrition bias) All outcomes	Low risk	None evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	4 intubators, > 5 years' experience with DL and > 50 intubations with Airtraq

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Reena 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA I and II patients, aged 18–50 years, undergoing elective surgeries requiring oro-tracheal intubation **Exclusion criteria:** ASA grade ≥ III, increased risk of pulmonary aspiration, history of difficult intubation, anticipated airway difficulties, patients with BMI > 30 kg/m^2 and patients unwilling to consent **Baseline characteristics** **Macintosh** • Age, mean (SD): 31.5 (± 7.2) years • Gender M/F, n: 24/26 • ASA I/II/III/IV, n: 39/11/0/0 • Mallampati 1/2/3/4, n: 24/20/6/0 **King Vision** • Age, mean (SD): 28.9 (± 8.1) years • Gender M/F, n: 29/21 • ASA I/II/III/IV, n: 41/9/0/0 • Mallampati 1/2/3/4, n: 18/27/5/0 Notes: the study examined the use of these devices when using armoured tracheal tubes for intubation.
Interventions	**General details**: intubating anaesthetist had > 5 years' experience and > 50 intubations using the King Vision VL. **Macintosh** • Randomized = 50; no losses; analysed = 50 • The use of a bougie or stylet was not permitted for the initial attempt at intubation. Following an unsuccessful first attempt a bougie was used to facilitate intubation on subsequent attempts. **King Vision** • Randomized = 50; no losses; analysed = 50 • The tracheal tube was pre-loaded in the side channel of the King Vision blade before laryngoscopy. **VL classification:** channelled Notes: Armoured tracheal tubes, which are more flexible than standard tracheal tubes, were used for all intubations.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as unsuccessful intubation after 3 attempts • Successful first attempt • Number of attempts: 1-3

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Reena 2019 *(Continued)*

- Airway trauma: mucosal injury; no dental injury reported
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time interval between passing the scope's blade through the interdental line to confirmation of correct tube placement by capnography.

Notes: outcomes for POGO score were reported but not in a format that could be extracted for our analysis (they did not report it as a continuous outcome with mean ± SD). Use of airway optimization manoeuvres was also reported. Haemodynamic outcomes including changes in HR and BP were also reported but are not relevant to our review.

Notes

Funding/sponsor/declarations of interest: the study authors report no conflicts of interest and do not make any financial disclosures.

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	5 years' clinical experience, > 50 intubations with King Vision

Rewari 2017

Study characteristics

Methods

RCT; parallel design

Participants

Total number of participants: 50

Country: India

Setting: theatre; single centre

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Rewari 2017 *(Continued)*

	Inclusion criteria: hypertensive patients **Exclusion criteria**: not specified **Baseline characteristics:** not reported Notes: this study was reported in abstract form only.
Interventions	**General details**: intubators were reported to be experienced in the use of both devices. Use of additional airway equipment was not specified in the study. **Macintosh** • Randomized = 25; no losses; analysed = 25 **GlideScope** • Randomized = 25; no losses; analysed = 25 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** Notes: it was not possible to extract any outcome data of relevance to the meta-analysis from the study. Time to intubation was reportedly longer in the GlideScope group than the Macintosh group but the study authors did not report respective mean intubation times (± SD). The main focus of the study was the changes in HR and BP during intubation, which are not outcomes of interest to our analysis.
Notes	**Funding/sponsor/declarations of interest**: none declared **Study dates**: not specified Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Risse 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of randomized participants:** 70 **Country:** Germany **Setting:** theatre; single centre **Inclusion criteria**: adult patients scheduled for elective thoracic surgery requiring GA with the need of a DLT for lung separation, ASA I–IV **Exclusion criteria**: patient age < 18 years, non-elective surgery, pregnancy, scheduled rapid-sequence induction, contraindication for DLT insertion, contraindication to one-lung ventilation, abnormal physical status of the C-spine **Baseline characteristics** **Macintosh** • Age, median (range): 60 (52–65) years • Gender M/F, n: 25/6 • Weight, median (range): 83 (75–95) kg

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Risse 2020 *(Continued)*

- Height, median (range): 178 (172–181)cm
- BMI, mean (range): 25.7 (24.2–30.8) kg/m^2
- ASA I/II/III/IV, n: 0/10/19/2
- Mallampati 1/2/> 2, n: 11/16/4

GlideScope

- Age, median (range): 66 (58–75) years
- Gender M/F, n: 25/9
- Weight, median (range): 80 (68–90) kg
- Height, median (range): 173 (165–178) cm
- BMI, mean (range): 25.2 (24.1–29.1) kg/m^2
- ASA I/II/III/IV, n: 1/9/24/0
- Mallampati 1/2/> 2, n: 14/14/6

Notes: the study compared the use of these devices when used for insertion of a DLT for lung isolation.

Interventions	**General details:** 3 intubators were used in the study, all experienced physicians. Their relative experience with each device was not specified. All intubations were performed with a preformed stylet shaped according to the device used. Participants were intubated with DLTs (size 35-41 Fr). These were all left-sided DLTs with the exception of a single right-sided DLT in 1 participant in the GlideScope group. **Macintosh** • Number randomized = 35; losses = 4 (2 impossible intubation, 2 declined postoperative endoscopic examination); analysed = 31 • #3 or #4 blade, pre-formed stylet **GlideScope** • Number randomized = 35; losses = 1 (required extended postoperative ventilation); analysed = 34 • #3 or #4 blade, pre-formed stylet **VL classification:** hyperangulated Notes: no outcomes, including baseline characteristics, were recorded for excluded participants.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Hypoxia: SpO_2 < 85% • Successful first attempt • Number of attempts: 1, 2, 3, > 3 • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: intubation time was defined as "blade passes mouth opening to positive capnography (visualization of 3 expirations in the capnography)". Reported as median (IQR) Notes: 2 participants were excluded from the outcome analysis due to unsuccessful intubation with a DLT. We have not extracted any failed intubation outcomes for this study. Blood on device, lip trauma and carinal trauma were also reported but not included in our analysis as it was felt that dental trauma was the most patient-centred outcome. We did not extract data for TTI.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures.

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Risse 2020 *(Continued)*

Study dates: February 2017–September 2017

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Envelope method". Randomization method not clear
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of airway outcome assessment not possible. Patients and postoperative outcome assessors were blinded to patient allocation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered (German Clinical trials registry DRKS00020978). All outcomes reported
Experience of intubator	Unclear risk	3 experienced clinicians. Relative experience with each device was not specified.

Robitaille 2008

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 20 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** scheduled to undergo an elective interventional neuroradiological procedure under GA **Exclusion criteria:** incapable of informed consent, clinical or radiological evidence of C-spine abnormalities, requiring RSI or an induction without a neuromuscular blocking drug **Baseline characteristics:** none reported, reference made to Table 1, which is not printed
Interventions	**General details**: all intubations were performed by 2 senior anaesthesiology residents who had performed both laryngoscopy techniques at least 30 times before the beginning of the study. Cross-over study design in which laryngoscopy was performed with each device sequentially: "During the first of the 2 techniques, the glottis was visualized and an appropriately shaped endotracheal tube was then advanced until it reached the glottic aperture. Afterwards, it was withdrawn without actual-

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Robitaille 2008 *(Continued)*

	ly entering the trachea. The second technique was then performed, with the tube being advanced this time into the trachea." **GlideScope intubation (second device)** • Randomized = 10; no losses reported; analysed = 10 • Large blade **Macintosh intubation (second device)** • Randomized = 10; no losses reported; analysed = 10 • #3 or #4 blade **VL classification:** hyperangulated Notes: a trained assistant, positioned at the participant's head, maintained MILS of the C-spine throughout airway manoeuvres by grasping the mastoid processes bilaterally with the fingertips while cupping the occiput in the palms of the hands.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-3
Notes	**Funding/sponsor/declarations of interest**: none apparent **Study dates:** October 2004–September 2005 **Additional**: long study period with few participants

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"randomization table"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.

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Robitaille 2008 *(Continued)*

Experience of intubator	Low risk	"All intubations were performed by two senior anesthesiology residents...having performed both laryngoscopy techniques at least 30 times at the beginning of the study"

Rovsing 2010

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Denmark **Setting:** theatre; single centre **Inclusion criteria:** patients scheduled for bariatric surgery, BMI > 35 kg/m^2 **Exclusion criteria**: not specified **Baseline characteristics:** abstract only, baseline demographic data were not published but study authors included a statement indicating, "There were no differences in sex, age, BMI, Mallampati score, neck circumference and history of sleep apnoea between the groups". Participants were all morbidly obese with BMI > 35kg/m^2 and were intubated in the ramped position.
Interventions	**General details:** 5 intubating anaesthetists who were experienced in the use of both laryngoscopes. The use of additional airway equipment such as a stylet or bougie was not specified. **GlideScope** • Randomized = 50; no losses; analysed = 50 **Macintosh** • Randomized = 50; no losses; analysed = 50 **VL classification:** hyperangulated Notes: participants were intubated in the "ramped" position and were pre-oxygenated for 5 min prior to induction.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. The failed attempts were both in the Macintosh group and the participants were successfully intubated after switching device to the GlideScope • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from picking up the laryngoscope to successful intubation (confirmed by capnography) Notes: number of attempts, airway trauma and sore throat were reportedly examined, but these outcome data were not available in the abstract. IDS scores were reported as median values for each group and we could not extract these data for use in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures.

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Rovsing 2010 *(Continued)*

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not specified
Allocation concealment (selection bias)	Unclear risk	Concealment not specified in abstract
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Authors did not report outcomes for number of attempts, airway trauma or postop sore throat
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	5 intubators, all experienced in the use of both devices. Quantitative extent of experience not specified

Ruetzler 2020

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 129 **Country:** USA **Setting:** theatre; single centre **Inclusion criteria:** 18–99 years, with BMI ≥ 40 kg/m^2 , ASA I-III **Exclusion criteria:** patients requiring RSI or awake fibreoptic intubation **Baseline characteristics** **McGrath** • Age, mean (SD): 51 (± 14) years • Gender M/F, n: 25/49 • BMI, median (IQR): 46 (43-51) kg/m^2 • ASA I/II/III/IV: 0/1/65/0 • Mallampati 1/2/3/4: 17/28/18/3

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Ruetzler 2020 *(Continued)*

Macintosh

- Age, mean (SD): 47 (± 13) years
- Gender M/F, n: 27/46
- BMI, median (IQR): 47 (43-51) kg/m^2
- ASA I/II/III/IV: 0/0/63/0
- Mallampati 1/2/3/4: 21/22/18/2

Notes: obese study population (BMI > 40 kg/m^2). Other demographic data relating to baseline airway characteristics were balanced.

Interventions	**General details**: intubators were experienced anaesthesia attendings who had previously performed at least 75 intubations each with Macintosh direct laryngoscopy and the McGrath VL. Tracheal tubes were all prepared with a hockey-shaped stylet and the use of external laryngeal manipulation manoeuvres was allowed. Participants were all intubated in the ramped position and were pre-oxygenated to end-tidal oxygen > 80% **McGrath** • Randomized = 66; no losses; analysed = 66 • #3 or #4 blade, stylet used **Macintosh** • Randomized = 64; losses = 1 (intubation cancelled for medical reasons); analysed = 63 • #3 or #4 blade, stylet used **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as when any of the following occurred: grade 4 CL glottis view, failure to intubate within 3 intubation attempts, need to switch intubators or intubation device, or at the anaesthetist's discretion • Successful first attempt • Number of attempts: 1-2 • Airway trauma: airway or dental trauma; reported as a combined outcome, we did therefore not extract the data for the purposes of our analysis. • Patient-reported sore throat: reported as mild/moderate/severe • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time between the introduction of the tracheal tube into the oral cavity, and expired $ETCO_2$ was detected. Reported as median (IQR) Notes: POGO score was reported but not in a format that could be extracted for our analysis. The study classified patient-reported sore throat as mild, moderate or severe, the incidence of which we have combined to generate a dichotomous outcome measure.
Notes	**Funding/sponsor/declarations of interest**: the trial was supported by Medtronic but the sponsor was not involved in data collection, analysis or interpretation of data. The study authors declared no conflicts of interest. **Study dates:** July 2018–June 2019
Risk of bias	

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Ruetzler 2020 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of airway outcomes not possible. It was not clear if participants were blinded for patient-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant loss of data evident
Selective reporting (reporting bias)	Low risk	ClinicalTrials.gov prospective protocol NCT03467048. Prespecified outcomes reported
Experience of intubator	Low risk	Experienced attending anaesthetists. Experienced in the use of both devices, including > 75 intubations with the McGrath

Russell 2012

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 23 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II, aged > 18 years, undergoing elective surgical procedures requiring tracheal intubation **Exclusion criteria:** RSI or another intubation method indicated; known or suspected oral, pharyngeal or laryngeal masses; poor dentition, symptomatic gastro-oesophageal reflux, C-spine instability, unstable hypertension, coronary artery disease, cerebral disease or asthma; resources not available for procedure to be conducted on the scheduled date of surgery **Baseline characteristics** Not reported by group because of cross-over design • Age, mean (SD): 47.9 (± 14.4) years • Gender M/F, n: 14/9 • BMI < 30/30-35, n: 19/4 kg/m^2 • ASA I/II/III/IV, n: 12/11/0/0 • Mallampati 1/2/3/4, n: 7/11/5/0

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Russell 2012 *(Continued)*

Interventions	**General details**: all participants were intubated by anaesthesia staff that included specialists, fellows and third- and fifth-year anaesthesia trainees with experience in using the GlideScope on > 25 occasions. Laryngoscopy was performed with both devices and a styletted tracheal tube was advanced to the vocal cords on both laryngoscopies. Participants were subsequently intubated with the second device. Allocation of first device used was randomized, but not reported. **GlideScope and Macintosh** • Recruited = 24; losses = 1 (force sensor cable connection failed during laryngoscopy); analysed = 23 • #3 blade used for Macintosh laryngoscopies, stylets used for all intubations **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: reported as median (IQR (range)). we could not assume a normal distribution therefore data were not extracted for inclusion in the review. Notes: the main outcomes studied were the forces applied to the base of the tongue during laryngoscopy. These are not outcomes of interest to our review.
Notes	**Funding/sponsor/declarations of interest**: this study was funded with a research grant from The Society for Airway Management. The Society of Airway Management had no input into the study design, collection, analysis, and interpretation of data and writing the report. Dr Richard Cooper is an unpaid consultant to Verathon Medical, the manufacturer of the GlideScope. No other external funding or competing interests declared. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"use of a computer-generated code"
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to blind outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	One exclusion; unlikely to impact outcomes

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Russell 2012 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No prepublished protocol was available. It is not possible to assess reporting bias without these documents.
Experience of intubator	Low risk	Intubators were "specialists, fellows and third- and fifth-year anaesthesia trainees with experience in using the GlideScope on more than 25 occasions"

Russell 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** aged > 18 years, undergoing elective surgical procedures requiring endobronchial intubation with a left-sided DLT **Exclusion criteria:** history of previous failed or difficult tracheal intubation, difficult tracheal intubation anticipated (2 risk factors of Mallampati score ≥ 3, incisor gap < 3.5 cm, thyromental distance < 6.5 cm, reduced neck extension and flexion), alternative method of tracheal intubation indicated (e.g. RSI), contraindication to a left DLT, contraindication to one lung ventilation, anticipated difficult bag-mask ventilation of the lungs, BMI > 40 kg/m^2 **Baseline characteristics** **GlideScope** • Age, mean (SD): 59 (± 12) years • Gender M/F, n: 15/20 • BMI, mean (SD): 26 (± 5) kg/m^2 • ASA I/II/III/IV, n: 8/24/0/0 • Mallampati 1/2/3/4, n: 15/13/7/0 **Macintosh** • Age, mean (SD): 62 (± 14) years • Gender M/F, n: 18/17 • BMI, mean (SD): 26 (± 4) kg/m^2 • ASA I/II/III/IV, n: 5/29/0/0 • Mallampati 1/2/3/4, n: 22/11/2
Interventions	**General details**: study centre performs > 1500 thoracic cases per annum, and the GlideScope has been the primary video-laryngoscope since 2001. All anaesthetists were specialists or fellows who regularly perform thoracic anaesthesia and regularly use the GlideScope for tracheal intubation. However, most staff had used the GlideScope for DLT insertion only around 3-6 times. Stylet used to shape DLT to replicate GlideScope or Macintosh blades, depending on device used. **GlideScope** • Randomized = 35; losses = 0; analysed = 35 **Macintosh**

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Russell 2013 *(Continued)*

- Randomized = 35; losses = 0; analysed = 35

VL classification: hyperangulated

Notes: all participants had a DLT inserted.

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: study authors provided details regarding failed initial intubation attempts including reason for failure and whether a change of device was required. This allowed us to extract data based on our review definition of failed intubation. • Successful first attempt: "The first intubation attempt was considered a failure if the trachea was not successfully intubated within 120s" • Airway trauma: lip trauma, blood on device, dental damage; we extracted data for dental trauma. • Patient-reported sore throat **Continuous outcomes** • Time for tracheal intubation: reported as median (IQR (range)) and therefore could not be extracted as we could not assume a normal distribution. Notes: study authors also reported use of a NRS to rate subjective intubation difficulty ranging from 1 (none) to 10 (severe). This outcome is not of interest to our review.
Notes	**Funding/sponsor/declarations of interest**: no external funding and no competing interests declared by study authors **Study dates**: not reported **Additional**: see also abstract reports of same study (secondary references under Russell 2013). In these abstracts, study authors reported duration of first intubation as GlideScope 77 s (44) compared with Macintosh 51 s (61). They do not state whether this is a mean value (SD). Also in these abstracts, study authors stated different percentages for success of first intubation (74% vs 88%, unclear which figure relates to which scope). For the purpose of this review, we have taken data from the full report, not from the abstracts.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomisation was computer-generated"
Allocation concealment (selection bias)	Unclear risk	"revealed to the anaesthetists and research staff after the airway assessment and immediately before induction of anaesthesia" Insufficient detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias)	Low risk	No apparent losses after randomization

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Russell 2013 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Operators were experienced in use of both laryngoscopes but had very limited experience with a GlideScope blade for DLT intubations.

Sandhu 2014

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** India **Setting**: theatre **Inclusion criteria:** undergoing elective surgery under GA **Exclusion criteria:** no details **Baseline characteristics:** no details, described as comparable in both groups
Interventions	**General details**: no details provided on intubator background or experience **GlideScope** • Randomized = 100; no losses reported; analysed = 100 **Macintosh** • Randomized = 100; no losses reported; analysed = 100 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: study authors' quote: "the difference in CL grades during final laryngoscopy between the two groups was statistically highly significant (P < 0.001)". No data presented in abstract, not stated in which direction this result is significant. **Continuous outcomes** • Time for tracheal intubation: not explicitly defined • IDS: presented as mean (SD): GlideScope 0.4 (± 0.7); Macintosh 1.2 (± 1.3), P < 0.05. we could not extract these data for inclusion in our review. • POGO score: 0%-100%. Scores taken initially with all participants and again at laryngoscopy attempt, which included intubation. This review used POGO scores from second laryngoscopy.
Notes	**Funding/sponsor/declarations of interest**: no details **Study dates**: not reported **Additional**: abstract only

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Sandhu 2014 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants described as randomly assigned, but no additional details in abstract
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No details reported
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details of experience reported in abstract

Sanguanwit 2021

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 158 **Country:** Thailand **Setting:** ED **Inclusion criteria:** age > 18 years, requiring intubation, acute respiratory failure **Exclusion criteria:** no signs of undergoing resuscitation, end-of-life care **Baseline characteristics** **GlideScope** • Age, mean (SD): 73 (± 12.9) years • Gender M/F, n: 44/34 • Mallampati 1/2/3/4/NA, n: 5/6/4/4/59 **Macintosh** • Age, mean (SD): 65 (± 17.2) years • Gender M/F, n: 40/40 • Mallampati 1/2/3/4/NA, n: 1/7/6/6/60

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Sanguanwit 2021 *(Continued)*

	Notes: data on Mallampati score missing for a large proportion of participants in both groups
Interventions	**General details**: the study included a range of mixed-experience intubators, with the study authors categorising them as either experienced or inexperienced. They defined first, second and third year emergency medicine residents or attendings as experienced. They defined 6th year medical students as inexperienced. All participants received training in laryngoscopy on a manikin prior to participation, but the study authors do not report what devices were used for said training. They note furthermore that intubators classified as experienced have overall > 3 years' intubating experience, whereas medical students have < 1 year. **GlideScope** • Randomized = 78; no losses; analysed = 78 **Macintosh** • Randomized = 80; no losses; analysed = 80 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: failure to intubate after 2 attempts or oesophageal intubation • Successful first attempt • Number of attempts: 1 or 2 • Airway trauma: oral bleeding and broken teeth reported as percentages combined, not possible to extract data • CL grade: reported as 1-2 and 3-4. It was not possible to extract these data. • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time from the blade introduction into the mouth until passing the tracheal tube through the vocal cords with the cuff inflated. It was not possible to extract these data because it was reported as median (IQR).
Notes	**Funding/sponsor/declarations of interest**: the study authors report no financial support and do not declare any conflicts of interest. **Study dates:** July 2015–June 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"We randomized the patients by using the sealed opaque envelope in a block of 10 with SNOSE before enrolment"
Allocation concealment (selection bias)	Low risk	"Sealed opaque envelope"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias)	High risk	Not possible to blind outcome assessors

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Sanguanwit 2021 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No evident losses
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (TCTR20200503003). Trial registered retrospectively, all outcomes reported in final manuscript
Experience of intubator	Unclear risk	Varied skill mix, from senior residents to medical students. Study authors state all intubators received manikin training, but their experience is not further quantified.

Sansone 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 42 **Country:** Italy **Setting:** theatre; single centre **Inclusion criteria**: facial trauma, ASA II-III, scheduled for maxillofacial surgery **Exclusion criteria**: not specified **Baseline characteristics:** not specified in the abstract, but were reported to be "similar" by the study authors. Notes: abstract only. The study population all had facial trauma and were Mallampati 3 or 4 on pre-operative airway assessment
Interventions	**General details**: the number of intubators and their relative skill and experience with either device was not specified. **Macintosh** • Randomized = 21; no losses; analysed = 21 **Airtraq** • Randomized = 21; no losses; analysed = 21 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined, but the study authors specified that the failed intubations all required a change of device **Continuous outcomes** • Time for tracheal intubation: outcome was reported, but not defined in methods Notes: the study also reported changes in HR and BP, which are not relevant to our review.

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Sansone 2012 *(Continued)*

Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and make no financial disclosures. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Baseline characteristics not reported, number of attempts not reported. Abstract only
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubator experience not specified

Saracoglu 2014

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria**: aged 18-65 years, ASA I or II, requiring endotracheal intubation under GA for elective surgery **Exclusion criteria:** ASA III or IV, Mallampati 3 or 4, previous history of difficult intubation, thyromental distance < 6.5cm, sternomental distance < 12.5cm, BMI > 35 kg/m^2 or limited neck mobility **Baseline characteristics** **Airtraq** • Age, mean (SD): 42.3 (± 13.5) years • Gender M/F, n: 16/15

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Saracoglu 2014 *(Continued)*

- Weight, mean (SD): 72.7 (± 12.9) kg
- Height, mean (SD): 168.6 (± 9.5) cm

Macintosh

- Age, mean (SD): 40.7 (± 17) years
- Gender M/F, n: 14/16
- Weight, mean (SD): 70.7 (± 13.0) kg
- Height, mean (SD): 166.9 (± 9.4) cm

Notes: the study included a third group where participants were intubated with a fibreoptic bronchoscope (FOB). We did not include this group in our review.

Interventions	**General details**: 3 experienced anaesthetists. All had > 500 intubations with the Macintosh, at least 50 intubations with the FOB, but experience with the Airtraq was not specified. Manoeuvres including external laryngeal manipulation to optimize view and facilitate intubation were allowed for all groups. **Airtraq** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 • #3 blade **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: considered failed if intubation duration > 120 s • Airway trauma: mucosal injury or dental trauma • Patient-reported sore throat: reported at 30 min, 6 h, 12 h, 24 h time points • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time from the device insertion into the oral cavity until the tracheal tube crossed the vocal cords. Notes: the study looked at patient-reported sore throat at several different time points postoperatively. For the purpose of our analysis we took the data from the 6-h timepoint, which reported the highest incidence of sore throat for each group. It was noted that the first pass success rate was improbably low- for all groups but we included these data in our analysis. We did not extract haemodynamic outcomes. The reported success rates for intubation in Table 2 were 4/30 and 2/30 in the Airtraq and Macintosh groups, respectively. This is likely a misprint, given that the study authors also report that all participants were successfully intubated, and only 4 participants in the Macintosh group required assistance of a second intubator. In light of this discrepancy we opted to not extract data for this outcome.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and disclose no funding sources. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement

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Saracoglu 2014 *(Continued)*

Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Concealment method not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	3 experienced intubators, but experience with Airtraq device not specified

Sargin 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Turkey **Setting:** theatre; single centre **Inclusion criteria**: scheduled for elective surgery under GA requiring tracheal intubation, ADS < 8 points, ASA physical status I-II, > 18 years of age **Exclusion criteria:** patients with an ADS score > 8 and thyroid-to-chin length of ≤ 5 cm, a Mallampati ≥ 3, mouth opening < 3 cm, restriction in neck extension or protruding front teeth, or requiring RSI. Previous history of previous difficult direct laryngoscopy, or uncontrolled hypertension, ischaemic heart disease, acute or recent stroke or myocardial infarction, C-spine instability or cervical myelopathy, symptomatic asthma or reactive airway disease and history of gastric reflux **Baseline characteristics** **Macintosh** • Age, mean (SD): 40.36 (± 14.67) years • Gender M/F, n: 17/33 • BMI, mean (SD): 24.97 (± 4.13) kg/m^2 **McGrath Series 5** • Age, mean (SD): 39.46 (± 15.58) years • Gender M/F, n: 23/27

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Sargin 2016 *(Continued)*

	• BMI, mean (SD): 24.23 (± 3.41) kg/m^2
Interventions	**General details:** 1 anaesthetist intubator, > 50 intubations with each device. Airway manoeuvres including external laryngeal manipulation and the use of a bougie or stylet was allowed with either laryngoscope. **Macintosh** • Randomized = 50; no losses; analysed = 50 **McGrath Series 5** • Randomized = 50; no losses; analysed = 50 **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure after 3 attempts • Successful first attempt • Number of attempts: 1, > 1 • Airway trauma: reported as oropharyngeal trauma or mucosal bleeding; dental injury not explicitly reported, therefore we did not extract this outcome. **Continuous outcomes** • Time to intubation: defined as from the time the allocated laryngoscope was inserted in the participant's mouth until $ETCO_2$ was detected. Reported as median (IQR) • POGO score: 0%-100%, mean (± SD) Notes: CL grade was reported as a dichotomous outcome (CL 1, CL > 1) and we did not extract these data for use in the meta-analysis. We did not include reported haemodynamic outcomes in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors report no conflicts of interest and make no financial disclosures. **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer generated block randomisation"
Allocation concealment (selection bias)	Unclear risk	Allocation concealment method not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias)	Low risk	No data attrition evident

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Sargin 2016 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Protocol retrospectively registered with the Australian New Zealand Clinical Trials Registry (registration number: ACTRN12614000910606)
Experience of intubator	Low risk	Intubator had > 50 intubations experience with both devices

Sarkilar 2015

Study characteristics	
Methods	Quasi-RCT; parallel design
Participants	**Total number of participants:** 110 **Country:** Turkey **Setting:** theatre, single centre **Inclusion criteria:** > 18 years of age, good ventricular function, scheduled for elective cardiac surgery **Exclusion criteria:** patients with SBP > 160 mmHg at the baseline measurements in the operating room, with airway anomaly and apparent neck pathology were excluded **Baseline characteristics** **Macintosh** • Age, mean (SD): 58.5 (± 16.2) years • Gender M/F, n: 37/18 • Weight, mean (SD): 73.7 (± 14.3) kg • Height, mean (SD): 164.7 (± 9.7) cm • BMI, mean (SD): 27.1 (± 4.2) kg/m^2 **C-MAC** • Age, mean (SD): 61.3 (± 13.3) years • Gender M/F, n: 33/22 • Weight, mean (SD): 73.8 (± 15.6) kg • Height, mean (SD): 163.3 (± 10.4) cm • BMI, mean (SD): 27.7 (± 5.9) kg/m^2 Notes: quasi-randomized study design, randomized by week of surgery to either C-MAC or Macintosh-groups. The study population were all undergoing cardiac surgery. Other baseline demographic data compared co-morbidities, medication and type of surgery (CABG vs valve surgery), all of which were broadly similar.
Interventions	**General details**: 2 intubating anaesthetists, both experienced in the use of videolaryngoscopy. The use of external laryngeal manipulation and a stylet was allowed, the use of either was recorded in outcomes. **Macintosh** • Randomized = 55; no losses; analysed = 55 • #3 and #4 blade **C-MAC** • Randomized = 55; no losses; analysed = 55

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Sarkilar 2015 *(Continued)*

	• #3 blade **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. All participants were intubated within 3 attempts • Successful first attempt • Number of attempts: 1-3 • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time from the laryngoscope passing through the participant's lips until it is removed Notes: POGO score was reported, but not in a format that allowed extraction for use in our analysis. Cardiovascular outcomes were also reported, which are not of interest to this meta-analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors report no conflicts of interest and make no financial disclosures. **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quasi-randomized study design, randomized by week of surgery to either C-MAC or Macintosh groups
Allocation concealment (selection bias)	High risk	Quasi-randomized study design, randomized by week of surgery to either C-MAC or Macintosh groups. Concealment not possible
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	2 intubators both experienced in the use of videolaryngoscopy. Experience with study devices was not further quantified

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Sbeghen 2021

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 49 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II, Mallampati 1 or 2, > 18 years old, having elective general, gynaecological, neurologic, orthopedic, plastic, or urological surgery under GA requiring tracheal intubation **Exclusion criteria:** refusal to participate, history of psychiatric diseases or psychological problems (including developmental delay), inability to give consent, anticipated difficult airway (Mallampati 3 and 4, thyromental distance < 6 cm, mouth opening < 3 cm, neck extension < 80° and neck flexion < 35°, or inability to protrude the mandible adequately as assessed by upper lip bite test), history of neck rigidity or instability, BMI > 35, presence of a beard, history of oropharyngeal or tracheal surgery (excluding adenoidectomy, amygdalectomy, or tooth removal), severe coronary artery disease, serious cardiac arrhythmias (including atrial fibrillation), use of beta blockers, history of opioid or illicit drug use, allergy to remifentanil or propofol, pregnancy, contraindications to mask ventilation (gastrointestinal tract obstruction, pregnancy, active gastroesophageal reflux disease, non-fasting patients) **Baseline characteristics** Reported jointly for all participants due to cross-over design • Age, mean (SD): 51.2 (± 16.2) years • Gender M/F, n: 11/38 • BMI, mean (SD): 26.2 (± 3.4) kg/m^2 • ASA I/II/III/IV, n: 19/30/0/0
Interventions	**General details**: all laryngoscopies/intubations were performed by only 2 experienced anesthesiologists. **GlideScope and Macintosh** • Recruited = 49; no losses; analysed = 49 • #3 or #4 blade used with Macintosh based on patient characteristics **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-2 Notes: the main outcomes in this study were nociceptive and haemodynamic variables. These are not outcomes of interest to this meta-analysis. CL grades reported for all participants together; we were therefore not able to extract any data from this study.
Notes	**Funding/sponsor/declarations of interest**: the PMD200TM device was a loan from Medasense LTD. Dr. Philippe Richebe was a member of the advisory board of the company Medasense until 2020 and a consultant for this company. Nevertheless, all the studies he performed as a PI were done after a contract signed between both the parties (attorneys of the Research Center of HMR-CEMTL and the companies) and always via an Independent Investigator Initiated Trial grant-contract. He also received honoraria as medical consultant from Abbvie, Medtronic, Biosyent, Edwards, Merck, and Avirpharma for lectures. There is no conflict of interest between the present study/article and the above cited contracts. This study was partly supported by an Independent Investigator Initiated Trial Research Grant from Ve-

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Sbeghen 2021 *(Continued)*

rathon, Bothell, WA, USA as well as CHS, Oakville, ON, Canada, and by the Department of Anesthesiology of Maisonneuve Rosemont Hospital.

Study dates: September–November 2017

Note: we did not complete risk of bias assessments because this study reported no relevant review outcomes.

Serocki 2010

Study characteristics	
Methods	RCT; cross-over
Participants	**Total number of participants:** 120 **Country:** Germany **Setting**: theatre; single centre **Inclusion criteria:** at least 18 years of age, ASA ≤ III, ≥ 1 positive predictor of a difficult airway, Mallampati score ≥ 2 **Exclusion criteria:** refusal of participation, indication for RSI, known difficult facemask ventilation **Baseline characteristics** **C-MAC DCI** • Age, mean (SD): 63 (± 15) years • Gender M/F, n: 21/19 • Weight, mean (SD): 78 (± 15) kg • Height, mean (SD): 1.72 (± 0.12) m • ASA I/II/III/IV, n: 4/28/8/0 • Mallampati 1/2/3/4, n: 0/23/16/1 **GlideScope** • Age, mean (SD): 66 (± 10) years • Gender M/F, n: 26/14 • Weight, mean (SD): 83 (± 13) kg • Height, mean (SD): 1.73 (± 0.1) m • ASA I/II/III/IV, n: 2/29/9/0 • Mallampati 1/2/3/4, n: 0/22/16/2 **Macintosh** • Age, mean (SD): 66 (± 13) years • Gender M/F, n: 21/19 • Weight, mean (SD): 77 (± 17) kg • Height, mean (SD): 1.70 (± 0.09) m • ASA I/II/III/IV, n: 3/23/14/0 • Mallampati 1/2/3/4, n: 0/23/17/0
Interventions	**General details**: intubation was carried out by 2 board-certified anaesthetists. Both were familiar with all the laryngoscopes investigated (50 intubations each).

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Serocki 2010 *(Continued)*

Laryngoscopy was performed with all 3 study devices in a sequence determined by randomization. Intubation was performed with the third device used. Group allocation was as per intubating device.

C-MAC DCI

- Randomized = 40; losses = 0; analysed = 40
- Fixed blade size, equivalent to #3 Macintosh

GlideScope

- Randomized = 40; losses = 0; analysed = 40
- Standard adult/large blade used for all

Macintosh

- Randomized = 40; losses = 0; analysed = 40
- #3 blade for male and female participants, #4 blade for tall participants

VL classification: hyperangulated (GlideScope), Macintosh-style (C-MAC DCI)

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: "After two failed intubation attempts, the study protocol was stopped".
- Hypoxia: not explicitly defined
- Successful first attempt
- Number of attempts: 1-3
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as, "touching the endotracheal tube until cuff inflation of the inserted tube". Reported as median (IQR) and therefore could not be extracted.

Notes

Funding/sponsor/declarations of interest: VLs supplied by manufacturers

Study dates: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomized sequence" No additional details
Allocation concealment (selection bias)	Low risk	"Allocation of patients by opening of a sealed envelope"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias)	Low risk	"In total, 120 patients were enrolled in this study; none had to be excluded for data analysis"

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Serocki 2010 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"The investigation was carried out by two board-certified anaesthetists ... Both were familiar with all the laryngoscopes investigated (≥ 50 intubations each)"

Serocki 2013

Study characteristics	
Methods	RCT; cross-over
Participants	**Total number of participants:** 96 **Country:** Germany **Setting**: theatre; single centre **Inclusion criteria:** scheduled for elective ENT surgery requiring tracheal intubation, ≥ 1 of the following: Mallampati score ≥ 2, reduced mobility of the atlanto-occipital joint (≤ 15°), mouth opening < 4 cm, thyromental distance < 6 cm **Exclusion criteria:** refusal of participation, age < 18 years and ASA > III, indication for RSI, known difficult facemask ventilation, hypopharyngeal or laryngeal tumours with risk of bleeding or swelling **Baseline characteristics** **GlideScope** • Age, mean (SD): 59 (± 13) years • Gender M/F, n: 8/24 • Weight, mean (SD): 81 (± 14) kg • Height, mean (SD): 1.77 (± 0.11) m • ASA I/II/III/IV, n: 0/21/11/0 • Mallampati 1/2/3/4, n: 1/16/13/2 **Macintosh** • Age, mean (SD): 59 (± 16) years • Gender M/F, n: 16/16 • Weight, mean (SD): 76 (± 16) kg • Height, mean (SD): 1.71 (± 0.09) m • ASA I/II/III/IV, n: 2/19/11/0 • Mallampati 1/2/3/4, n: 0/20/9/3 **C-MAC D-BLADE** • Age, mean (SD): 51 (± 19) years • Gender M/F, n: 7/25 • Weight, mean (SD): 81 (± 17) kg • Height, mean (SD): 1.76 (± 0.1) m • ASA I/II/III/IV, n: 3/21/8/0 • Mallampati 1/2/3/4, n: 1/16/11/4

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Serocki 2013 *(Continued)*

Interventions	**General details**: intubation was carried out by 3 board-certified anaesthetists familiar with all laryngoscopes (> 50 intubations each). Stylets were used; in hockey stick shape for GlideScope and C-MAC, moderate curve for Macintosh. Laryngoscopy was performed with all 3 study devices in a sequence determined by randomization. Intubation was performed with the third device used. Group allocation was as per intubating device. **GlideScope** • Randomized = 32; losses = 1 (problems with facemask); analysed = 31 • Large blade **Storz C-MAC D-BLADE** • Randomized = 32; losses = 0; analysed = 32 **Macintosh** • Randomized = 32; losses = 0; analysed = 32 • #3 blade for male and female participants, #4 blade only for tall individuals **VL classification:** hyperangulated (GlideScope, Storz C-MAC D-BLADE) Notes: randomized repeated laryngoscopy was performed with Macintosh, GlideScope and C-MAC D-BLADE. Intubation performed with final device
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as > 3 unsuccessful intubation attempts • Successful first attempt • Number of attempts: 1-3 • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from touching tracheal tube to inflating cuff Notes: outcomes for the GlideScope and C-MAC D-BLADE groups were combined as both are considered hyperangulated devices for the purposes of our review. It was not possible to reliably determine the respective CL grades from the plot provided without tabular data, therefore data for this outcome not extracted for meta-analysis
Notes	**Funding/sponsor/declarations of interest:** Volker Doerges (study author) reported his membership in the Karl Storz advisory board and involvement in the development of C-MAC. Manufacturers supplied the scopes. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomized sequence" No additional details
Allocation concealment (selection bias)	Low risk	"sealed envelope"

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Serocki 2013 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant excluded from GlideScope group owing to problems with face-mask. No other exclusions
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"The investigation was carried out by three board certified anaesthetists familiar with all laryngoscopes (≥ 50 intubations each)"

Shah 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: age 18–80 years, ASA I–II, suffering from malignancy and requiring a DLT for elective thoracic surgery **Exclusion criteria**: risk of regurgitation and pulmonary aspiration, patients with tracheobronchial masses or compression, patients with < 70% predicted forced expiratory volume in 1 s, < 80% predicted forced vital capacity, a PaO_2 < 9.3 kPa while breathing air and mouth opening < 1.5 cm **Baseline characteristics** **Macintosh** • Age, mean (SD): 52.13 (± 12.69) years • Gender M/F, n: 20/10 • Weight, mean (SD): 71.73 (± 14.30) kg • Height, mean (SD): 166.86 (± 7.86) cm • ASA I/II/III/IV, n: 16/14 **C-MAC D-BLADE** • Age, mean (SD): 54.57 (± 11.06) years • Gender M/F, n: 22/8 • Weight, mean (SD): 67.90 (± 7.44) kg • Height, mean (SD): 167.60 (± 7.18) cm • ASA I/II/III/IV, n: 14/16

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Shah 2016 *(Continued)*

	Notes: broadly balanced baseline characteristics. Study population was undergoing intubation with a DLT for thoracic surgery.
Interventions	**General details**: all intubations performed by 1 of 2 experienced anaesthetists. A stylet was used for DLT insertion with all intubations. A left-sided DLT was used for all intubations. **Macintosh** • Randomized = 30; losses = 1 (failed intubation); analysed = 29 **C-MAC D-BLADE** • Randomized = 30; no losses; analysed = 30 • A stylet was used, the "distal 10 cm concavity of the DLT with the stylet in situ was moulded along the D-BLADE convexity" **VL classification:** hyperangulated Notes: for women, a 35 Fr or 37 Fr DLT was used. For men a 37 Fr or 39 Fr DLT was used.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: the study reports that a single participant from the Macintosh group was excluded from primary outcome (TTI) analysis due to failed intubation. The participant was successfully intubated with the alternate device (the C-MAC D-BLADE), which we have included in our analysis an instance of failed intubation. • Hypoxia: defined as SpO_2 < 90% • Successful first attempt • Airway trauma: blade was inspected for blood stains and the buccal cavity, pharynx and larynx examined for any signs of trauma. Dental injury not reported, we therefore did not extract this outcome. • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as from the time the laryngoscope passed between the participant's lips until 3 complete cycles of end-tidal CO_2 were displayed on capnography monitoring • POGO score: 0%-100% as mean (± SD) Notes: the study examined confirmation of correct DLT positioning as a separate outcome from TTI. This, along with reported haemodynamic outcomes were not included in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no financial support or conflicts of interest. **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sequentially numbered, sealed opaque envelopes

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Shah 2016 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible. Participants blinded to group allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of intubators not possible. Participants blinded to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Unclear risk	Prospective trials registry protocol not available. It is not feasible to assess risk of reporting bias without these documents.
Experience of intubator	Unclear risk	2 experienced anaesthetists used. Relative experience with C-MAC D blade not evident

Shimazaki 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Japan **Setting:** theatre; single centre **Inclusion criteria:** ASA I and II, adult patients, scheduled to undergo GA with orotracheal intubation **Exclusion criteria**: inability to cooperate, inability to communicate, already intubated patients, patients predicted to be at risk of difficult mask ventilation and intubation **Baseline characteristics** **McGrath with rigid stylet and standard endotracheal tube** • Age, median (range): 51 (21-71) years • Gender M/F, n: 2/18 • BMI, median (range): 21.8 (16.8-26.1) kg/m^2 • ASA I/II/III/IV, n: 14/6/0/0 **Macintosh laryngoscope with standard endotracheal tube** • Age, median (range): 52 (26-76) years • Gender M/F, n: 6/14 • BMI, median (range): 21.8 (17.9-35.2) kg/m^2 • ASA I/II/III/IV, n: 10/10/0/0 Notes: a third group of participants were intubated with the McGrath laryngoscope and an Endotrol endotracheal tube. We did not include this group in our analyses.

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Shimazaki 2018 *(Continued)*

	CL score was recorded in baseline demographics, as all participants underwent direct laryngoscopy prior to their allocated intervention. Neck circumference and temporomandibular disorders were also reported and were similar between groups.
Interventions	**General details**: the anaesthetist had > 5 years' experience, and had experience using the Endotrol tracheal tube. No information was provided about relative experience with the laryngoscopes. Blade sizes used were not specified. **McGrath with rigid stylet and standard endotracheal tube** • Randomized = 20; no losses; analysed = 20 **Macintosh laryngoscope with standard endotracheal tube** • Randomized = 20; no losses; analysed = 20 **VL classification:** Macintosh-style Notes: use of the Macintosh-style blade was assumed.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as > 3 attempts at intubation • Successful first attempt • Number of attempts: 1-3 • Patient-reported sore throat: 1 h postoperatively Notes: we did not extract outcomes from the McGrath + Endotrol tracheal tube group due to difference in tracheal tube potentially having impact on outcomes when comparing Macintosh and McGrath laryngoscopes. Data for time to intubation could not be extracted for use in our analysis because it was reported as median (range), and not mean (SD). The reported CL score reflected the initial view on direct laryngoscopy before intubation with the allocated device and we did therefore not include it in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors do not declare any conflicts of interest or sources of funding. **Study dates:** December 2015–November 2016

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No detail
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias)	High risk	Blinding not possible. Some outcomes (such as TTI) were recorded by a separate anaesthetist.

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Shimazaki 2018 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (UMIN000020079). Registered prospectively and all prespecified outcomes reported
Experience of intubator	Unclear risk	Single intubator, > 5 years' experience in anaesthesiology. Relative experience with Macintosh and McGrath devices not specified.

Shippey 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 50 **Country:** UK **Setting**: theatre; single centre **Inclusion criteria:** no details **Exclusion criteria:** no details **Baseline characteristics** **McGrath** • Age, mean (SD): 55.5 (± 17.0) years • Gender M/F, n: 18/7 • BMI, mean (SD): 27 (± 4.2) kg/m^2 **Macintosh** • Age, mean (SD): 52.7 (± 14.3) years • Gender M/F, n: 15/10 • BMI, mean (SD): 29.2 (± 4.9) kg/m^2
Interventions	**General details**: no details on intubator experience provided. C-spine immobilization maintained with rigid cervical collar in all participants. **McGrath** • Randomized = 25, losses = 1; analysed = 24 **Macintosh** • Randomized = 25, losses = 0; analysed = 25 **VL classification:** Macintosh-style Notes: type of McGrath device not specified in abstract. Assumed Macintosh-style blade
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes**

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Shippey 2013 *(Continued)*

- Failed intubation: not explicitly defined
- Successful first attempt
- Number of attempts: 1-3

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of laryngoscope to first appearance of CO_2 on capnograph trace

Notes	**Funding/sponsor/declarations of interest**: none evident **Study dates**: not reported **Additional**: abstract only

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"single-blinded, randomized controlled trial" No details
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	One participant excluded from McGrath group after randomization due to surgery cancellation. Losses minimal and accounted for
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	No details

Shukla 2017

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 80 **Country:** India **Setting:** theatre; single centre

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Shukla 2017 *(Continued)*

	Inclusion criteria: patients of ASA Grade I and II, age > 18 years of either sex; possession of at least 2 of the following difficult intubation criteria: thyromental distance < 6 cm, Mallampati classification 3 or 4, interincisor distance < 4 cm, previously documented difficult intubation **Exclusion criteria**: history of relevant drug allergy, patient refusal **Baseline characteristics** **Airtraq** • Age, mean (SD): 35.9 (± 11.97) years • Gender M/F, n: 14/26 • Weight, mean (SD): 65.17 (± 12.01) kg • Height, mean (SD): 162.65 (± 5.18) cm **Macintosh** • Age, mean (SD): 38.75 (± 13.19) years • Gender M/F, n: 16/24 • Weight, mean (SD): 61.22 (± 9.85) kg • Height, mean (SD): 162.25 (± 4.2) cm
Interventions	**General details**: all intubating anaesthetists were reportedly experienced in the use of both devices. The number of intubators was not specified. The use of optimization manoeuvres including external laryngeal manipulation was permitted. **Airtraq** • Randomized = 40; losses = 0; analysed = 40 **Macintosh** • Randomized = 40; losses = 0; analysed = 40 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as an attempt in which the trachea is not intubated or where tracheal intubation attempts terminate after 120 s. Following failed intubation with the allocated device, the alternate device was used as a rescue device • Hypoxia: SpO_2 < 90% during intubation attempt • Successful first attempt • Number of attempts: 1-3 • Airway trauma: visible trauma to lip or oral mucosa or blood on laryngoscope or dental trauma **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from insertion of the blade between the teeth until the tracheal tube is placed through the vocal cords as evidenced by visual confirmation Notes: the use of optimization manoeuvres to aid tracheal intubation was recorded as an outcome but was not included for extraction in our analysis. Dental trauma not reported explicitly, we did therefore not extract data for this outcome
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** February 2015–August 2016

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Shukla 2017 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomization
Allocation concealment (selection bias)	Unclear risk	Allocation concealment not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of outcome assessment not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Anaesthesiologists were reportedly experienced in the use of both devices. Relative experience with the study devices was not further quantified.

Siddiqui 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** ASA I or II, normotensive patients, aged 18-65 years, scheduled for elective surgery requiring tracheal intubation **Exclusion criteria:** receiving medications known to affect BP or HR, Mallampati classification 3 or 4, anticipated difficult airway **Baseline characteristics** **GlideScope** • Age, mean (SD): 38.9 (± 10.9) years • Gender M/F, n: 17/3 • BMI, mean (SD): 26.6 (± 4.1) kg/m^2 **Macintosh**

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Siddiqui 2009 *(Continued)*

- Age, mean (SD): 43.7 (± 16.1) years
- Gender M/F, n: 9/11
- BMI, mean (SD): 25.0 (± 3.8) kg/m^2

Interventions	**General details**: all intubations were performed by a single anaesthetist who had performed > 50 intubations with each device and was well experienced in all 3 techniques of tracheal intubation **GlideScope** • Randomized = 20; losses = 0; analysed = 20 • Stylet used to stiffen tracheal tube to conform with the angle of the blade **Macintosh** • Randomized = 20; losses = 0; analysed = 20 • #3 blade used **VL classification:** hyperangulated Notes: a third intervention arm (Trachlight) was included in this study. We have not included this in the meta-analysis because it is an intubating stylet, not a VL and is therefore not an intervention of interest to our review.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Number of attempts: reported as mean (SD) therefore not able to extract data • Patient-reported sore throat: graded as none (no sore throat), moderate (similar to that noted with a cold) and severe (more severe than a cold). Reported separately for recovery area, postoperative day 1, postoperative day 2. We extracted data from recovery area **Continuous outcomes** • Time for tracheal intubation: defined as time from insertion of intubating device into the oral cavity to inflation of the tracheal tube cuff Notes: the main outcomes studied were haemodynamic responses associated with laryngoscopy; these are not of interest to this review.
Notes	**Funding/sponsor/declarations of interest**: study authors received no funding, and declare no conflicts of interest. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"a computerized random-number generator"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators

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Siddiqui 2009 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"All 60 patients were successfully intubated" No losses reported in CONSORT diagram
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"Intubations were performed by a single anaesthetist, who had performed more than 50 intubations with each device and is well experienced in all three techniques of tracheal intubations"

Silverberg 2015

Study characteristics	
Methods	Quasi-RCT; parallel design
Participants	**Total number of participants:** 117 **Country:** USA **Setting:** ICU; single centre **Inclusion criteria**: all patients who required urgent or emergent intubation in which the critical care fellow was team leader either in the medical ICU or on the wards as part of the rapid response or code teams **Exclusion criteria**: elective intubation for a procedure; a known history of difficult intubation; presence of limited mouth opening, oropharyngeal masses, or swollen tongue, suggesting the inability to use a DL or GlideScope; oxygen saturation < 92% after bag valve mask ventilation **Baseline characteristics** **GlideScope** • Age, mean: 65.4 years • Gender M/F, n: 27/30 • Weight, mean: 66 kg • BMI, mean: 23 kg/m^2 **Direct laryngoscopy** • Age, mean: 69.6 years • Gender M/F, n: 34/23 • Weight, mean: 68 kg • BMI, mean: 25 kg/m^2 Notes: the study population were participants undergoing urgent intubation on the medical ICU or medical wards by a critical care fellow. Cardiac arrest patients were included in the study. Other baseline characteristics including APACHE II score, and incidence of various co-morbidities were broadly balanced between groups. The randomization strategy described reflects a quasi-randomized 'even/

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Silverberg 2015 *(Continued)*

	odd' design in which the first participant intubated by a fellow used the DL, for the next participant the GlideScope was used and this alternating pattern continued subsequently.
Interventions	**General details**: intubators were all critical care fellows in the institution, ranging from postgraduate year 4-8 and attended medical emergencies on the wards or the medical ICU. There were 8 intubators in total. First-year fellows performed 71% of the intubations. They all received standardized training with the intubating devices although their clinical experience with each was not specified. **Direct laryngoscopy** • Randomized = 60; no losses; analysed = 60 • Macintosh size 3 and 4 and Miller size 4 blades were available **GlideScope** • Randomized = 57; no losses; analysed = 57 • #3 and #4 blade • A rigid stylet was used **VL classification:** hyperangulated Notes: the relative frequency with which the Macintosh blade was used vs the Miller blade was not specified in the publication. We contacted the study authors who reported that all DL intubations during the study period had used the Macintosh blade.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: the study authors did not include a definition for failed intubation. However, in the study methods they specify that "when the operator was unsuccessful despite 2 attempts with any laryngoscope, they were required to switch devices or operators". We have included data for patients requiring > 2 attempts for intubation as 'failed' for the purpose of our analysis. • Hypoxia: < 80% • Successful first attempt • Number of attempts: 1, 2, > 2 • Airway trauma: dental injury • Oesophageal intubation Notes: other reported outcomes including oesophageal intubation, aspiration and hypotension were not relevant to our analysis. The CL data could not be extracted for inclusion because CL grades 1 and 2 were not reported separately. Time to intubation data could not be extracted because a SD was not provided.
Notes	**Funding/sponsor/declarations of interest**: the study authors report no conflicts of interest or sources of funding. **Study dates:** August 2012–April 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"Even/odd" randomization strategy - alternating between DL and VL for any given critical care fellow
Allocation concealment (selection bias)	High risk	Allocation concealment not possible with randomization strategy

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Silverberg 2015 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT01683526). All outcomes reported, registered prospectively
Experience of intubator	Unclear risk	Intubators (critical care fellows, most in their first year) are likely relatively inexperienced with both devices. Relative experience with either device was not quantified

Sulser 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 147 **Country:** Switzerland **Setting:** ED; single centre **Inclusion criteria**: aged 18-99 years undergoing emergency RSI **Exclusion criteria:** patients suffering from major maxillofacial trauma, patients with an immobilized C-spine, patients with an indication for awake fibreoptic-guided intubation and patients with ongoing cardiopulmonary resuscitation were not included **Baseline characteristics** **C-MAC** • Age, mean (SD): 53 (± 21) years • Gender M/F, n: 68/6 • Weight, mean (SD): 75 (± 19) kg • Height, mean (SD): 172 (± 13) cm • BMI, mean (SD): X (± X) kg/m^2 • ASA I/II/III/IV: 20/38/31/11 **Macintosh** • Age, mean (SD): 54 (± 17) years • Gender M/F, n: 55/18 • Weight, mean (SD): 76 (± 18) kg • Height, mean (SD): 171 (± 9) cm • BMI, mean (SD): X (± X) kg/m^2 • ASA I/II/III/IV: 23/37/33/7

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Sulser 2016 *(Continued)*

	Notes: study population were patients undergoing emergency intubation in the ED setting using RSI.
Interventions	**General details**: intubation was performed by 1 of 3 experienced anaesthesia consultants. A stylet was used with all intubations. RSI was employed for all intubations. **C-MAC** • Randomized = 75; losses = 1 (participant requested to be withdrawn); analysed = 74 **Macintosh** • Randomized = 75; losses = 2 (1 participant requested to be withdrawn and documentation of 1 participant was incomplete); analysed = 73 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors:** **Dichotomous outcomes** • Successful first attempt • Number of attempts • Airway trauma: dental trauma • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as time between insertion of the blade into the mouth until detection of $ETCO_2$ Notes: overall success rate was not reported
Notes	**Funding/sponsor/declarations of interest**: departmental and university funding. The study authors declare no conflicts of interest. **Study dates:** November 2015–December2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Opaque envelopes that were opened immediately before intubation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	Minimal missing data

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Sulser 2016 *(Continued)*

Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT02297113). Stated primary outcome was success rate, which was not directly reported in the trial, but first pass success was reported with only 1 intubation attempt requiring > 1 attempt. Registered prospectively
Experience of intubator	Unclear risk	3 experienced emergency physicians, all experienced intubators. Relative experience with each device was not specified.

Sun 2005

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 200 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** presenting for surgery requiring tracheal intubation **Exclusion criteria:** raised ICP, known airway pathology or C-spine injury, requiring RSI **Baseline characteristics** **GlideScope** • Age, mean (range): 52 (20-87) years • Gender M/F, n: 32/68 • Weight, mean (SD): 75 (± 21) kg • Height, mean (SD): 1.66 (± 0.12) m • ASA I/II/III & IV, n: 27/44/24 • Mallampati 1/2/3/4, n: 52/36/11/1 **Macintosh** • Age, mean (range): 54 (20-87) years • Gender M/F, n: 38/62 • Weight, mean (SD): 73 (± 17) kg • Height, mean (SD): 1.65 (± 0.12) m • ASA I/II/III & IV, n: 26/45/21 • Mallampati 1/2/3/4, n: 50/41/9/0
Interventions	**General details**: intubations were performed by 5 different anaesthetists, all of whom were experienced in anaesthesia (> 10 years' experience) and use of the GlideScope (20 intubations) before the study. **GlideScope** • Randomized = 100; losses = 0; analysed = 100 (4 participants excluded from analysis of time for tracheal intubation due to multiple attempts) **Macintosh** • Randomized = 100; losses = 0; analysed = 100 (1 participant excluded from analysis of time for tracheal intubation due to multiple attempts) • #3 blade

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Sun 2005 *(Continued)*

VL classification: hyperangulated

Notes: after approximately 3 min, all participants underwent an initial direct laryngoscopy, which was scored according to the CL grading system with the Macintosh laryngoscope and a size 3 blade. This was performed by a separate anaesthetist, who was neither one of the intubators nor involved with the participant's overall care. Then participants were allocated to randomized groups for intubation with given scope.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as failure after 3 attempts, then change to another blade
- Successful first attempt
- Number of attempts: 1 and > 1
- Airway trauma: dental trauma data only extracted
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of device until $ETCO_2$ was detected Reported as mean (95% CI), which we converted to mean (SD) as per the guidance in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2021).

Notes

Funding/sponsor/declarations of interest: study authors received no funding, and declare no conflicts of interest.

Study dates: July 2003–March 2004

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"patients were allocated by computer-generated randomization in blocks of six"
Allocation concealment (selection bias)	Unclear risk	No details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Five patients from the pilot study were excluded from the final TTI (*time to intubate)* analysis. Four of these patients required multiple attempts at intubation, and the recorded TTI included interim bag-and-mask time and did not reflect true intubation time; 1 of these patients was in the DL group (*Macintosh)* (C&L grade 2) and 3 were in the GS group (GlideScope*)* (one each of C&L grade 1, 2, and 3)" Only small number of exclusions; unlikely to affect results and full explanations given

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Sun 2005 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"The intubations were performed by five different anaesthetists, all of whom were experienced in anaesthesia (> 10 yr experience) and the use of the GlideScope (> 20 intubations) prior to the study"

Suzuki 2008

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 50 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria:** scheduled for elective anaesthesia **Exclusion criteria:** no details given. Abstract only **Baseline characteristics:** no details given in abstract. Study authors state: "Patient profiles such as height and body weight were similar in both groups."
Interventions	**General details**: intubators had experience of at least 100 intubations with the Macintosh and 50 intubations with the Pentax AWS (response to email request). "50 patients without hypertension scheduled for elective anesthesia were randomly assigned to group AWS or group McL". The number of patients assigned to each group was not specified. **Pentax AWS** **Macintosh** **VL classification:** channelled Notes: denominator figures not given by group
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt: "All intubations were successful at the first attempt"; however, numbers of participants per group not provided **Continuous outcomes** • Time for tracheal intubation: time for tracheal intubation: no definition given. AWS 19 s (SD ± 9); Macintosh 18 s (SD ± 8) Notes: the main outcomes studied were haemodynamic responses to laryngoscopy; these are not of interest to our review.
Notes	**Funding/sponsor/declarations of interest**: departmental funding only (response to email request) **Study dates**: not reported

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Suzuki 2008 *(Continued)*

Additional: abstract only. We did not complete risk of bias assessments because this study reported no relevant review outcomes.

Takenaka 2011

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 69 **Country:** Japan **Setting**: theatre; single centre **Inclusion criteria:** ASA I-III, scheduled for elective non-obstetrical surgery in the lateral position requiring GA with tracheal intubation **Exclusion criteria:** BMI > 30 kg/m^2, C-spine abnormality, pharyngolaryngeal disorder, anticipated difficult airway, increased risk of aspiration **Baseline characteristics** **Pentax AWS** • Age, mean (range): 68.3 (30-83) years • Gender M/F, n: 12/23 • Weight, mean (SD): 55.9 (± 12.1) kg • Height, mean (SD): 1.56 (± 0.09) m **Macintosh** • Age, mean (range): 67.6 (32-88) years • Gender M/F, n: 8/26 • Weight, mean (SD): 55.0 (± 12.8) kg • Height, mean (SD): 1.54 (± 0.09) m Notes: all participants were placed in the lateral position.
Interventions	**General details**: 2 anaesthetists with prior experience of > 5000 intubations with the Macintosh laryngoscope and > 300 intubations with the Pentax AWS in the supine position. However, as they had few experiences in the lateral position, they practised tracheal intubation in this position with a manikin. External laryngeal manipulation and adjustment of participant's head and neck position were performed as necessary. All participants placed in lateral position prior to intubation **Pentax AWS 1** • Randomized = 35; losses = 0; analysed = 35 **Macintosh** • Randomized = 35; losses = 1 (cancellation of surgery); analysed = 34 • Stylet used for intubation **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes**

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Takenaka 2011 *(Continued)*

- Failed intubation: defined as failure to intubate within 60 s. Required intubation with alternative device or change to lateral position
- Successful first attempt
- Number of attempts: 1
- CL grade: 1-3

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of blade between the teeth until tracheal tube cuff was passed through vocal cords. Data provided as median (IQR) and could not be extracted because a normal data distribution could not be assumed.
- IDS: intubation difficulty score given as median (IQR) and therefore could not be extracted for inclusion

Notes	**Funding/sponsor/declarations of interest**: departmental funding only. No conflicts declared **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"patients were randomly assigned into two groups using a sealed envelope technique" Insufficient detail
Allocation concealment (selection bias)	Low risk	"sealed envelope technique"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 1 loss after randomization due to cancellation of surgery
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	2 anaesthetists experienced with both laryngoscopes, (> 5000 Macintosh intubations and > 300 Pentax AWS intubations each). Intubators had practised intubation in the lateral position with a manikin.

Taylor 2013

Study characteristics

Methods	RCT; cross-over design
Participants	**Total number of participants:** 88

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Taylor 2013 *(Continued)*

Country: Canada

Setting: theatre; single centre

Inclusion criteria: ASA I or II, scheduled for elective surgery under GA requiring tracheal intubation

Exclusion criteria: required RSI, history of previous difficult direct laryngoscopy and required awake tracheal intubation, unable or unwilling to provide informed consent, uncontrolled hypertension, history of ischaemic heart disease without optimal control of symptoms, history of acute or recent stroke or myocardial infarction, C-spine instability or cervical myelopathy, symptomatic asthma or reactive airway disease requiring daily pharmacological treatment for control of symptoms, history of gastric reflux

Baseline characteristics

McGrath Series 5

- Age, mean (SD): 52 (± 13) years
- Gender M/F, n: 18/26
- BMI, mean (SD): 29.3 (± 6.5) kg/m^2
- ASA I/II/III/IV, n: 22/22/0/0
- Mallampati 1/2/3/4, n: 14/22/7/1

Macintosh

- Age, mean (SD): 54 (± 16) years
- Gender M/F, n: 20/24
- BMI, mean (SD): 28.2 (± 6.2) kg/m^2
- ASA I/II/III/IV, n: 13/31/0/0
- Mallampati 1/2/3/4, n: 24/17/2/1

Interventions

General details: each of the consultant anaesthetists involved in the study had previously practiced with the McGrath using a manikin until subjectively comfortable with the device. Stylet used for all participants.

MILS used to simulate difficult airway for all participants.

In the cross-over design of the study, participants underwent an initial laryngoscopy with 1 device (with CL and POGO scoring completed) before undergoing subsequent laryngoscopy and intubation with the other device.

McGrath Series 5 (Macintosh followed by McGrath)

- Randomized = 44; losses = 0; analysed = 44
- #3 blade

Macintosh (McGrath followed by Macintosh)

- Randomized = 44; losses = 0; analysed = 44
- #3 blade

VL classification: hyperangulated

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: considered failed if tracheal tube could not be placed owing to difficulty viewing the glottis, attempt > 60 s, unsafe attempt or considered futile or oxygen desaturation. Alternate device used for subsequent attempt
- Successful first attempt
- Airway trauma: we only extracted dental trauma data

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Taylor 2013 *(Continued)*

- Patient-reported sore throat
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of the laryngoscope into the oral cavity until its removal
- POGO score: 0%-100%

Notes	**Funding/sponsor/declarations of interest**: departmental funding. McGrath scopes supplied by Vitaid Canada. 1 investigator is a consultant for a McGrath distributor. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details
Allocation concealment (selection bias)	Low risk	"A sealed envelope was opened, revealing to which of two study groups the patient had been randomly assigned"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No apparent losses
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	"Each of the consultant anaesthetists involved in the study had previously practised with the McGrath videolaryngoscope using a manikin until subjectively comfortable with the device" Assumed therefore that experience was greater in Macintosh group

Tempe 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting:** theatre; single centre

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Tempe 2016 *(Continued)*

Inclusion criteria: patients aged 40–70 years of either sex undergoing elective CABG

Exclusion criteria: patients with renal, hepatic or neurological diseases; history of bleeding diathesis, Mallampati score of 3–4, anticipated difficult intubation or history of difficult intubation, limited nuchal range of motion, gastroesophageal reflux disease, delayed gastric emptying, serious respiratory disease, kyphoscoliosis, left ventricular ejection fraction < 35%, ASA grade IV

Baseline characteristics

Truview PCD

- Age, mean (SD): 52.5 (± 7.6) years
- Gender M/F, n: 19/0
- Weight, mean (SD): 63.0 (± 10.2) kg
- Height, mean (SD): 166.7 (± 9.1) cm
- BMI, mean (SD): 22.3 (± 4.1) kg/m^2
- Mallampati 1/2/3/4: 4/15/0/0

McGrath Series 5

- Age, mean (SD): 54.9 (± 9.7) years
- Gender M/F, n: 16/4
- Weight, mean (SD): 64.7 (± 9.3) kg
- Height, mean (SD): 167.5 (± 7.1) cm
- BMI, mean (SD): 23.1 (± 3.5) kg/m^2
- Mallampati 1/2/3/4: 5/15/0/0

Macintosh

- Age, mean (SD): 51.1 (± 8.6) years
- Gender M/F, n: 16/3
- Weight, mean (SD): 62.7 (± 10.7) kg
- Height, mean (SD): 168.2 (± 4.2) cm
- BMI, mean (SD): 22.6 (± 2.7) kg/m^2
- Mallampati 1/2/3/4: 3/16/0/0

Interventions

General details: intubators were experienced anaesthetists with a minimum experience of 20 intubations with a VL prior to the study.

Truview PCD

- Randomized = 20; losses = 1 (> 3 attempts); analysed = 20

McGrath Series 5

- Randomized = 20; no losses; analysed = 19

Macintosh

- Randomized = 20; losses = 1 (> 3 attempts); analysed = 19
- #3 and #4 blades

VL classification: hyperangulated (McGrath Series 5, Truview PCD)

Notes: the denominator used for failed intubation and number of attempts was 20 in all groups.

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as unsuccessful intubation following 3 attempts

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Tempe 2016 *(Continued)*

- Hypoxia: SpO_2 < 95%
- Number of attempts: 1-3
- Airway trauma: injury to lips, teeth and oropharyngeal structures; we extracted data for dental injury only
- Patient-reported sore throat
- CL grade: 1-3

Continuous outcomes

- Time for tracheal intubation: defined as the time interval between oral placement of the ET to the attainment of tracing of 3 $ETCO_2$ waveforms
- POGO score: reported as median (IQR (range)) and therefore could not be extracted

Notes: 1 participant from both the Macintosh group and Truview groups were excluded from the study due to failed intubation after 3 attempts. We have included these participants as failed intubations in our analysis. Reported haemodynamic outcomes including changes in BP and HR are not outcomes of interest to our analysis and we did not extract them.

Notes	**Funding/sponsor/declarations of interest**: institutional support. Study authors declare no conflicts of interest. **Study dates:** October 2012-August 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sequentially numbered, sealed, opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding to main outcomes not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	Minimal impact for outcomes of interest
Selective reporting (reporting bias)	Low risk	Published protocol at Indian Clinical Trials Registry (CTRI/2013/04/003554). Primary outcome and majority of secondary outcomes reported
Experience of intubator	Low risk	Intubators had a minimum experience of 20 intubations with a VL.

Teoh 2010

Study characteristics

Methods	RCT; parallel design

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Teoh 2010 *(Continued)*

Participants	**Total number of participants:** 400 **Country:** Singapore **Setting**: theatre; single centre **Inclusion criteria:** scheduled for elective gynaecological, orthopaedic, breast or aesthetic surgery in tertiary maternity and women's hospital, consented to GA and tracheal intubation **Exclusion criteria:** pregnant, ASA IV, aged < 21 or > 80 years, weight < 30 kg, BMI > 40 kg/m^2, limited mouth opening (< 2.5 cm), respiratory tract pathology, preoperative sore throat, high risk of regurgitation or aspiration, allergy to any study medication **Baseline characteristics** **GlideScope** • Age, mean (SD): 43.4 (± 11.2) years • Weight, mean (SD): 61.1 (± 11.8) kg • Height, mean (SD): 1.57 (± 0.07) m • BMI, mean (SD): 24.7 (± 4.6) kg/m^2 • Mallampati 1/2/3/4, n: 28/43/26/3 **Pentax AWS** • Age, mean (SD): 37.0 (± 10.5) years • Weight, mean (SD): 59.7 (± 13.9) kg • Height, mean (SD): 1.58 (± 0.06) m • BMI, mean (SD): 23.7 (± 5.2) kg/m^2 • Mallampati 1/2/3/4, n: 48/35/17/0 **C-MAC** • Age, mean (SD): 41.5 (± 12.3) years • Weight, mean (SD): 60.7 (± 14.1) kg • Height, mean (SD): 1.58 (± 0.06) m • BMI, mean (SD): 24.3 (± 5.6) kg/m^2 • Mallampati 1/2/3/4, n: 52/33/12/3 **Macintosh** • Age, mean (SD): 39.6 (± 9.9) years • Weight, mean (SD): 58.87 (± 12.7) kg • Height, mean (SD): 1.57 (± 0.06) m • BMI, mean (SD): 23.6 (± 4.2) kg/m^2 • Mallampati 1/2/3/4, n: 46/32/19/3
Interventions	**General details**: all intubations were performed by experienced anaesthetists who had performed > 30 intubations with each of the devices being tested. Use of a stylet or bougie was left to the preference of the intubator. **GlideScope** • Randomized = 100; losses = 0; analysed = 100 • tracheal tube preloaded with preconfigured rigid stylet **Pentax AWS** • Randomized = 100; losses = 0; analysed = 100 • If intubation not feasible after first or second attempt, C-MAC or Macintosh was used

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Teoh 2010 *(Continued)*

	C-MAC • Randomized = 100; losses = 0; analysed = 100 **Macintosh** • Randomized = 100; losses = 0; analysed = 100 **VL classification:** hyperangulated (GlideScope), Macintosh-style (Storz C-MAC), channelled (Pentax AWS)
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: required > 3 attempts, or exceeded 120 s • Hypoxia: defined as SpO_2 < 95% • Successful first attempt • Number of attempts: 1-3 • Airway trauma: mucosal bleeding, lip bleeding, dental trauma. We only extracted dental trauma data for inclusion • Patient-reported sore throat: postoperative sore throat recorded in recovery room • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as interval from insertion of the laryngoscope blade into the mouth to inflation of the tracheal tube cuff Notes: intubation difficulty reported on a VAS scale from 0: easy, to 100: difficult. Median (IQR (range)): AWS 0 (0-8.75 (0-60)); C-MAC 10 (0-20 (0-90)); GlideScope 0 (0-20 (0-80)); Macintosh 0 (0-20 (0-90)). Quality of view was subjectively assessed.
Notes	**Funding/sponsor/declarations of interest**: no external funding. No declarations on conflicts of interest **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"computer-generated random number table"
Allocation concealment (selection bias)	Low risk	"After recruitment, the enrolling investigator opened a sealed opaque envelope that concealed group allocation in the anaesthetic induction room"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Four hundred patients were successfully recruited and there were no dropouts"

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Teoh 2010 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All intubations were performed by experienced anaesthetists who had performed > 30 intubations with each of the devices being tested"

Thion 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 122 **Country:** France **Setting:** theatre; single centre **Inclusion criteria:** patients aged from 18-80 years undergoing elective surgery under GA requiring standard tracheal intubation **Exclusion criteria**: pregnant women, breastfeeding mothers, patients needing a RSI, patients with ENT surgery and with history of previous difficult intubation. In addition, features predictive of difficult intubation indicated by the presence of at least 2 of the following factors: diseases associated with difficulties in intubation or clinical symptoms of airway disease, snoring or obstructive sleep apnoea syndrome, short thick neck, limited mandibular protrusion, head and neck movement 808 or less, edentulous, thyromental distance < 65 mm, interincisor gap < 35 mm and Mallampati class > 2 **Baseline characteristics** **Macintosh** • Age, mean (SD): 53.5 (± 13.3) years **McGrath MAC** • Age, mean (SD): 59.1 (± 13.2) years Notes: age was the only baseline characteristic for which data were provided. Other unspecified baseline demographic data was reportedly similar.
Interventions	**General details**: the experience and number of intubators was not specified. The intubator was allowed the use of external laryngeal manipulation to optimize laryngeal view. The use of a stylet was permitted with either device. **Macintosh** • Randomized = 60; losses = 3 ("not completed"); analysed = 57 **McGrath MAC** • Randomized = 70; losses = 5 ("not completed"); analysed = 65 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes**

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Thion 2018 *(Continued)*

- Hypoxia: defined as incidence of SpO_2 < 92%
- Patient-reported sore throat
- CL grade: 1-4
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: reported as median (IQR), not defined

Notes: IDS and POGO score were reported, but not in a format that could be extracted for inclusion in the analysis. We did not extract time of tracheal intubation.

Notes	**Funding/sponsor/declarations of interest**: sponsored by the institution (Hospital Foch, France). The study authors make no declarations of conflicts of interest. **Study dates:** February 2015–October 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Centrally randomized"
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	Incomplete reporting of outcomes. Minimal baseline data available
Selective reporting (reporting bias)	High risk	Trial registry data examined (NCT02292901). Multiple outcomes not reported
Experience of intubator	Unclear risk	Not specified

Toker 2019

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 100 **Country:** Turkey **Setting:** theatre; single centre

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Toker 2019 *(Continued)*

Inclusion criteria: patients were aged 18-40 years and were scheduled for elective caesarean section under GA

Exclusion criteria: retrognathia; restricted neck movement; a Mallampati score of 4; emergency surgery; a history of airway-related surgery; renal, hepatic, neuromuscular, or cardiovascular illness; and ASA III or IV

Baseline characteristics

Macintosh

- Age, median (IQR): 27.5 (24–31) years
- Gender M/F, n: 0/50
- Weight, mean (SD): 81.1 (± 6.9) kg
- Height, mean (SD): 165.9 (± 6.1) cm
- BMI, mean (SD): 29.6 (± 2.2) kg/m^2

McGrath

- Age, mean (IQR): 26 (22–35) years
- Gender M/F, n: 0/50
- Weight, mean (SD): 80.3 (± 7.6) kg
- Height, mean (SD): 165.6 (± 5.8) m
- BMI, mean (SD): 29.3 (± 2.5) kg/m^2

Notes: obstetric population. All participants included were undergoing elective caesarian section.

Interventions

General details: intubation was carried out by 3 attending anaesthetists who had prior experience of at least 100 successful intubations using VLs. A stylet was used for all intubations.

Macintosh

- Randomized = 50; no losses; analysed = 50

McGrath

- Randomized = 50; no losses; analysed = 50

VL classification: Macintosh-style

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as from the point at which the laryngoscope blade was inserted into the mouth until detection of an $ETCO_2$ trace

Notes: POGO score was reported, but provided a median (IQR), therefore we did not extract this outcome. The study also reported changes in HR and BP which are not of relevance to our analysis.

Notes

Funding/sponsor/declarations of interest: the study authors report no conflicts of interest or sources of funding.

Study dates: June 2018–July 2018

Risk of bias

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Toker 2019 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	Minimal loss of data
Selective reporting (reporting bias)	Low risk	Trial registry data examined (ACTRN12618000902291); registered prospectively, all outcomes reported
Experience of intubator	Low risk	All intubators had > 100 intubations with VL device

Tolon 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 40 **Country:** Egypt **Setting:** theatre; single centre **Inclusion criteria:** adult ASA I and II patients undergoing GA with tracheal intubation **Exclusion criteria:** Mallampati 3 or 4, thyromental distance < 6 cm, risk of gastric aspiration and cervical injury or instability **Baseline characteristics** **Macintosh** • Age, mean (SD): 31.05 (± 6.34) years • Gender M/F, n: 11/9 • Weight, mean (SD): 80.12 (± 21.1) kg • ASA I/II/III/IV, n: 7/13/0/0 **Airtraq** • Age, mean (SD): 29.55 (± 6.72) years • Gender M/F, n: 8/12 • Weight, mean (SD): 83.51 (± 21.7) kg

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Tolon 2012 *(Continued)*

	• ASA I/II/III/IV, n: 5/15/0/0 Notes: study population had C-spine immobilization with MILS.
Interventions	**General details**: the number of intubators and their experience with each device was not specified. Optimization manoeuvres were permitted and their use recorded in outcomes. **Macintosh** • Randomized = 20; no losses; analysed = 20 **Airtraq** • Randomized = 20; no losses; analysed = 20 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: overall intubation success rate reported • Airway trauma: lip or tongue bruising; study authors report teeth clicking, which we included as dental trauma. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from insertion of the laryngoscope blade between the teeth until the endotracheal tube is passed through the vocal cords and confirmed by auscultation of the chest • IDS: 0, 1-5, > 5 Notes: we did not extract outcomes such as changes in HR and BP and C-spine mobility.
Notes	**Funding/sponsor/declarations of interest**: none reported **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No evidence of incomplete data

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Tolon 2012 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Experience of intubators not specified

Tosh 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 130 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: aged 18–60 years, ASA I or II, Mallampati score of 1 or 2, undergoing short elective laparoscopic surgeries lasting < 2 h **Exclusion criteria**: anticipated difficult intubation, requiring > 2 attempts at intubation or nasogastric tube insertion and those with upper respiratory tract infection **Baseline characteristics** **Macintosh** • Age, mean (SD): 39.4 (± 9.5) years • Gender M/F, n: 21/44 • Weight, mean (SD): 66.6 (± 6.0) kg • ASA I/II/III/IV, n: 29/36/0/0 • Mallampati 1/2/3/4, n: 36/29/0/0 **C-MAC D-BLADE** • Age, mean (SD): 44.0 (± 11.4) years • Gender M/F, n: 27/38 • Weight, mean (SD): 68.9 (± 11.4) kg • ASA I/II/III/IV, n: 40/25/0/0 • Mallampati 1/2/3/4, n: 41/24/0/0
Interventions	**General details**: 2 intubating anaesthetists, both with > 5 years' experience. The extent of experience with the C-MAC D-BLADE was not specified. The use of a bougie for intubation was permitted and recorded, although a stylet was reportedly used with all intubations. **Macintosh** • Randomized = 65; no losses; analysed = 65 **C-MAC D-BLADE** • Randomized = 65; no losses; analysed = 65 • Stylet used, tracheal tube angled at 60° **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors**

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Tosh 2018 *(Continued)*

	Dichotomous outcomes • Failed intubation: not explicitly reported by study authors, but all participants successfully intubated within 2 attempts • Successful first attempt • Number of attempts • Patient-reported sore throat: reported at 2 h, 6 h, 12 h and 24 h timepoints. We have extracted the data from the 6 h timepoint Notes: we did not include other reported outcomes, such as postoperative hoarseness of voice and postoperative cough in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and no sources of funding. **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No lost outcome data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	2 intubators with > 5years' experience, but degree of experience with C-MAC D blade not specified

Trimmel 2011

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 212 **Country:** Austria

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Trimmel 2011 *(Continued)*

Setting: pre-hospital; single centre

Inclusion criteria: emergency patients > 18 years of age requiring pre-hospital airway management

Exclusion criteria: exclusion criteria were not specified.

Baseline characteristics

Macintosh

- Age, mean (SD): 58 (± 19) years
- Gender M/F, n: 70/36
- BMI, mean (SD): 28 (± 5.7) kg/m^2

Airtraq

- Age, mean (SD): 63 (± 19) years
- Gender M/F, n: 71/35
- BMI, mean (SD): 29 (± 5) kg/m^2

Notes: pre-hospital intubation study population. The study included patients undergoing cardiopulmonary resuscitation (52 in the Macintosh group, 49 in the Airtraq group). Other baseline data were broadly balanced between the groups including incidence of GCS < 9, head trauma, multiple trauma, respiratory insufficiency

Interventions	**General details**: intubators were anaesthetists or emergency physicians with > 3 years of experience and > 80 intubations per year. Intubators underwent some manikin training with the Airtraq and between 2 and 5 clinical intubations with the Airtraq in theatre. **Macintosh** • Randomized = 106; no losses; analysed = 106 **Airtraq** • Randomized = 106; no losses; analysed = 106 **VL classification:** channelled Notes: optical viewfinder used with Airtraq, not video screen
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to intubate following 2 attempts at intubation. An attempt was discontinued when SpO_2 fell close to 90% or when oesophageal intubation was suspected, or in instances of tracheal tube cuff failure. • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the interval between opening of the patient's mouth until the tracheal tube was passed through the glottis Notes: there was a high rate of failed intubation with the Airtraq device in this study. The study authors included a separate table detailing reasons for failed intubation including several due to cuff damage, some due to impaired view by vomitus or blood, poor visibility and other technical problems. CL views were reported in the form of a chart that did not permit sufficient resolution for data extraction.
Notes	**Funding/sponsor/declarations of interest**: supported, in part, by Habel Medizintechnik, Vienna, Austria, providing 50% of the Airtraq devices for the study. The study authors have not disclosed any potential conflicts of interest.

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Trimmel 2011 *(Continued)*

Study dates: July 2008-December 2009

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Intubators were experienced with intubation, with > 3 years' experience and > 80 intubations per year. However, with the Airtraq they had only received manikin training and between 2 and 5 clinical intubations in theatre. Balance of experience likely to favour Macintosh.

Trimmel 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 326 **Country:** Austria **Setting**: pre-hospital; multi-centre **Inclusion criteria**: emergency patients > 18 years old requiring pre-hospital airway management **Exclusion criteria:** < 18 years of age **Baseline characteristics** **Macintosh** • Age, median (range): 64 (18-100) years • Gender M/F, n: 104/54 • BMI, median (range): 26.2 (18-51) kg/m^2

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Trimmel 2016 *(Continued)*

	GlideScope • Age, median (range): 68 (18-93) years • Gender M/F, n: 106/62 • BMI, median (range): 26.3 (17-55) kg/m^2 Notes: pre-hospital intubation study population. The study included patients undergoing cardiopulmonary resuscitation (102 in the Macintosh group, 104 in the GlideScope group). Other baseline data including incidence of impaired consciousness, brain trauma, multiple trauma and respiratory insufficiency was balanced between the groups.
Interventions	**General details**: intubators underwent a 2-h GlideScope training programme followed by manikin training. They further undertook an average of 5 supervised clinical intubations in the theatre environment. **Macintosh** • Randomized = 161; losses = 3 (excluded for protocol deviation; age); analysed = 158 **GlideScope** • Randomized = 170; losses = 2 (excluded for protocol deviation; age); analysed = 168 • A GlideScope Ranger was used for all GlideScope intubations. **VL classification:** hyperangulated Notes: all intubations were performed in the pre-hospital setting.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to intubate following 2 attempts at intubation. An attempt was discontinued when SpO_2 fell close to 90%. Following 2 failed intubation attempts with the randomized device the alternate device was used for a third attempt at intubation before the rescue device (Fastrach LMA) was employed. • Successful first attempt • Oesophageal intubation Notes: data for time to tracheal intubation could not be extracted for analysis because the provided values reflected median (range) values. A large number of failed intubations occurred in the GlideScope group. The reasons for problems in airway management were detailed in a separate table.
Notes	**Funding/sponsor/declarations of interest**: supported, in part, by Sanova Medical Systems, Vienna, Austria, providing the GlideScope Ranger and single-use blades for the study. Dr. Voelckel disclosed other support from Sanova Medical Systems, Vienna, Austria, providing the GlideScope Ranger and single-use blades for the study. The remaining study authors have disclosed that they do not have any potential conflicts of interest. **Study dates:** April 2011-September 2012

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sealed envelopes

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Trimmel 2016 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Intubators were all experienced pre-hospital physicians. However, experience with GlideScope was limited to manikin training sessions and an average of 5 supervised intubations in theatre. Balance of experience likely to favour Macintosh

Tsan 2020

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 138 **Country:** Malaysia **Setting:** theatre; single centre **Inclusion criteria:** ASA I-III patients, 18-75 years of age undergoing elective tracheal intubation **Exclusion criteria**: ischaemic heart disease, cerebrovascular disease, respiratory disease, BMI > 35 kg/m^2, patients who required RSI or had airway obstruction, small mouth opening, or contraindication to neck extension **Baseline characteristics** **Macintosh** • Age, mean (SD): 48.67 (± 14.87) years • Gender M/F, n: 26/43 • BMI, mean (SD): 26.24 (± 5.02) kg/m^2 • ASA I/II/III/IV: 28/36/5 • Mallampati 1/2/3/4: 23/41/5 **GlideScope** • Age, mean (SD): 49.09 (± 14.96) years • Gender M/F, n: 25/44 • BMI, mean (SD): 25.67 (± 4.60) kg/m^2 • ASA I/II/III/IV: 29/38/2 • Mallampati 1/2/3/4: 25/36/8

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Tsan 2020 *(Continued)*

	Notes: participants in the Macintosh group were intubated in the bed up head elevated (BUHE) position. Participants in the GlideScope group were intubated in the supine position.
Interventions	**General details**: single experienced intubator with > 50 previous intubations with a GlideScope. Use of external laryngeal manipulation and airway adjuncts was permitted. **Macintosh** • Randomized = 69; no losses; analysed = 69 • #3 or #4 blade • BUHE position **GlideScope** • Randomized = 69; no losses; analysed = 69 • LoPro T3 blade • Supine position **VL classification:** hyperangulated Notes: the BUHE position was created by "elevating the head of the bed up to 20° to 30°, with end point being horizontal alignment between the patient's external acoustic meatus and sternal angle".
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as failure to intubate following 3 attempts • Hypoxia: SpO_2 < 92% • Successful first attempt • Number of attempts • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as from the moment the tip of the laryngoscope blade passes through the incisors to the first detected $ETCO_2$ trace • POGO score: 0%-100%
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest. This study was funded by the Malaysian Society of Anaesthesiologists K. Inbasegaran fund. **Study dates:** December 2017-September 2018

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated sequences in blocks of 6
Allocation concealment (selection bias)	Low risk	Sealed numbered envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible

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Tsan 2020 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No significant loss of data evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT03357679). Main outcomes all reported. 1 secondary outcome (trauma) was not reported in the study.
Experience of intubator	Low risk	Single experienced intubator with > 50 intubations with GlideScope

Turkstra 2005

Study characteristics	
Methods	RCT; cross-over design
Participants	**Total number of participants:** 18 **Country:** Canada **Setting**: theatre; single centre **Inclusion criteria:** ASA physical status I-III, age 18-75 years, elective non-cardiac surgery requiring GA with tracheal intubation **Exclusion criteria:** gastro-oesophageal reflux disease, BMI > 35 kg/m^2, possibility of pregnancy, previous neck surgery, unstable C-spine, difficult airway **Baseline characteristics** **GlideScope and Macintosh** • Age, mean (SD): 40 (± 13) years • Gender M/F, n: 5/13 • Weight, mean (SD): 70 (± 14) kg • Height, mean (SD): 1.67 (± 0.08) m • ASA I/II/III/IV, n: 3/12/3/0 • Mallampati 1/2/3/4, n: 8/8/1/1
Interventions	**General details**: all laryngoscopies were performed by 1 person to minimize interoperator variability. Before this study, said intubator had performed > 50 intubations with the GlideScope and > 500 intubations with the Macintosh laryngoscope. In the cross-over design of the study participants "underwent laryngoscopy using the 2 assigned techniques; intubation was completed as part of the second laryngoscopy". The study authors included a statement, "near the end of the study, the radiology department suffered simultaneous failure of the main and back-up servers, and data for 11 patients were lost. As a result, an additional 7 patients were recruited before analysis". The groups to which these participants were assigned was not specified. **GlideScope and Macintosh** • Analysed = 18 • Sequence was randomized

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Turkstra 2005 *(Continued)*

	• #3 Macintosh blade used **VL classification:** hyperangulated Notes: a second arm with 18 participants compared Macintosh with the Lightwand (an intubating stylet), which is outside of the scope of this review and was therefore excluded.
Outcomes	**Outcomes relevant to the review reported by study authors** **Continuous outcomes** • Time for tracheal intubation: defined from time when the blade or stylet passed the central incisors to when the tracheal tube was positioned at the vocal cords Notes: study authors also report cervical motion and extension outcomes
Notes	**Funding/sponsor/declarations of interest**: supported, in part, by the 2004 Canadian Anesthesia Society **Study dates:** November 2003–January 2004

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of computer-generated numbers
Allocation concealment (selection bias)	Low risk	"sealed envelopes"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Near the end of the study, the radiology department suffered simultaneous failure of the main and back-up servers, and data for 11 patients were lost. As a result, an additional 7 patients were recruited before analysis, allowing 36 patients to be analyzed in the groups assigned" Explanation given for losses; additional recruitment attempted
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All laryngoscopies were performed by one person to minimise interoperator variability. Before this study, (intubator) had performed 50 intubations with the GlideScope and 500 intubations using the Macintosh laryngoscope"

Turkstra 2009

Study characteristics

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Turkstra 2009 *(Continued)*

Methods	RCT; cross-over design
Participants	**Total number of participants:** 24 **Country:** Canada **Setting:** theatre; single centre **Inclusion criteria**: elective non-cardiac surgery patients requiring intubation for the surgery; cardiac surgery uses transoesophageal echocardiogram; there would not be space for the fluoroscopy machine; ASA I-III; BMI < 35 **Exclusion criteria:** patients with previous neck surgery or unstable C-spine; patients with gastroesophageal reflux disease; patients who are or may be pregnant; known difficult airway **Baseline characteristics** **Macintosh laryngoscopy, Airtraq intubation** • Age, mean (SD): 48 (± 18) years • Gender M/F, n: 7/6 • Weight, mean (SD): 76 (± 15) kg • BMI, mean (SD): 27 (± 3) kg/m^2 • ASA I/II/III/IV, n: 2/6/5/0 • Mallampati 1/2/3/4, n: 5/8/0/0 **Airtraq laryngoscopy, Macintosh intubation** • Age, mean (SD): 49 (± 15) years • Gender M/F, n: 3/8 • Weight, mean (SD): 80 (± 23) kg • BMI, mean (SD): 27 (± 8) kg/m^2 • ASA I/II/III/IV, n: 2/5/4/0 • Mallampati 1/2/3/4, n: 9/2/0/0 Notes: all patients underwent laryngoscopy and intubation with MILS in place. The study used a cross-over design in which an initial laryngoscopy was performed with 1 device and the tracheal tube tip advanced just beyond the vocals cords before the alternate device was used for repeat laryngoscopy and intubation.
Interventions	**General details**: single intubator who had > 3000 Macintosh intubations and > 50 intubations with the Airtraq device. #3 blade Macintosh used. Large size Airtraq used for men and small size used for women. **Macintosh laryngoscopy, Airtraq intubation** • Randomized = 13; no losses; analysed = 13 **Airtraq laryngoscopy, Macintosh intubation** • Randomized = 11; no losses; analysed = 11 **VL classification:** channelled
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as a laryngoscopy sequence taking > 120 s to complete. • CL grade: 1-4

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Turkstra 2009 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as the time from when the Airtraq or Macintosh blade passed the central incisors to the time when the tracheal tube was positioned just past the vocal cords. Reported as median (IQR) Notes: the primary outcome of the study was C-spine movement during laryngoscopy, which is not an outcome of interest in our analysis.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest and no funding. **Study dates:** January 2008-May 2008

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible for outcomes of interest
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of outcome assessor not possible for outcomes of interest
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (NCT00664612). Prespecified primary and secondary outcomes reported, trial registered retrospectively
Experience of intubator	Low risk	Single experienced intubator with > 3000 Macintosh intubations, > 50 Airtraq intubations

Varsha 2019

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 70 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** patients undergoing CABG surgery, ASA III, ejection fraction > 40%, age 35-75 years, Mallampati 1-3, thyromental distance > 6 cm, mouth opening > 3 cm

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Varsha 2019 *(Continued)*

Exclusion criteria: valvular heart disease, pulmonary artery hypertension and left main disease, ejection fraction < 35%, conduction abnormality, permanent pacemaker, emergency surgery, features predictive of difficult airway, Mallampati 4, history of reactive airway disease, obesity (BMI > 35 kg/m2), gastroesophageal reflux, vital organ dysfunction

Baseline characteristics

Airtraq

- Age, mean (SD): 57.34 (± 9.66) years
- Gender M/F, n: 30/5
- Weight, mean (SD): 64.2 (± 7.05) kg
- Height, mean (SD): 163.74 (± 7.31) cm
- Mallampati 1/2/3/4: 3/22/10/0

Macintosh

- Age, mean (SD): 59 (± 9.5) years
- Gender M/F, n: 33/2
- Weight, mean (SD): 64.85 (± 6.6) kg
- Height, mean (SD): 161.14 (± 7.71) cm
- Mallampati 1/2/3/4: 1/17/17/0

Notes: study population all undergoing elective CABG surgery

Interventions

General details: 4 intubators, all experienced anaesthetists with > 7 years' experience with the Macintosh laryngoscope and had done in excess of 20 intubations each with the Airtraq device. Airway manoeuvres such as external laryngeal manipulation or use of a stylet or bougie was permitted.

Airtraq

- Randomized = 35; no losses; analysed = 35

Macintosh

- Randomized = 35; no losses; analysed = 35
- #3 or #4 blade

VL classification: channelled

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as 3 unsuccessful intubation attempts with the assigned device or intubation taking > 120 s to complete
- Successful first attempt
- Number of attempts: 1-3
- Airway trauma: lip trauma; dental trauma not reported
- CL grade: 1-4

Continuous outcomes

- Time for tracheal intubation: defined as time from insertion of the laryngoscope into the mouth to obtaining 3 capnograph waveforms. Reported as median (IQR)

Notes: haemodynamic outcomes were not extracted for use in our analysis. IDS score was recorded but data provided as mean ± SD and could not be extracted

Notes

Funding/sponsor/declarations of interest: no financial support. The study authors declared no conflicts of interest.

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Varsha 2019 *(Continued)*

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomized number tables
Allocation concealment (selection bias)	Low risk	Sequentially numbered, sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding not possible to intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible for outcomes of interest
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data was evident
Selective reporting (reporting bias)	Low risk	Protocol found at Cochrane Central Register of Controlled Trials (CTRI/2018/03/012455). Registered prospectively, primary and secondary outcomes reported
Experience of intubator	Low risk	4 experienced intubators, > 20 intubations with Airtraq each

Verma 2020

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** India **Setting**: theatre; single centre **Inclusion criteria:** patients aged 18- 60 years of either sex, height ≥ 150 cm, weight between 45-75 kg, ASA III-IV, undergoing various cardiac surgeries with a duration of surgery from 3-6 h **Exclusion criteria:** patients not willing to give consent, any bleeding or coagulation abnormalities, any major pre-existing neurological, metabolic, hepatic, respiratory or renal disease, history of allergy or hypersensitivity to any anaesthetic drugs, and any anticipated difficult intubation during pre-anaesthetic check or difficult intubation with > 2 attempts **Baseline characteristics** **McGrath MAC** • Age, mean (SD): 42.47 (± 14.81) years • Gender M/F, n: 20/10 • Weight, mean (SD): 57.9 (± 10.15) kg

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Verma 2020 *(Continued)*

- Height, mean (SD): 1.61 (± 0.06) m
- BMI, mean (SD): 20.98 (± 3.27) kg/m^2
- Mallampati 1/2/3/4, n: 28/1/1/0

Macintosh

- Age, mean (SD): 42.87 (± 12.49) years
- Gender M/F, n: 13/17
- Weight, mean (SD): 53.77 (± 7.38) kg
- Height, mean (SD): 1.61 (± 0.07) m
- BMI, mean (SD): 20.87 (± 2.6) kg/m^2
- Mallampati 1/2/3/4, n: 27/3/0

Interventions	**General details**: all intubations were performed by experienced consultants. Their experience with the respective devices is not further quantified. **McGrath MAC** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 **VL classification:** Macintosh-style
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • CL grade: 1-3 **Continuous outcomes** • Time for tracheal intubation: not explicitly defined in the manuscript
Notes	**Funding/sponsor/declarations of interest:** not reported **Study dates:** December 2019-March 2020

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Sealed envelope based randomized allocation method" Insufficient detail
Allocation concealment (selection bias)	Low risk	Use of sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors

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Verma 2020 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Participant with > 2 attempts at intubation were excluded from the trial. The study authors do not report whether any such exclusions occurred.
Selective reporting (reporting bias)	Low risk	Trial registry data examined (CTRI/2019/12/022256). Registered prospectively and all prespecified outcomes reported
Experience of intubator	Unclear risk	"All intubations were performed by experienced consultants" Not further quantified

Vijayakumar 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 90 **Country:** India **Setting:** theatre; single centre **Inclusion criteria**: adult patients aged 18-60 years of either sex, ASA I and II, with normal airway parameters undergoing elective abdominal, urological, and gynaecological surgeries under GA requiring tracheal intubation **Exclusion criteria:** patients at risk for gastric aspiration, anticipated difficult airway (previous history/documented difficult intubation, interincisor distance of < 3 cm, bucked tooth, modified Mallampati classification 3/4, thyromental distance of < 6 cm, restricted neck extension, patient who cannot bring mandibular incisors anterior to maxillary incisors, any gross abnormality of head and neck, and obese with BMI > 30 kg/m^2) **Baseline characteristics** **Airtraq** • Age, mean (SD): 35.88 (± 11.25) years • Gender M/F, n: 14/31 • Weight, mean (SD): 57.7 (± 8.13) kg • BMI, mean (SD): 23.22 (± 2.51) kg/m^2 • ASA I/II/III/IV: 45/0/0/0 • Mallampati 1/2/3/4: 8/37/0/0 **Macintosh** • Age, mean (SD): 34.17 (± 10.66) years • Gender M/F, n: 15/30 • Weight, mean (SD): 56.84 (± 8.27) kg • BMI, mean (SD): 22.94 (± 2.51) kg/m^2 • ASA I/II/III/IV: 44/1/0/0 • Mallampati 1/2/3/4: 9/36/0/0 Notes: participants underwent laryngoscopy and intubation with MILS applied for the purpose of the study.

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Vijayakumar 2016 *(Continued)*

Interventions	**General details**: 2 experienced anaesthetist intubators, each with > 100 "normal airway" intubations and > 20 "difficult airway" intubations with the Airtraq. Extensive experience with the Macintosh blade is assumed. The use of a bougie or external laryngeal manipulation was permitted. **Airtraq** • Randomized = 45; no losses; analysed = 45 • #2 blade for female participants, #3 blade for male participants **Macintosh** • Randomized = 45; no losses; analysed = 45 **VL classification:** channelled Notes: female patients were intubated with a size 7 cuffed tracheal tube and male participants size 8 mm cuffed tracheal tube
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: 2 unsuccessful intubation attempts with the primary intubating device. An intubation attempt was defined as introduction of the laryngoscope tip between the teeth to the appearance of capnogram following intubation. An attempt was considered 'failed' if it exceeded 120 s or if there was drop in saturation below 92%. • Hypoxia: SpO_2 < 92% • Successful first attempt • Number of attempts: 1, > 1 • Airway trauma: soft-tissue or dental injury. We extracted data for dental injury only • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from introduction of the laryngoscope into the oral cavity till confirmation of intubation by capnogram. Reported as median (IQR) • IDS: 0, 1-5, > 5
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no conflicts of interest or funding. **Study dates:** not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization table
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants were blinded to device, but blinding not possible for intubator
Blinding of outcome assessment (detection bias)	High risk	Blinding not possible. Observers used for TTI measurement

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Vijayakumar 2016 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	2 experienced anaesthetists, each with > 120 intubations with Airtraq

Walker 2009

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 120 **Country:** Scotland **Setting**: theatre; single centre **Inclusion criteria:** aged 18 years, undergoing elective surgery, anaesthesia plan consisting of routine tracheal intubation under GA performed by a first-year trainee anaesthetist and supervised by a senior colleague **Exclusion criteria:** other intubation techniques planned, RSI indicated **Baseline characteristics** **McGrath Series 5** • Age, median (range): 48 (21-84) years • Gender M/F, n: 17/43 • Weight, median (range): 71.0 (50.0-116.4) kg • Height, median (range): 1.66 (1.50-1.89) m • BMI, median (range): 25.7 (16.1-39.5) kg/m^2 • Mallampati 1/2/3/4, n: 29/29/2/0 **Macintosh** • Age, median (range): 60.5 (21-84) years • Gender M/F, n: 19/41 • Weight, median (range): 69.8 (44.0-106.5) kg • Height, median (range): 1.64 (1.48-1.90) m • BMI, median (range): 25.2 (17.3-47.2) kg/m^2 • Mallampati 1/2/3/4, n: 32/27/1/0
Interventions	**General details**: all 4 anaesthetists who performed tracheal intubation had undergone between 6 and 12 months of anaesthesia training during the study. All had achieved the Royal College of Anaesthetists initial competency in GA with tracheal intubation and had also received training in use of the McGrath laryngoscope. This followed a standard competency-based model, initially with a manikin, followed by 10 successful intubations in clinical practice. **McGrath Series 5**

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Walker 2009 *(Continued)*

- Randomized = 60; losses = 0; analysed = 60
- Shaped stylet used for all intubations

Macintosh

- Randomized = 60; losses = 0; analysed = 60
- Stylet or other intubation aid used at the discretion of intubator

VL classification: hyperangulated

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined • Successful first attempt • Hypoxia: defined as SpO_2 < 92% • Airway trauma: trauma/blood in airway after intubation. However, 3 participants in the Macintosh group had undergone airway surgery, which could have accounted for blood. Dental injuries not reported • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as time between anaesthetist taking the laryngoscope in his hand until effective ventilation was initiated via the tracheal tube. Data provided as median (range) and therefore could not be extracted for inclusion in the review.
Notes	**Funding/sponsor/declarations of interest**: no conflicts declared. Scopes bought with charitable foundation fund **Study dates:** February–August 2008

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"The randomization sequence was generated in advance by the study's statistical advisor" Insufficient details on how randomization was completed
Allocation concealment (selection bias)	Low risk	"Sequentially numbered opaque envelopes were used to conceal the sequence and were opened only on arrival of the patient in the anaesthetic room"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	"All patients in the Macintosh group were intubated successfully, but in one patient in the McGrath group, a Macintosh laryngoscope had to be used be-

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Walker 2009 *(Continued)*

		cause of battery failure in the McGrath during intubation. Time to intubation was also not recorded for this patient owing to an error with the stopwatch"
Selective reporting (reporting bias)	Low risk	Clinical trial register protocol examined (NCT00633867). Protocol outcomes comparable with study reported outcomes
Experience of intubator	Unclear risk	All 4 anaesthetists had undergone 6 -12 months of training to include manikin training in use of the McGrath blade. Unclear whether this is equivalent to use of the Macintosh

Wallace 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 105 **Country:** UK **Setting:** theatre; single centre **Inclusion criteria:** patients > 16 years of age undergoing elective surgery requiring oral tracheal intubation **Exclusion criteria:** patients undergoing emergency surgery, those unable to consent, those needing a RSI or those with a known difficult airway **Baseline characteristics** **McGrath MAC indirect laryngoscopy** • Age, mean (SD): 48 (± 17) years • Gender M/F, n: 26/26 • BMI, mean (SD): 28 (± 5.5) kg/m^2 • ASA I, II/III, IV, n: 44/8 **Macintosh direct laryngoscopy** • Age, mean (SD): 53 (± 21) years • Gender M/F, n: 28/25 • BMI, mean (SD): 27 (± 4.4) kg/m^2 • ASA I, II/III, IV, n: 46/7 Notes: the study authors report a third arm where participants were intubated with the MacGrath MAC being used as a DL. We did not include outcomes from that arm.
Interventions	**General details:** 5 experienced intubating anaesthetists, all had > 20 clinical intubations using the McGrath over a 6-month period prior to the study. The choice of laryngoscope blade size was at the discretion of the attending anaesthetist **McGrath MAC indirect laryngoscopy** • Randomized = 52; no losses; analysed = 52 • #3 or #4 blade available **Macintosh direct laryngoscopy** • Randomized = 53; no losses; analysed = 53

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Wallace 2015 *(Continued)*

- #3 or #4 blade available

VL classification: Macintosh-style

Notes: tracheal tube internal diameter 7.5 mm used for women and 8.5 mm used for men

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not specifically defined. However the study authors reported that all participants were successfully intubated with the allocated intervention. • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as time from the passage of laryngoscope tip past the incisors to the appearance of an $ETCO_2$ trace. Reported as median (IQR (range)) Notes: only outcomes from McGrath MAC indirect laryngoscopy and Macintosh direct laryngoscopy groups were extracted for use in the analysis. It was felt that McGrath MAC direct laryngoscopy could not be considered as equivalent to Macintosh laryngoscopy and therefore these outcomes were excluded. IDS score was reported as median (IQR (range)) in the study and could not be extracted for use in our analysis.
Notes	**Funding/sponsor/declarations of interest:** Aircraft Medical Ltd provided the McGrath MAC VLs. Statement indicating no conflicts of interest or external funding made by study authors. **Study dates**: study dates not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Concealment method for group allocation not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	5 intubating anaesthetists all with > 20 intubations with McGrath MAC

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Wasem 2013

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Germany **Setting:** theatre; single centre **Inclusion criteria:** patients > 18 years of age, ASA classification I-III, scheduled for elective surgery requiring oral intubation with a DLT **Exclusion criteria**: patient refusal, pregnancy **Baseline characteristics** **Airtraq** • Age, mean (SD): 63 (± 10) years • Gender M/F, n: 22/8 • Weight, mean (SD): 80 (± 10) kg • Height, mean (SD): 171 (± 7.5) cm • BMI, mean (SD): 27.4 (± 2.8) kg/m^2 • ASA I/II/III/IV: 0/16/14/0 • Mallampati 1/2/3/4: 11/18/1/0 **Macintosh** • Age, mean (SD): 55 (± 19) years • Gender M/F, n: 19/11 • Weight, mean (SD): 81 (± 19) kg • Height, mean (SD): 173 (± 11) cm • BMI, mean (SD): 27.1 (± 6.2) kg/m^2 • ASA I/II/III/IV: 2/15/13/0 • Mallampati 1/2/3/4: 12/15/3/0 Notes: all patients were undergoing thoracic surgery requiring placement of a DLT. An initial "scout" laryngoscopy was performed for all participants with a Macintosh laryngoscope before attempted intubation with the allocated device. "Scout" laryngoscopy revealed a CL score of 1 for 24 (n = 30) participants in the Airtraq group and 17 (n = 30) participants in the Macintosh group.
Interventions	**General details**: intubators were 1 of 2 experienced thoracic anaesthetists, each with "vast" experience in use of the Airtraq. **Airtraq** • Randomized = 30; no losses; analysed = 30 **Macintosh** • Randomized = 30; no losses; analysed = 30 • #3 and #4 blade used **VL classification:** channelled Notes: women were intubated with a DLT size 35, 37 or 39 and men with a DLT size 39 or 41.
Outcomes	**Outcomes relevant to the review reported by study authors**

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Wasem 2013 *(Continued)*

Dichotomous outcomes

- Failed intubation
- Number of attempts: 1-3
- Airway trauma: reported for oral or mucosal trauma; no data for dental injury reported
- Patient-reported sore throat: recorded at 30 min and 24 h post-surgery. We have taken the data from the 30-min point for inclusion in our analysis.
- CL grade: 1-4. Scores were reported at initial "scout" laryngoscopy with a Macintosh blade (for all participants) and then subsequently recorded again at the time of definitive intubation with the assigned device. We extracted the data from the time of intubation.
- Oesophageal intubation

Continuous outcomes

- Time for tracheal intubation: defined as from insertion of the laryngoscope past the participant's lips and until passage of the tracheal tube through the vocal cords, confirmed by the intubating anaesthetist.
- IDS: 0, 1-5, > 5

Notes: we did not extract haemodynamic outcome data for inclusion in our analysis.

Notes

Funding/sponsor/declarations of interest: financial support was provided by the Department of Anaesthesiology, University Hospital of Wurzburg, Germany. Prodol Limited provided the Airtraq devices free of charge. The study authors declared no conflicts of interest.

Study dates: July 2009–June 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomization method not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes opened after participants entered the operating room
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible for intubator-reported outcomes. It was not clear if participants were blinded to device allocation for the purpose of participant-reported outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	2 experienced thoracic anaesthetists, each with "vast" experience in use of the Airtraq device. A quantitative indication of intubator experience was not reported.

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Wasinwong 2017

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 46 **Country:** Thailand **Setting:** theatre; single centre **Inclusion criteria**: obese patients (BMI > 28 kg/m^2), aged 18-65 years old, ASA I-III, undergoing elective surgery under GA with oral tracheal intubation **Exclusion criteria:** patients with a history of difficult airway or probable difficult airway, unstable C-spine, contraindication to succinylcholine, dental problems that may impact intubation, risk of pulmonary aspiration, full stomach, or patients who needed RSI **Baseline characteristics** **Macintosh** • Age, mean (SD): 49.3 (± 9.2) years • Gender M/F, n: 3/20 • Weight, mean (SD): 82.5 (± 13.7) kg • BMI, mean (SD): 33.4 (± 5.4) kg/m^2 • Mallampati score, median (range): 2 (1-3) **GlideScope** • Age, mean (SD): 49.2 (± 10.2) years • Gender M/F, n: 3/20 • Weight, mean (SD): 81.7 (± 12.5) kg • BMI, mean (SD): 33.3 (± 3.8) kg/m^2 • Mallampati score, median (range): 3 (1-3) Notes: obese study population. Other baseline data relating to co-morbidities and airway assessment were well balanced between groups.
Interventions	**General details**: intubation was performed by second year anaesthesiology residents, who had performed a minimum of 10 intubations with the GlideScope previously. The use of external laryngeal manipulation was permitted and recorded if used. Patients were intubated supine in the sniffing position. **Macintosh** • Randomized = 23; no losses; analysed = 23 • Standard stylet used **GlideScope** • Randomized = 23; no losses; analysed = 23 • Pre-formed GlideScope stylet used **VL classification:** hyperangulated Notes: tracheal tube of internal diameter 8.0 mm used for male participants and 7.5 mm for female participants
Outcomes	**Outcomes relevant to the review reported by study authors**

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Wasinwong 2017 *(Continued)*

Dichotomous outcomes

- Failed intubation: defined as inability to intubate with the allocated device after 2 attempts
- Successful first attempt
- Number of attempts

Continuous outcomes

- Time for tracheal intubation: defined as the time from passing the blade through the participant's lips until the $ETCO_2$ curve was shown on the capnograph. Reported as median (IQR)

Notes: data for CL scores could not be extracted because they were presented as median (range). Airway trauma and postoperative sore throat data were reported within a composite "complications" outcome, which meant that these outcomes could not be extracted for inclusion separately. Reported haemodynamic outcome data are not relevant to our analysis and have not been included.

Notes	**Funding/sponsor/declarations of interest**: financial support was provided by Songklanagarind Hospital, Department of Anesthesia, Faculty of Medicine, Prince of Songkla University, Thailand. The study authors declare no conflicts of interest **Study dates:** December 2010–June 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	Method of concealment not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding to outcomes of interest not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No incomplete data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Second year anaesthesiology residents, minimum 10 GlideScope intubations. Balance of experience likely to favour Macintosh device

Wei 2016

Study characteristics

Methods	RCT; parallel design

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Wei 2016 *(Continued)*

Participants	**Total number of participants:** 80 **Country:** China **Setting:** theatre; single centre **Inclusion criteria**: aged 18-65 years old, ASA grades I-III, undergoing elective thoracic surgery **Exclusion criteria**: obesity (BMI > 30), history of difficult intubation, mouth opening < 3 cm, failure of initial intubation **Baseline characteristics** **GlideScope** • Age, mean (SD): 57.2 (± 5.4) years • Gender M/F, n: 21/19 • Weight, mean (SD): 62.4 (± 12) kg • Height, mean (SD): 165.6 (± 8.4) cm • BMI, mean (SD): 21 (± 5.6) kg/m^2 • ASA I/II/III/IV: 12/18/0/0 **Macintosh** • Age, mean (SD): 60.1 (± 8.7) years • Gender M/F, n: 17/23 • Weight, mean (SD): 60.1 (± 9.5) kg • Height, mean (SD): 168 (± 6.8) cm • BMI, mean (SD): 21.3 (± 3.4) kg/m^2 • ASA I/II/III/IV: 14/16/0/0 Notes: the patients studied were all undergoing elective thoracic surgery with a DLT.
Interventions	**General details:** the number of intubators and their experience with each device was not specified. The proximal tip of each DLT was curved by approximately 90°. **GlideScope** • Randomized = 40; no losses; analysed = 40 **Macintosh** • Randomized = 40; no losses; analysed = 40 **VL classification:** hyperangulated Notes: left-sided DLTs only were used.
Outcomes	**Outcomes relevant to the review reported by study authors** Notes: No outcomes of interest to our analysis were reported. The focus of the study was changes in various haemodynamic variables around the time of intubation, such as HR and BP.
Notes	**Funding/sponsor/declarations of interest**: nil financial support. No declared conflicts of interest **Study dates**: study dates not specified We did not complete risk of bias assessments because this study reported no relevant review outcomes.

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Woo 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 159 **Country:** Korea **Setting**: theatre, single centre **Inclusion criteria:** aged 18-65, scheduled for regular escharectomy under GA with a hypermetabolic state due to burn injury (occurring < 1 month from surgery), ASA II or III, second- or third-degree burns over 25% of body surface **Exclusion criteria:** loose teeth, craniocervical or cervical injury or malformation, arteriosclerosis, uncontrolled hypertension, myocardial infarction, cerebrovascular disease, Mallampati class 4, existing tracheal tube, bandages due to burns on the face or neck, difficulties in manual ventilation **Baseline characteristics** **Pentax AWS** • Age, mean (SD): 45.5 (± 10.4) years • Gender M/F, n: 37/13 • Weight, mean (SD): 66.6 (± 16.0) kg • Height, mean (SD): 1.67 (± 0.09) m • ASA I/II/III/IV, n: 0/34/16/0 • Mallampati 1/2/3/4, n: 8/32/10/0 **Macintosh** • Age, mean (SD): 47.4 (± 10.5) years • Gender M/F, n: 38/12 • Weight, mean (SD): 65.9 (± 11.5) kg • Height, mean (SD): 1.66 (± 0.1) m • ASA I/II/III/IV, n: 0/37/13/0 • Mallampati 1/2/3/4, n: 6/29/15/0 Notes: baseline characteristics not reported for 59 participants excluded after randomization from the Macintosh arm.
Interventions	**General details**: all intubations were performed by a resident in the Department of Anesthesiology & Pain Medicine who had > 3 years of experience in intubation with the Macintosh laryngoscope and had performed > 50 procedures with the Pentax AWS. In case of failure of the first attempt, second attempt was performed after manual ventilation with 100% oxygen for 30 s. After the second attempt, cricoid pressure was applied in Group P (Pentax AWS). In Group M (Macintosh) after the second attempt, cricoid pressure and a stylet were used. **Pentax AWS** • Randomized = 50; losses = 0; analysed = 50 **Macintosh** • Randomized = 109; losses = 59 (failure on first attempt); analysed = 50 • #3 blade for female participants, #4 blade for male participants **VL classification:** channelled

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Woo 2012 *(Continued)*

Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined in the study as, "unsuccessful intubation in the trachea within 30 seconds for the first attempt". Participants were excluded from the main analysis if the first attempt failed. A second attempt with the same device using cricoid pressure and a stylet were then used (Macintosh group only). Following 2 failed attempts a fibreoptic bronchoscope or LMA were used. • Successful first attempt • Patient-reported sore throat: measured on 4-point scale at 24 h postoperatively. For this review data were extracted as dichotomous (sore throat or not). **Continuous outcomes** • Time for tracheal intubation: defined as time from moment when the blade of the laryngoscope passed the incisor to moment when it was outside the oral cavity after tracheal tube • POGO score: 0%-100% Notes: we have extracted data for failed intubation based on our review definition of failed intubation. Therefore where intubation was successful at the second attempt using the same device (irrespective of cricoid pressure or stylet use) we considered it to have been successful. The main analyses including POGO, TTI and sore throat excluded the 59 participants in the Macintosh group who failed first attempt at intubation.
Notes	**Funding/sponsor/declarations of interest**: study authors declare no conflicts of interest or funding. **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"simple random sampling with 50 subjects each group" Concerns about randomization methods. Insufficient detail given. Paper says that an additional 59 were randomized to the Macintosh group.
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	59 participants from Macintosh group were excluded owing to failed intubation on first attempt
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	"All endotracheal intubations were performed by a resident in the Department of Anesthesiology & Pain Medicine, with over 3 years of experience in endo-

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Woo 2012 *(Continued)*

	tracheal intubation using the Macintosh laryngoscope and with more than 50 procedures using the Pentax-AWS"

Xue 2007

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 57 **Country:** People's Republic of China **Setting**: theatre; single centre **Inclusion criteria:** adults; ASA I; scheduled for elective plastic surgery during GA requiring orotracheal intubation **Exclusion criteria:** receiving medications known to affect BP or HR; predicted difficult airways **Baseline characteristics** **GlideScope** • Age, mean (SD): 28.2 (± 9.5) years • Gender M/F, n: 11/17 • Weight, mean (SD): 61.4 (± 11.9) kg • Height, mean (SD): 1.65 (± 0.06) m **Macintosh** • Age, mean (SD): 32.3 (± 11) years • Gender M/F, n: 9/18 • Weight, mean (SD): 61.7 (± 13.6) kg • Height, mean (SD): 1.65 (± 0.07) m
Interventions	**General details**: all intubation procedures were performed by a single anaesthetist experienced in using a Macintosh and a GlideScope. External laryngeal compression was applied if necessary. After visualization of the glottis, a precurved styletted tracheal tube was inserted into the glottis. **GlideScope** • Randomized = 30; losses = 2 (1 case failed on the first attempt because of the poor laryngeal view caused by fogging of the camera lens, 1 case failed because of difficult immobilization of the blade due to the lubricant); analysed = 28 **Macintosh** • Randomized = 27; losses = 0; analysed = 27 • #3 blade used **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined

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Xue 2007 *(Continued)*

- Successful first attempt
- Number of attempts: 1-3

Continuous outcomes

- Time for tracheal intubation: defined from termination of manual ventilation with a facemask to restart of ventilation through a tracheal tube.

Notes: the study authors also report haemodynamic outcomes, which are not of interest to our review.

Notes	**Funding/sponsor/declarations of interest**: none apparent **Study dates**: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Allocated by a sequence of random numbers" Insufficient detail
Allocation concealment (selection bias)	Unclear risk	Insufficient detail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubators
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants excluded from statistical analysis, with explanations provided
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	1 anaesthetist experienced in the use of both devices. Relative experience with the study devices was not further quantified.

Yallapragada 2016

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 93 **Country:** India **Setting:** theatre; single centre **Inclusion criteria:** ASA physical status I and II, with an expected easy airway, scheduled for GA

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Yallapragada 2016 *(Continued)*

Exclusion criteria: difficult airway, coronary artery disease, beta blocker medication and patients who required RSI

Baseline characteristics

Airtraq

- Age, mean (SD): 44.7 (± 13.15) years
- Weight, mean (SD): 61.25 (± 9.25) kg

Macintosh

- Age, mean (SD): 46.05 (± 13.22) years
- Weight, mean (SD): 62.83 (± 12.57) kg

Notes: no other baseline data were provided.

Interventions

General details: intubators were all second-year postgraduate anesthesiology residents, all had > 20 intubations with the Airtraq. Use of a bougie was not permitted and any cause of removal of the laryngoscope blade from the mouth excluded the participant from the study at the time of laryngoscopy.

Airtraq

- Randomized = 49; excluded = 9 (1 light source failure; 8 obliteration of view via lens due to excess secretions); analysed = 40

Macintosh

- Randomized = 44; excluded = 4 (bougie required); analysed = 40

VL classification: channelled

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Patient-reported sore throat

Continuous outcomes

- Time for tracheal intubation: defined as the time from introduction of the laryngoscope blade into the mouth to the visual appearance of capnography trace on the monitor following intubation

Notes: the 'rate pressure product' (RPP) was also reported as an outcome. This is not an outcome of interest to our analysis.

Notes

Funding/sponsor/declarations of interest: the study authors declare no conflicts of interest or financial support.

Study dates: January 2015-June 2015

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization
Allocation concealment (selection bias)	Unclear risk	No detail

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Yallapragada 2016 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	High risk	A total of 13 participants were excluded from the study after laryngoscopy. This was due to the requirement for use of a bougie in all 4 cases from the Macintosh group. In 9 cases from the Airtraq group, it was due to light failure (1 case) and view obliteration by secretions (8 cases).
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	Second-year anaesthesiology residents who all had > 20 intubations with the Airtraq

Yao 2015

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 96 **Country:** China **Setting:** theatre; single centre **Inclusion criteria**: adult patients aged 18–70 years old, of ASA physical status I–III, scheduled for thoracic surgery requiring intubation with a DLT for one lung ventilation **Exclusion criteria**: patients with a simplified airway risk index score ≥ 4, increased risk of pulmonary aspiration, planned tracheostomy **Baseline characteristics** **McGrath Series 5** • Age, mean (SD): 47.6 (± 13.8) years • Gender M/F, n: 33/15 • Weight, mean (SD): 60.9(± 8.7) kg • Height, mean (SD): 166.6 (± 6.7) cm • BMI, mean (SD): 22.0 (± 3.4) kg/m^2 • ASA I/II/III/IV: 25/22/1/0 • Mallampati 1/2/3/4: 27/18/3/0 **Macintosh** • Age, mean (SD): 47.8 (± 16.3) years • Gender M/F, n: 33/15 • Weight, mean (SD): 61.3 (± 10.2) kg • Height, mean (SD): 166.8 (± 6.8) cm

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Yao 2015 *(Continued)*

- BMI, mean (SD): 21.9 (± 3.0) kg/m^2
- ASA I/II/III/IV: 22/22/4/0
- Mallampati 1/2/3/4: 28/18/2/0

Non-randomized

- Age, mean (SD): 59.2 (± 7.3) years
- Gender M/F, n: 16/2
- Weight, mean (SD): 68.6 (± 11.4) kg
- Height, mean (SD): 170.5 (± 6.5) cm
- BMI, mean (SD): 23.6 (± 3.6) kg/m^2
- ASA I/II/III/IV: 3/12/3/0
- Mallampati 1/2/3/4: 5/7/6/0

Notes: in this study patients were randomized following an initial laryngoscopy with a Macintosh laryngoscope. If the CL view of the glottis was 1 or 2A then the patient underwent randomization. Patients with a CL view of 2B or higher were not randomized and underwent intubation with the McGrath device. In our analysis we have only extracted outcome data from the 2 groups that underwent randomization. The study used a thoracic surgical population requiring a DLT for one lung ventilation.

Interventions	**General details**: intubators were 1 of 3 senior anaesthetists with extensive experience of DLT placement using both McGrath and Macintosh laryngoscopes. A malleable stylet was used with the DLT for all intubations. **McGrath Series 5** • Randomized = 48; no losses; analysed = 48 **Macintosh** • Randomized = 48; no losses; analysed = 48 • #3 or #4 blade **Non-randomized** • Number of participants = 18 • Participants intubated with McGrath Series 5 device **VL classification:** hyperangulated Notes: a left-sided DLT was used for all intubations. DLT sizes 35-39 Fr were available to intubators.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as unsuccessful intubation after 3 attempts • Successful first attempt • Number of attempts: 1-3 • Airway trauma: minor injury; no dental injury reported • Patient-reported sore throat • CL grade: 1-4 (with study device) **Continuous outcomes** • Time for tracheal intubation: defined as the time from when the laryngoscope blade was passed between the patient's lips until the first upstroke of the capnograph trace.
Notes	**Funding/sponsor/declarations of interest**: the study was supported by grants from the National Natural Science Foundation of P.R. China. No conflicts of interest declared.

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Yao 2015 *(Continued)*

Study dates: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated code sequence
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident in randomized participants
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Unclear risk	Intubators were 1 of 3 senior anaesthetists with extensive experience of DLT placement using both McGrath and Macintosh laryngoscopes. Relative experience with the study devices was not further quantified.

Yeatts 2013

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 623 **Country:** USA **Setting:** ED, single centre **Inclusion criteria:** all patients who required tracheal intubation in the trauma resuscitation unit during the study period were assessed for eligibility. Indications for intubation followed Eastern Association for the Surgery of Trauma guidelines; included airway obstruction, hypoventilation, severe hypoxia, cognitive impairment (GCS score ≤ 8) and haemorrhagic shock. Altered mental status, combativeness and extreme pain were additional criteria. **Exclusion criteria:** minors; suspected laryngeal trauma or extensive maxillofacial injury requiring an immediate surgical airway; known or strongly suspected spinal cord injury with awake flexible fibre-optic intubation indicated; cardiac arrest on arrival; those who died in the trauma resuscitation unit **Baseline characteristics** **GlideScope**

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Yeatts 2013 *(Continued)*

- Age, mean (range): 42 (18-119) years
- Gender M/F, n: 216/87

Macintosh

- Age, mean (range): 43 (18-94) years
- Gender M/F, n: 244/76

Notes: trauma patients requiring emergency intubation

Interventions	**General details**: emergency medicine or anaesthesiology residents with a minimum of 1 year of previous intubation experience performed most procedures under the direct supervision of an attending trauma anaesthetist. The remaining intubations were performed by the attending anaesthetist or by a nurse anaesthetist under attending guidance. GlideScope had been in routine use at the study institution for 2 years before initiation of the trial. All participants received RSI. **GlideScope** (n = 303) • Randomized = 303; losses = 0; analysed = 303 • Blade sizes not specified **Macintosh** (n = 320) • Randomized = 320; losses = 0; analysed = 303 • Blade sizes not specified **VL classification:** hyperangulated
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Successful first attempt • Mortality: 30 days **Continuous outcomes** • Time for tracheal intubation: defined as interval between when the laryngoscope was inserted into the participant's mouth and when it was fully removed. Data presented as mean (95% CI), which was converted to mean (SD) as per the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2021). Notes: participants who subsequently died in ED were excluded from the study. The study authors do not report the number of participants excluded. A substantial amount of data were missing for a proportion of several different reported outcomes. This included missing data for 24.2% successful first attempt and TTI outcomes. Study authors did not specify the ratio of missing data for each group. There is a high risk of attrition bias for these outcomes. Regarding mortality data, study authors state, "When post hoc analysis was performed on a much smaller cohort of patients, there was an observed higher mortality rate for the subgroup of patients with severe head injuries (head AIS score > 3) who were randomized to intubation with GVL (*GlideScope)* (22 (30%) of 73) versus DL (*Macintosh)* (16 (14%) of 112) (p = 0.047). This association between mortality and use of the GlideScope remained significant even when controlling for patient characteristics such as admission physiology, mechanism of injury, and injury severity"
Notes	**Funding/sponsor/declarations of interest**: intramural research funding from University of Maryland School of Medicine Program in Trauma. The study authors declare no conflicts of interest. **Study dates:** July 2008–May 2010

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Yeatts 2013 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No details other than "randomly assigned". A large number of exclusions followed randomization at the discretion of the anaesthetist. However, analysis confirmed lack of selection bias
Allocation concealment (selection bias)	Unclear risk	Equipment and study forms (airway kit) were kept in the bag until participant was selected. Insufficient details
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not possible to blind intubator
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	High risk	Large number of participants excluded at intubator's discretion. In addition, 24.2% reported data for successful first attempt and TTI outcomes were missing. Study authors did not specify the ratio of missing data for each group. High risk of attrition bias
Selective reporting (reporting bias)	Low risk	Protocol sourced (NCT01235065), registered prospectively, outcomes comparable with reported study outcomes
Experience of intubator	Unclear risk	GlideScope had been in routine use at the institution for 2 years. All personnel had at least 1 year of experience in intubation. However, it is unclear from this description whether personnel had sufficient equivalent experience with GlideScope.

Yoo 2018

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 44 **Country:** South Korea **Setting:** theatre; single centre **Inclusion criteria:** 19-60 years of age, scheduled for thoracic surgery and requiring one lung ventilation **Exclusion criteria**: indication for RSI, history of difficult intubation, C-spine instability or cervical myelopathy, tendency to bleed **Baseline characteristics** **Macintosh** • Age, median (IQR): 47 (43-53) years • Gender M/F, n: 14/8 • Weight, median (IQR): 67 (62-72) kg

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Yoo 2018 *(Continued)*

- Height, median (IQR): 164 (161-170) cm
- ASA I/II/III/IV: 17/5/0/0
- Mallampati 1/2/3/4: 12/7/3/0

McGrath

- Age, median (IQR): 48 (46-55) years
- Gender M/F, n: 14/8
- Weight, median (IQR): 63 (58-73) kg
- Height, median (IQR): 167 (163-170) cm
- ASA I/II/III/IV: 19/3/0/0
- Mallampati 1/2/3/4: 13/4/4/1

Notes: thoracic surgical population, all requiring intubation with a DLT. C-spine immobilization with MILS was used for all intubations.

Interventions	**General details**: single intubating anaesthetist, experience of DLT insertion with both Macintosh and McGrath devices, quantitative estimate of experience not provided. A stylet with angulation of the distal tip was used for all intubations. MILS was provided by a second investigator. The use of external laryngeal manipulation was permitted and recorded. **Macintosh** • Randomized = 22; no losses; analysed = 22 **McGrath** • Randomized = 22; no losses; analysed = 22 **VL classification:** Macintosh-style Notes: size 35 Fr DLT used for female participants and a size 37 Fr DLT used for male participants.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as inability to successfully intubate within 120 s or 2 attempts • Hypoxia: defined as SpO_2 < 95% • Trauma: oral bleeding; dental injury not reported • CL grade: 1-4 • Oesophageal intubation **Continuous outcomes** • Time for tracheal intubation: defined as the time from when the laryngoscope passed between the participant's lips to the confirmation of $ETCO_2$ on the capnograph. This was the primary outcome in the study. If > 1 intubation attempt was required, the duration of the subsequent attempt was added to that of the first attempt without including the time interval between attempts. Only successful intubations were included in their analysis. Reported as median (IQR). We did not extract this outcome. • POGO score: 0%-100%. Median (IQR) reported. We did not extract this outcome. Notes: IDS score was reported in median (IQR) format and could not be extracted for inclusion in our analysis. The study also reported haemodynamic outcomes, which are not of interest to our analysis and have therefore not been extracted.
Notes	**Funding/sponsor/declarations of interest**: the study authors declare no funding or conflicts of interest. **Study dates:** not reported

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Yoo 2018 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number table
Allocation concealment (selection bias)	Unclear risk	Allocation concealment method not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses evident
Selective reporting (reporting bias)	Unclear risk	Trial registry data examined (KCT0002150). Registered retrospectively and additional non-prespecified outcomes reported in the final manuscript.
Experience of intubator	Unclear risk	Single intubator. Reportedly had some experience with DLT insertion with both devices but no estimate of extent of experience was provided

Yousef 2012

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 60 **Country:** Egypt **Setting:** theatre; single centre **Inclusion criteria:** ASA I–III morbidly obese (BMI > 35 kg/m^2) patients, undergoing general, gynaecological and bariatric surgery requiring oral tracheal intubation **Exclusion criteria**: history of hiatus hernia, symptomatic gastric reflux, previous gastric banding, interincisor distance of < 3.5 cm **Baseline characteristics** **Macintosh** • Age, mean (range): 50 (29-74) years • Gender M/F, n: 17/13 • BMI, mean (SD): 43.6 (± 9.5) kg/m^2 • ASA, median (IQR): II (II/III) • Mallampati 1/2/3/4, n: 0/3/20/7

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Yousef 2012 *(Continued)*

	GlideScope • Age, mean (range): 45 (22-65) years • Gender M/F, n: 15/15 • BMI, mean (SD): 43.2 (± 7.4) kg/m^2 • ASA, median (IQR): II (II/III) • Mallampati 1/2/3/4, n: 1/4/18/7 Notes: morbidly obese study population
Interventions	**General details**: all intubating anaesthetists were trained with the 3 devices on a manikin. The number of intubators and their clinical experience with the intubating devices was not specified. A gum elastic bougie was used if the CL score was 3 or 4 **Macintosh** • Randomized = 30; no losses; analysed = 30 • #3 or #4 blade **GlideScope** • Randomized = 30; no losses; analysed = 30 **VL classification:** hyperangulated Notes: only outcomes from the Macintosh and GlideScope groups were extracted for our analysis. A third arm looked at LMA CTrach, which is a supraglottic airway device.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: defined as intubation that could not be accomplished within 3 attempts or 180 s • Hypoxia: SpO_2 < 92% • Successful first attempt • Number of attempts: 1, > 1 • Airway trauma: pharyngeal bleeding; data on dental injury not reported • Patient-reported sore throat • CL grade: 1-4 **Continuous outcomes** • Time for tracheal intubation: defined as the time taken from the end of the period of bag-mask ventilation (prior to laryngoscopy), and ended when $ETCO_2$ was detected on the monitor. Reported as median (IQR) • IDS: 0, 1-5, >5
Notes	**Funding/sponsor/declarations of interest:** The study authors declare no funding or conflicts of interest. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Sequence generation method was not specified

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Yousef 2012 *(Continued)*

Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes opened in the anaesthetic room
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding of outcome assessment not possible for majority of reported outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	High risk	Intubators had training for all devices with manikins but clinical experience was not specified. Experience likely to favour Macintosh device

Yumul 2016

Study characteristics	
Methods	RCT; parallel design
Participants	**Total number of participants:** 121 **Country:** USA **Setting:** theatre; single centre **Inclusion criteria:** ASA I-III, aged 18-80 years, BMI > 30 kg/m^2 undergoing elective bariatric surgery **Exclusion criteria:** patients with a history of facial abnormalities, previous oral-pharyngeal cancer or reconstructive surgery, C-spine injury, patients who required an awake fibre-optic intubation, emergency operations, severe mental disorder, pregnant patients and those with a history of difficult intubation **Baseline characteristics** **Macintosh** • Age, mean (SD): 46 (± 12) years • Gender M/F, n: 8/23 • BMI, mean (SD): 42 (± 5) kg/m^2 • ASA I/II/III/IV, n: 0/2/29/0 • Mallampati 1/2/3/4, n: 1/20/10/0 **V-MAC** • Age, mean (SD): 44 (± 12) years • Gender M/F, n: 7/23 • BMI, mean (SD): 43 (± 8) kg/m^2

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Yumul 2016 *(Continued)*

- ASA I/II/III/IV, n: 0/2/28/0
- Mallampati 1/2/3/4, n: 5/17/7/1

GlideScope

- Age, mean (SD): 45 (± 12) years
- Gender M/F, n: 7/23
- BMI, mean (SD): 43 (± 5) kg/m^2
- ASA I/II/III/IV, n: 0/0/30/0
- Mallampati 1/2/3/4, n: 5/13/12/0

McGrath Series 5

- Age, mean (SD): 45 (± 12) years
- Gender M/F, n: 10/20
- BMI, mean (SD): 41 (± 6) kg/m^2
- ASA I/II/III/IV, n: 0/1/29/0
- Mallampati 1/2/3/4, n: 4/19/7/0

Notes: obese study population. All patients were undergoing elective bariatric surgery.

Interventions	**General details**: participating anaesthetists had been trained in the use of all devices and had performed a minimum of 20 intubations with each. Participants followed a standardized intubation protocol involving pre-oxygenation and positioning in the ramped position. Tracheal tubes were styletted. The use of a bougie was permitted. **Macintosh** • Randomized = 31; no losses; analysed = 31 • #3 and #4 blades **V-MAC** • Randomized = 30; no losses; analysed = 30 • #3 and #4 blades **GlideScope** • Randomized = 30; no losses; analysed = 30 **McGrath Series 5** • Randomized = 30; no losses; analysed = 30 **VL classification:** hyperangulated (GlideScope, McGrath Series 5), Macintosh-style (V-MAC) Notes: the V-MAC device is an early iteration of the C-MAC device and is a Macintosh-style VL.
Outcomes	**Outcomes relevant to the review reported by study authors** **Dichotomous outcomes** • Failed intubation: not explicitly defined. All participants in the study were reportedly intubated in ≤ 2 attempts. However, the study also reported the requirement to change intubating device as an outcome, which is included in our study definition of a failed intubation and these have been counted as such in our analysis. • Number of attempts: 1, > 1 • Airway trauma: blood on laryngoscope blade, mucosal and lip trauma; dental trauma not reported • Patient-reported sore throat • CL grade: 1-4

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Yumul 2016 *(Continued)*

	Continuous outcomes • Time for tracheal intubation: defined as the time from the passage of the blade between the teeth to the appearance of an $ETCO_2$ waveform • POGO score: 0%-100% Notes: the McGrath Series 5 and the GlideScope are both hyperangulated devices and outcomes from these groups have been combined for use in our analysis. The study also reported time to obtain glottic view and time to placement of the tracheal tube, but it was felt that time to appearance of $ETCO_2$ was most consistent with other studies as a definition of TTI. Reported haemodynamic outcomes were not extracted for use in our analysis.
Notes	**Funding/sponsor/declarations of interest**: there were no declared conflicts of interest. Funding was provided by Department of Anesthesiology, Cedars Sinai Medical Center, Los Angeles, California, USA **Study dates:** May 2010–October 2011

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomization (Minitab 12 computer software)
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubator not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding not possible for majority of outcomes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident
Selective reporting (reporting bias)	Low risk	Trial registry data examined (NCT01114945). All prespecified outcomes reported, registered prospectively
Experience of intubator	Low risk	Intubators had a minimum of 20 intubations with each study device.

Zhao 2014

Study characteristics

Methods	RCT; parallel design
Participants	**Total number of participants:** 149 **Country:** China **Setting:** theatre; single centre

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Zhao 2014 *(Continued)*

Inclusion criteria: ASA I or II patients, aged 18-65 years old, scheduled for surgical procedures requiring GA and tracheal intubation

Exclusion criteria: history or any indicator of a difficult airway (i.e. Mallampati grade > 2, BMI > 30 kg/m^2, interincisor < 4 cm), or any risk factors for pulmonary aspiration

Baseline characteristics

Macintosh

- Age, mean (SD): 49 (± 17) years
- Gender M/F, n: 27/48
- Weight, mean (SD): 60.8 (± 8.1) kg
- Height, mean (SD): 165.0 (± 5.8) cm
- ASA I/II/III/IV: 48/27/0/0
- Mallampati 1/2/3/4: 56/19/0/0

Airtraq

- Age, mean (SD): 48 (± 18) years
- Gender M/F, n: 33/41
- Weight, mean (SD): 63.8 (± 8.2) kg
- Height, mean (SD): 164.9 (± 7.6) cm
- ASA I/II/III/IV: 42/32/0/0
- Mallampati 1/2/3/4: 52/22/0/0

Notes: the purpose of this study was to compare intubation success rates and time to intubation of the 2 devices when used by medical students with no prior experience of intubation, as part of their training.

Interventions

General details: there were 26 medical student intubators with no prior intubation experience. They underwent airway teaching including 10 practice intubations on a manikin before performing clinical intubations in the study. Each student performed 6 intubations with either the Macintosh or Airtraq laryngoscopes according to randomization. The use of optimization manoeuvres to improve glottic view were allowed.

Macintosh

- Randomized = 75; no losses; analysed = 75
- A stylet was used

Airtraq

- Randomized = 74; no losses; analysed = 74

VL classification: channelled

Outcomes

Outcomes relevant to the review reported by study authors

Dichotomous outcomes

- Failed intubation: defined as inability to intubate within 150 s or in cases of oesophageal intubation
- Successful first attempt: students were only permitted a single intubation attempt during the study
- Airway trauma: dental, lip or mucosal trauma. No events, reported together
- CL grade: 1, 2, 3/4

Continuous outcomes

- Time for tracheal intubation: defined as the period from opening the mouth to the first appearance of a normal capnography trace

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Zhao 2014 *(Continued)*

	Notes: 7 of the students performed only 5 intubations due to rotation limitations. The progression of intubation success for a student's first to third intubation attempts for subsequent participants with each device was compared. We did not extract these data for use in our analysis.
Notes	**Funding/sponsor/declarations of interest**: no conflicts of interest were declared. Funding was provided by Peking University People's Hospital. **Study dates**: not specified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random number list
Allocation concealment (selection bias)	Unclear risk	Allocation concealment method not specified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Blinding of intubators not possible
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not possible to fully blind outcome assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss of data evident for main outcomes
Selective reporting (reporting bias)	Unclear risk	Study authors do not report prepublished protocol or clinical trials registration; it is not feasible to effectively assess risk of selective reporting bias without these documents.
Experience of intubator	Low risk	All intubators were medical students and had no experience with either device.

#: number; **ADS:** airway difficulty score; **AIS:** abbreviated injury score; **APACHE:** Acute Physiologic Assessment and Chronic Health Evaluation; **ASA:** American Society of Anesthesiologists (physical status classification); **BIS:** bispectral index; **BMI:** body mass index; **BP:** blood pressure; **BURP:** 'backwards, upwards, rightward pressure'; **CABG:** coronary artery bypass graft; **CI:** confidence interval; **CL**: Cormack-Lehane (Cormack 1984); **C-MAC/SBT:** C-MAC device with straight blade; **CONSORT:** Consolidated Standards of Reporting Trials (CONSORT 2010); **CPR:** cardiopulmonary respiration; **CRNA:** certified registered nurse anaesthetist; **C-spine:** cervical spine; **DBP:** diastolic blood pressure; **DL:** direct laryngoscope; **DLT:** double-lumen tube; **ECG:** electrocardiogram; **ED:** emergency department; **EMS:** Emergency Medical Service; **ENT:** ear, nose and throat; **$ETCO_2$:** end-tidal carbon dioxide; **ETT:** endotracheal tube; **GA:** general anaesthesia; **GCS:** Glasgow Coma Scale; **HEMS:** Helicopter Emergency Medical Service; **HR:** heart rate; **ICU:** intensive care unit; **ICP:** intracranial pressure; **ID:** identification; **IDS:** Intubation Difficulty Scale; **IOP:** intraocular pressure; **IQR:** interquartile range; **ITT:** intention-to-treat; **LMA:** laryngeal mask airway; **MAP:** mean arterial pressure; **MET:** metabolic equivalents; **M/F:** male/female; **MILS:** manual in-line stabilization; **min/max:** minimum/maximum;**NRS:** numerical rating scale; **NYHA:** New York Heart Association Classification; **PACU:** postanaesthesia care unit; **POGO:** percentage of glottic opening; **Q1, Q3:** quartile range 1, quartile range 3; **RCT:** randomized controlled trial; **RSI:** rapid sequence induction/intubation; **SBP:** systolic blood pressure; **SD:** standard deviation; **SIAARTI:** National Congress of the Italian Society of Anaesthesiology and Intensive Care Medicine; **TTI:** time to intubation; **VAS:** visual analogue scale; **VL:** videolaryngoscope

Characteristics of excluded studies *[ordered by study ID]*

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Study	Reason for exclusion
Aleksandrowicz 2016	Manikin study
Benhocine 2020	Ineligible comparison
Cirilla 2015	Ineligible comparison
Dorges 2016	Ineligible comparison
Gawlowski 2017	Manikin study
Pieters 2018	Ineligible study design
Raimann 2019	Ineligible study design
Scholtis 2017	Ineligible population
Stoll 2019	Ineligible comparison
Thomas 2019	Missing outcome data for 1 group
Valencia 2016	Ineligible comparison

Characteristics of studies awaiting classification *[ordered by study ID]*

CTRI/2018/05/014284

Methods	RCT; parallel design
Participants	**Number of participants:** 80 **Inclusion criteria:** ASA grade I or II; Mallampati score 1 or 2 **Exclusion criteria:** patient not giving informed consent; history of previous neck surgery; history of difficult intubation in any previous surgery; interincisor distance < 3 cm; ASA grade > II; Mallampati score 3 or 4 **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Time taken in successful intubation; ease of intubation; percentage of glottic opening; modified CL grading; change in vitals; postoperative upper airway symptoms
Notes	

CTRI/2018/07/014986

Methods	RCT; parallel design
Participants	**Number of participants:** 60 **Inclusion criteria:** ASA grade I and II patients; age 25-60 years; weight 45-70 kg; patients of either sex; patients planned for elective surgery

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CTRI/2018/07/014986 *(Continued)*

	Exclusion criteria: previous history of multiple/failed intubation; predicted difficult laryngoscopy except for all class of Mallampati scores; any pathology of the oral cavity that may obstruct the insertion of device; mouth opening < 2.5 cm; potentially full stomach patients (trauma, morbid obesity, pregnancy, history of gastric regurgitation and heart burn) and at risk of oesophageal reflux (hiatus hernia) **Setting**: theatre
Interventions	Macintosh vs USB VL
Outcomes	To compare the laryngoscopy and intubation time using the 2 intubating devices To compare the number of attempts required for successful intubation To grade the ease of tracheal intubation using these devices To compare the glottic view using CL grading To compare the number of adjustment manoeuvres required for successful intubation To compare changes in HR and mean arterial BP during laryngoscopy and intubation using the 2 devices To look for any trauma during laryngoscopy and intubation To record the incidence of postoperative sore throat within 24 h
Notes	

CTRI/2019/04/018521

Methods	RCT; parallel design
Participants	**Number of participants:** 87 **Inclusion criteria:** patients undergoing thoracotomy with DLT, ASA grade I-III, age > 18 years of age and < 70 years, BMI < 30 **Exclusion criteria**: pregnant patients, patients with expected difficult laryngoscopy - neck extension < 35 - mandibular hyoid distance < 6 cm - sternomental distance < 12.5, height < 150 **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Intubation time for the DLT; haemodynamic response to intubation; IDS
Notes	

CTRI/2019/09/021358

Methods	RCT; parallel design
Participants	**Number of participants:** 60 **Inclusion criteria:** patients with; ASA grade I/II; age 18-60 years of either sex; patient undergoing elective surgeries requiring GA and orotracheal intubation

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CTRI/2019/09/021358 *(Continued)*

	Exclusion criteria: patient refusal; modified Mallampati class 3 or 4; mouth opening < 2.5cm; inter-incisor distance < 3.5 cm; thyromental distance < 6 cm; sternomental distance < 12 cm; mandibulo-hyoid distance < 4 cm; C-spine instability; BMI > 30 kg/m^2; risk of gastric aspiration; edentulous patients and patients having artificial denture **Setting**: theatre
Interventions	C-MAC vs McGrath MAC, direct laryngoscopy done with respective scope as comparison
Outcomes	Ease of orotracheal tube placement; time (in seconds) taken for orotracheal intubation; haemodynamic effects and oxygen saturation changes; complications
Notes	

CTRI/2020/07/026587

Methods	RCT; parallel design
Participants	**Number of participants:** 90 **Inclusion criteria:** ASA grade I/II; undergoing elective procedures under GA with tracheal tube **Exclusion criteria:** anticipated difficult airway; BMI > 35 kg/m^2; any pathology of mastoid; presence of neck trauma, neck mass and scar of previous neck surgery **Setting**: theatre
Interventions	Macintosh vs C-MAC vs C-MAC D-BLADE
Outcomes	Ease of intubation; CL grade; complications
Notes	

CTRI/2020/08/027461

Methods	RCT; parallel design
Participants	**Number of participants:** 60 **Inclusion criteria:** ASA grade II, controlled hypertensive patients posted for elective surgery under GA **Exclusion criteria:** patients with uncontrolled hypertension; patients with known coronary and cerebrovascular diseases; patients with difficult airway; pregnant patients; patients with BMI > 30 **Setting**: theatre
Interventions	Macintosh vs VL
Outcomes	Heart rate; SBP; DBP; mean arterial pressure; ease of insertion; number of attempts; duration of each attempt; adverse events
Notes	

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DRKS00011542

Methods	RCT; parallel design
Participants	**Number of participants:** 60 **Inclusion criteria**: both genders; age 18-100; patients with criteria for a RSI (BMI > 30, gastro-oesophageal reflux) **Exclusion criteria**: pregnancy, patients < 18 years of age, emergency cases **Setting**: theatre
Interventions	Macintosh vs GlideScope
Outcomes	Visualization of the glottis during intubation; comparison of the CL grading between groups; time needed for successful intubation; time from when the tube passes the participant's lips until the tube passes the vocal cords
Notes	

NCT00178555

Methods	RCT; parallel design
Participants	**Number of participants:** 200 **Inclusion criteria:** age 18-80 years; ASA I-III; presenting for elective surgery; requires GA; present as a possible difficult intubation (≥ 1 of the following: history of difficult intubations, morbid obesity, small mouth opening (< 3 fingerbreadths), limited neck mobility, Mallampati classes 2 and 3, short thyromental distance (< 6 cm)) **Exclusion criteria**: determined to be easily intubated (none of the factors listed above); considered so difficult (i.e. Mallampati 4) that an awake intubation should be performed; ASA IV and V **Setting**: theatre
Interventions	Storz DCI VL vs Macintosh
Outcomes	5-scale score of glottic view; time and number of attempts required; level of difficulty; degree of irritation of the pharynx, epiglottis and arytenoids; vital signs, oxygen saturation and $ETCO_2$
Notes	Registered at clinicaltrials.gov. Listed as completed, but no results posted and we have not been able to source completed study in 2021

NCT00602979

Methods	RCT; parallel design
Participants	**Number of expected participants:** 240 **Inclusion criteria**: elective adult surgical patient requiring tracheal anaesthesia; men and women; ASA I-III; age ≥ 18 years of age **Exclusion criteria:** BMI ≥ 35 kg/m^2; if patient is of childbearing potential, a positive pregnancy test at the time of study enrolment; has physical, mental, or medical conditions which, in the opinion

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NCT00602979 *(Continued)*

	of the Investigator, could compromise the participant's welfare, ability to communicate with the study staff, complete study activities, or would otherwise contraindicate study participation; intubated prior to surgery; severe cardiovascular, hepatic or renal disease; need for nasal intubation; an investigator of this study; inclusion in another clinical research study; patient's refusal or inability to agree to and to sign the Informed Consent Form in English; patient requiring awake airway management **Setting**: theatre
Interventions	Airtraq AWS and Storz DCI and GlideScope and McGrath vs Macintosh
Outcomes	Percentage distribution of Cook's modification of CL grading system. Each study participant will receive a grade of 1, 2A, 2B, 3A, 3B or 4 in the Cook classification Intubation time: measured from entry of the device into the oral cavity until confirmation of proper placement of tracheal tube, as judged by an exhaled tidal volume > 200 mL and the presence of ET-CO_2 Success rate: number of attempts required for successful intubation by an attending anaesthetist Maximal neck extension: using atlanto-occipital joint extension scale Ease of intubation: judged by laryngoscopist on a 5-point rating scale: 5 is excellent, 1 is poor Complication rate: all complications will be recorded, with special attention given to common complications, such as upper airway and dental trauma Interincisor distance: maximal mouth opening necessary for intubation Laryngoscopist's comments: pertinent device-specific clinical comments Vital signs (blood pressure, heart rate, mean arterial pressure, and pulse oximeter rate)
Notes	Registered at clinicaltrials.gov. Listed as completed, but have not been able to source completed study.

NCT00664612

Methods	RCT, cross-over design
Participants	**Number of participants:** 24 **Inclusion criteria**: elective non-cardiac surgery requiring intubation; adults; ASA I-III; BMI < 35 **Exclusion criteria:** patients with previous neck surgery or unstable C-spine; patients with reflux disease; patients who are or may be pregnant **Setting**: theatre
Interventions	Airtraq vs Macintosh
Outcomes	C-spine movement; TTI
Notes	Registered at clinicaltrials.gov. Listed as completed, but no results posted and have not been able to source completed study. No contact made with study authors

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NCT01029756

Methods	RCT; parallel design
Participants	**Number of participants:** 120 **Inclusion criteria:** adults ≥ 18 years; scheduled for elective surgery; anaesthetic plan would normally include oral intubation with a Macintosh laryngoscope blade by a junior anaesthetist; valid informed consent **Exclusion criteria:** patients requiring special techniques for intubation such as awake fibreoptic intubation; unconscious or critically ill patients; emergency situations; vulnerable patients **Setting**: theatre
Interventions	Pentax AWS vs Macintosh
Outcomes	Is there a clinically significant difference in the time taken to successfully intubate the trachea? Is there a difference in the IDS?
Notes	Registered at clinicaltrials.gov. Status listed as unknown but estimated completion date registered as September 2012. No results posted and have not been able to source completed study. No contact made with study authors.

NCT01114945

Methods	RCT; parallel design
Participants	**Number of participants:** **Inclusion criteria:** patients with documented BMI > 35 kg/m^2; scheduled to undergo inpatient surgery procedures under GA; willingness and ability to sign an informed consent document; 18-80 years of age; ASA II-III adults of either sex **Exclusion criteria:** patients who are deemed to be such a significant airway risk that they necessitate awake fibreoptic intubation; patients with a history of facial abnormalities, oral-pharyngeal cancer or reconstructive surgery; emergency surgeries; pregnancy; the inability to tolerate 0.2 mg of glycopyrrolate based on tachycardia; any other conditions or use of any medication that may interfere with the conduct of the study **Setting**: theatre
Interventions	Karl Storz Video-Mac and GlideScope and McGrath vs Macintosh
Outcomes	Intubation time using a stop watch; glottis visualization using CL and POGO score
Notes	Registered at clinicaltrials.gov. Listed as completed, but no results posted and have not been able to source completed study. No contact made with study authors

NCT01516164

Methods	RCT; parallel design
Participants	**Number of participants:** 158

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NCT01516164 *(Continued)*

	Inclusion criteria: elective procedure requiring oral tracheal tube intubation; > 16 years of age; airway assessment suggests to the anaesthetist that a standard Macintosh laryngoscope approach to intubation would be appropriate **Exclusion criteria:** any patient with C-spine abnormalities; any patients with known or probable difficult airways; any patient requiring RSI **Setting**: theatre
Interventions	McGrath vs Macintosh
Outcomes	IDS; TTI; number and types of alternative techniques used; perception of force used; complications; ease of intubation; failure to intubate
Notes	Registered at clinicaltrials.gov. Listed as completed, but no results posted and have not been able to source completed study. No contact made with study authors

NCT02190201

Methods	RCT; parallel design
Participants	**Number of participants:** 114 **Inclusion criteria:** adult patients, thoracic surgery requiring one lung ventilation **Exclusion criteria**: difficult ventilation; emergency operation **Setting**: theatre
Interventions	McGrath Series 5 VL vs Macintosh
Outcomes	Intubation time measured with a stopwatch, defined as time from insertion of blade into the mouth to withdrawal of blade; Number of successful intubations at first attempt
Notes	Registered at clinicaltrials.gov. Listed as completed, but no results posted and have not been able to source completed study. No contact made with study authors

NCT02564640

Methods	RCT; parallel design
Participants	**Number of participants:** 100 **Inclusion criteria:** ASA II-III; aged > 65 years; controlled hypertensive patients; scheduled for elective CABG **Exclusion criteria:** ASA IV; ejection fraction < 40%; any anatomical abnormality in head, neck or face; Mallampati score of 4; history of difficult intubation or laryngoscopy **Setting**: theatre
Interventions	Macintosh vs VL

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NCT02564640 *(Continued)*

Outcomes	BP changes during tracheal intubation; HR changes during tracheal intubation; ST segment elevation in ECG indicating myocardial ischaemia during tracheal intubation; arrhythmic changes in ECG during tracheal intubation
Notes	

NCT03089528

Methods	RCT; parallel design
Participants	**Number of participants:** 85 **Inclusion criteria:** patients undergoing elective surgery; patients needing intubation; patients having diabetes mellitus **Exclusion criteria**: emergency surgery **Setting**: theatre
Interventions	Macintosh vs videolaryngoscopy
Outcomes	First-attempt intubation success rate; intubation time; intubation difficulty; glottic view quality; POGO; the rate of conversion to another laryngoscopy method; adverse outcomes related to tracheal intubation
Notes	

NCT03256019

Methods	RCT; cluster parallel design
Participants	**Number of participants:** 600 **Inclusion criteria:** patients who suffer sudden out-of-hospital cardiac arrest **Exclusion criteria:** cardiac arrests from multiple trauma; cases of requesting the do-not attempt resuscitation before intubation; intubated cases before arrival to ED **Setting:** ED
Interventions	Macintosh vs VL
Outcomes	Survival with good neurologic outcome; ROSC; total time to complete intubation from the beginning; complication
Notes	

NCT03316443

Methods	RCT; parallel design
Participants	**Number of participants:** 90

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NCT03316443 *(Continued)*

	Inclusion criteria: patients aged > 20 years old; patients classified by the ASA as II or III with controlled hypertension; patients with BMI < 35; Mallampati score 1 or 2, thyromental distance > 4 cm and central incisor interdistance > 3 cm will be included **Exclusion criteria**: patient refusal; patient with uncontrolled hypertension (patients diagnosed as uncontrolled hypertension if they have history of hypertension and SBP after 3 measures after admission exceeding 150 mmHg despite of regular antihypertensive therapy); patient with major cardiac diseases (e.g. cardiomyopathy); patient with cerebrovascular accidents; patient with history of difficult intubation; patients at risk of aspiration who require RSI **Setting**: theatre
Interventions	Macintosh vs GlideScope
Outcomes	Haemodynamic changes; success rate of intubation; intubation time; attempts of intubation; severity of sore throat; severity of hoarseness of voice
Notes	

NCT03376828

Methods	RCT; cross-over design
Participants	**Number of participants:** 200 **Inclusion criteria:** age 18-75 years; underwent surgery under GA **Exclusion criteria:** ASA IV or V patients; preoperative SBP 180 mmHg, DBP > 110 mmHg; ejection fraction is < 40%; difficult intubation history; Mallampati 3 or 4 **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Haemodynamic response; intubation time; glottic view grade
Notes	

NCT03470116

Methods	RCT; parallel design
Participants	**Number of participants:** 1250 **Inclusion criteria:** < 2 criteria of difficult intubation admitted to the operating theatre for scheduled surgery requiring orotracheal intubation after curarization - informed consent **Exclusion criteria:** pregnancy; age < 18; contraindication to orotracheal intubation; emergency surgery; thoracic surgery; naso-tracheal intubation; patient protected by law; patient not affiliated to French social security; BMI > 45 kg/m^2; predicted patient with difficult intubation **Setting**: theatre
Interventions	Macintosh vs McGrath MAC

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NCT03470116 *(Continued)*

Outcomes	Successful first attempt intubation after curarization; presence of glottal exposure during the first laryngoscopy; use of a second laryngoscopy; type of laryngoscope used in second laryngoscopy; use of a mandrel; use of a supra-glottal device; use of a fibreoptic; use of a transtracheal oxygenation device; presence of desaturations < 92% during laryngoscopy; number of oesophageal intubations; pharyngeal lesions/bleeding
Notes	

NCT03589638

Methods	RCT; parallel design
Participants	**Number of participants:** 3 **Inclusion criteria:** ASA I-II; Mallampati 1 or 2 **Exclusion criteria**: glaucoma; diabetes mellitus; cardiovascular and pulmonary disease; ASA III-IV; BMI > 35; difficult intubation history; obstetric surgery; propofol, fentanyl, rocuronium contraindication **Setting**: theatre
Interventions	Macintosh vs C-MAC vs McGrath MAC
Outcomes	IOP; mean arterial pressure; SBP; DBP; HR; peripheral oxygen saturation
Notes	

NCT03647371

Methods	RCT; parallel design
Participants	**Number of participants:** 200 **Inclusion criteria:** patients scheduled for elective thoracic procedures, requiring GA, videolaryngoscopy and intubation with a Robert-Shaw type DLT; written, informed consent for participation in the study; > 18 years **Exclusion criteria:** emergency procedures; visible anatomic abnormalities; patients scheduled for awake fibre optic intubation; lack of consent for participation in the study **Setting**: theatre
Interventions	Macintosh vs McGrath
Outcomes	Thyromental height; score in CL scale; thyromental distance; sternomental distance; score in modified Mallampati test; distance of mouth opening
Notes	

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NCT03653910

Methods	RCT; parallel design
Participants	**Number of participants:** 62 **Inclusion criteria:** ASA I-II; patients aged 18-65 years; BMI 18-35 kg/m^2; elective pulmonary surgery under GA to DLT intubation; Mallampati classifications 1-2 **Exclusion criteria**: emergency operation; anticipated difficult airway or history of intubation difficulties; allergic to any of the drugs used in the experiment, or have a history of drug allergy; preoperative use of analgesic, sedative and other drugs; uncontrolled hypertension and heart disease; a history of heavy smoking and alcohol abuse, serious drug abuse, and severe systemic infections; severe mental and nervous system symptoms, and patients cannot co-operate with the study, such as language comprehension disorder, mental illness, etc; other clinical trials were conducted within 3 months prior to inclusion in the study **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Remifentanil target-controlled infusion effect site concentration; mean arterial pressure; HR; Narcotrend index
Notes	

NCT03677505

Methods	RCT; parallel design
Participants	**Number of participants:** 60 **Inclusion criteria:** patients scheduled for thoracic surgery requiring one lung ventilation **Exclusion criteria:** predicted difficult airway; RSI; cervical injury **Setting**: theatre
Interventions	Macintosh vs KoMAC VL
Outcomes	Intubation time
Notes	

NCT03743831

Methods	RCT; parallel design
Participants	**Number of participants:** 218 **Inclusion criteria:** specific medical conditions: ASA I or II; patient having given written consent to participate in the category 2 trial; intubation realized by experienced person; Social Insured patient; patient willing to comply with all procedures of the study and its duration **Exclusion criteria**: demographic characteristics: minor, > 65; medical history: history of difficult intubation, hypertension; Lille intubation score ≥ 7; treatments in progress: taking beta blocker the day of the operation; administrative reasons: inability to receive informed information, inability to

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NCT03743831 *(Continued)*

	participate in the entire study, lack of coverage by the social security system, refusal to sign consent **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Change from intubation mean BP at 1 min after intubation; other haemodynamic parameters; instantaneous ANI delta; intubation time in seconds from introduction of the intubation device into the mouth with inflation of the balloon; frequency of patients with dental trauma and/or an injury to the lips due to the intubation device
Notes	

NCT04424953

Methods	RCT; parallel design
Participants	**Number of participants:** 28 **Inclusion criteria: ≥** 21 years; not pregnant; ASA I, II and III; BMI < 35 kg/m^2; elective surgical operations requiring GA and intubation; able to give own informed consent; no features of difficult airway, which has to consist all of the following: class I and II on the modified Mallampati classification, thyromental distance of ≥ 6.5 cm, mouth opening of ≥ 3.5 cm, sternomental distance of ≥ 12.5 cm **Exclusion criteria**: < 21 years old; pregnancy; ASA status ≥ IV; poorly-controlled cardiorespiratory conditions (such as poorly-controlled asthma with Asthma Control Test ≤ 19, chronic obstructive pulmonary disease GOLD 2 and above, exertional angina, coronary artery disease with active symptoms, heart failure with NYHA Class III and above); BMI ≥ 35 kg/m^2; emergency operation; unable to give own consent; any feature of difficult airway which is: class III and IV on the modified Mallampati classification, thyromental distance < 6.5 cm, mouth opening < 3.5 cm, sternomental distance < 12.5 cm, history of difficult intubation, unstable C-spine **Setting**: theatre
Interventions	Macintosh vs McGrath MAC
Outcomes	TTI; incidence of success at first intubation attempt; incidence of the use of adjuncts at first attempt; incidence of the use of adjuncts at subsequent attempts; incidence of success and failure at intubation; IDS; incidence of oxygen desaturation to < 88% and oro-dental injuries; incidence of inability to intubate despite all efforts by the anaesthetist; closest distance from the patient's mouth to the anaesthetist's mouth during intubation
Notes	

TCTR20201209003

Methods	RCT; parallel design
Participants	**Number of participants:** 114 **Inclusion criteria:** patients underwent GA needed intubation; ASA I-II, III; age 18-65 **Exclusion criteria:** known case hypertension; on beta blocked for any reason; BMI > 32; pregnancy

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TCTR20201209003 *(Continued)*

	Setting: theatre
Interventions	Macintosh vs C-MAC
Outcomes	BP and HR; sore throat
Notes	

ANI: analgesia nociception index; **ASA:** American Society of Anesthesiologists (physical status classification); **BMI:** body mass index; **BP:** blood pressure; **CABG:** coronary artery bypass graft; **CL**: Cormack-Lehane (Cormack 1984); **C-spine:** cervical spine; **DBP:** diastolic blood pressure; **DLT:** double-lumen tube; **ECG:** electrocardiogram; **ED:** emergency department; **$ETCO_2$:** end-tidal carbon dioxide; **GA:** general anaesthesia; **HR:** heart rate; **IDS:** Intubation Difficulty Scale; **IOP:** intraocular pressure; **NYHA:** New York Heart Association Classification; **POGO:** percentage of glottic opening; **RCT:** randomized controlled trial; **ROSC:** return of spontaneous circulation; **RSI:** rapid sequence induction/intubation; **SBP:** systolic blood pressure; **TTI:** time to intubation; **VL:** videolaryngoscope

Characteristics of ongoing studies *[ordered by study ID]*

ChiCTR1900025553

Study name	To compare the clinical effect of endotracheal intubation with Macintosh laryngoscope, Dispo-scope endoscope and video laryngoscopy
Methods	RCT; parallel design
Participants	**Number of expected participants:** 95 **Inclusion criteria**: these patients were scheduled to undergo elective surgery requiring GA with tracheal intubation **Exclusion criteria:** patients with a history of cardiovascular diseases such as hypertension and heart disease; patients with airway difficulty **Setting**: theatre
Interventions	Macintosh laryngoscope vs diascope laryngoscope vs video laryngoscopy
Outcomes	Angle between adjacent cervical vertebrae; degree of mouth opening; CL grades; BP and HR
Starting date	1 September 2019
Contact information	Study leader: Zhouquan Wu Email: wuzhouquan2005@126.com Location: China
Notes	None

ChiCTR1900025718

Study name	A randommized, prospective, controlled trial of Glidscope, C-MAC (D) videolaryngoscope and Mac-intosh laryngoscope for double lumen endotracheal intubation in patients with predicted normal airways
Methods	RCT; parallel design

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ChiCTR1900025718 *(Continued)*

Participants	**Number of expected participants:** 90 **Inclusion criteria:** ASA I-II; aged 18-75 years; BMI ≤ 35 kg/m^2 **Exclusion criteria**: emergency surgery; history of severe cardiovascular diseases or patients with no stable situation; difficult intubation or difficult ventilation; Mallampati score ≥ 3, decreased interincisor distance (< 3 cm), short thyromental distance (< 6 cm), and reduced neck extension(< 80° from neck flexion), C-spine instability; severe pulmonary dysfunction; with a history of severe heart or lung diseases **Setting**: theatre
Interventions	GlideScope VL vs C-MAC (D) VL vs Macintosh laryngoscope
Outcomes	Insertion time; CL degree; difficulty in insertion and delivery; HR, BP and SpO_2; postoperative side effect
Starting date	Unknown
Contact information	Study leader: Zhou Renlong Email: zhourenlong@aliyun.com Location: China
Notes	None

ChiCTR2000030232

Study name	Study for orotracheal double-lumen endotrachea intubation in patients with a Mallampati score of III or 1V: is UE video laryngoscope really better than Macintosh laryngoscope?
Methods	RCT; parallel design
Participants	**Number of expected participants:** 130 **Inclusion criteria:** 1. aged 18-70 years old; transthoracic or thoracoscopic mediastinal tumour resection, lobectomy, bullectomy; ASA II, III; modified Mallampati Grade 3 or 4 **Exclusion criteria:** preoperative throat pain or hoarseness; mental illness; airway stenosis or tumour **Setting**: theatre
Interventions	Tracheal intubation with Macintosh laryngoscope vs intubation with UE VL
Outcomes	Throat pain score; success time of intubation; dislocation rate; CL rating; success rate of single intubation; haemodynamic fluctuation; time to correct position; incidence of hoarseness
Starting date	Unknown
Contact information	Study leader: Xie Yanhu Email: 2660747430@qq.com Location: China

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ChiCTR2000030232 *(Continued)*

Notes	None

ChiCTR-IOR-15007535

Study name	Postoperative sore throat after laryngoscopy with Macintosh or Tosight video laryngoscope blade in normal airway patients
Methods	RCT; parallel design
Participants	**Number of expected participants:** 200 **Inclusion criteria:** age over 18 years old, elective surgery **Exclusion criteria:** cold within 2 weeks **Setting**: theatre
Interventions	Macintosh vs Tosight
Outcomes	Placement of laryngoscope; frequency of adjustment; intubation times; classification of glottis; sore throat after surgery
Starting date	14 December 2015
Contact information	Study leader: Wang Lei Email: 100wlwl@163.com Location: China
Notes	None

CTRI/2015/02/005589

Study name	A randomized trial comparing the McGrath videolaryngoscope with the Macintosh laryngoscope for nasotracheal intubation in patients undergoing surgery for head and neck malignancies
Methods	RCT; parallel design
Participants	**Number of expected participants:** 60 **Inclusion criteria:** adult patients (≥ 18 years); ASA status I–II; undergoing elective surgery for malignancies of the head and neck; who will need nasotracheal intubation **Exclusion criteria**: refusal of consent; risk factors for gastric aspiration present; all patients with a previously documented difficult tracheal intubation; previous head and neck surgery; anticipated difficult airway where standard induction of GA (intravenous induction with non-depolarising muscle relaxant) is not planned **Setting**: theatre
Interventions	Macintosh vs McGrath
Outcomes	Time taken for intubation; success rates for intubation; difficulty level during intubation using Adnet scale

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CTRI/2015/02/005589 *(Continued)*

Starting date	04 August 2014
Contact information	Study leader: Reshma Ambulkar Email: rambulkar@hotmail.com Location: India
Notes	None

CTRI/2017/02/007809

Study name	Comparison of intubation in lateral position with simple laryngoscope versus video laryngoscope
Methods	RCT; parallel design
Participants	**Number of expected participants:** 60 **Inclusion criteria:** age 18-60; ASA physical status I, II, or III; surgery requiring GA with endotracheal tube **Exclusion criteria:** increased risk of pulmonary aspiration; C-spine pathology; anticipated airway difficulties (i.e. Mallampati grade 3 and 4 or thyromental distance < 6 cm); obesity; abnormal teeth or abnormal dentition; any cardiorespiratory disease (hypertension, chronic obstructive pulmonary disease, ischaemic heart disease); cerebrovascular disease; reflux oesophagitis; history of sore throat within 10 days **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Incidence of complication of intubation (hypoxia (95% of SpO_2), lip Injury, mucosal trauma, bleeding in the oral cavity, arrhythmia, dental injury, oesophageal intubation, laryngospasm, hypertension, hypotension, tachycardia, bradycardia); complication in postoperative period at 8 pm on day of surgery (postoperative sore throat, hoarseness of voice, mucosal or lip injury, laryngeal oedema)
Starting date	17 August 2016
Contact information	Study leader: Alpeshkumar Bhavanbhai Hadia Email: alpeshhadia@gmail.com Location: India
Notes	None

CTRI/2017/03/008092

Study name	Comparison of video laryngoscope and conventional laryngoscopes for tracheal intubation using cervical collar
Methods	RCT; parallel design
Participants	**Number of expected participants:** 60

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CTRI/2017/03/008092 *(Continued)*

	Inclusion criteria: age 18-60; ASA status I and II; patients posted for elective surgery requiring GA and intubation; patients willing to participate in the study **Exclusion criteria:** C-spine injury; anticipated difficult intubation; thyromental distance < 6 cm; interincisor gap < 3 cm; sternomental distance < 12 cm; neck circumference > 42 cm; pregnant and obese patients; at risk of gastric aspiration; Mallampati grade 3 or 4 **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Intubation time; IDS; haemodynamic parameters; complications
Starting date	24 February 2017
Contact information	Study leader: Aditi A Dhimar Email: dhimaraditi@yahoo.in Location: India
Notes	None

CTRI/2017/09/009656

Study name	To compare the ease of insertion of a special breathing tube called double lumen tube using laryngoscope with a video relay or a classic non video laryngoscope for the purpose of general anaesthesia to facilitate lung surgeries
Methods	RCT; parallel design
Participants	**Number of expected participants:** 80 **Inclusion criteria:** age 18-70; patients undergoing thoracotomy surgeries with the aid of DLT; ASA I and II; patients with El-Ganzouri Risk Index scoring ≤ 4 **Exclusion criteria**: restricted mouth opening < 2.5 cm; ASA III or IV; non-consenting **Setting**: theatre
Interventions	Macintosh vs C-MAC D-BLADE
Outcomes	Intubation time; haemodynamic response; IDS; incidence of complications
Starting date	08 May 2017
Contact information	Study leader: Roy Rajan Mathai Email: royrajan.m@gmail.com Location: India
Notes	None

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CTRI/2017/09/009810

Study name	Comparing the efficacy of C-MAC C-blade videolaryngoscope and Macintosh laryngoscope in patients with predicted difficult airways
Methods	RCT; parallel design
Participants	**Number of expected participants:** 110 **Inclusion criteria:** 18-60 years of age undergoing elective or emergency surgery belonging to ASA physical status classification of I-III requiring GA with orotracheal intubation having any 1 or combination of the following predictors of difficult airway. The predictors include: Mallampati classification 3 or 4, thyromental distance of < 6 cm, reduced range of neck movements inability to touch the sternum with chin or inability to extend neck, maxillary overbite or buck tooth, short neck, neck circumference > 36 cm, inability to protrude the jaw, noncompliant mandibular space, long incisor length, reduced mandibular space **Exclusion criteria**: pregnant women, patients with aspiration risk or requiring RSI, patients with laryngeal or tracheal pathologies, mouth opening < 3 cm **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	First pass intubation success rate; improved glottic view
Starting date	01 December 2017
Contact information	Study leader: Sakthirajan P Email: sakthiab8@gmail.com Location: India
Notes	None

CTRI/2018/01/011446

Study name	Comparison of Airtraq video laryngoscope and Macintosh laryngoscope for tracheal intubation in adults
Methods	RCT; parallel design
Participants	**Number of expected participants:** 50 **Inclusion criteria:** age 18-60; mouth opening > 3 finger breadths; modified Mallampati class 1 or 2; ASA I/II **Exclusion criteria:** patients who do not give consent to participate in the trial; patients with history of cardiovascular, cerebral, renal, hepatic, bronchospastic and endocrine disease or psychiatric disorder; patients with risk for difficult intubation (thyromental distance < 6 cm, interincisor distance < 3 cm); anticipated difficult bag and mask ventilation or difficult intubation; history of upper respiratory tract infection in last 15 days, C-spine disorders, coagulation disorders; patients posted for surgeries involving oral cavity, larynx, pharynx and neck; patients having features of raised ICP; patients at risk of pulmonary aspiration of gastric contents e.g. pregnant women, patients with full stomach, upper gastrointestinal tract problems like gastro-oesophageal reflux disease; obesity (BMI ≥ 35 kg/m^2) **Setting**: theatre

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CTRI/2018/01/011446 *(Continued)*

Interventions	Macintosh vs Aritraq
Outcomes	Time taken for tracheal intubation; ease of intubation; glottic view using POGO score and CL score; need for additional manoeuvres to facilitate intubation; attempts of intubation; incidence of failed intubation
Starting date	01 February 2018
Contact information	Study leader: Sujata Chaudhary Email: sujatac462@gmail.com Location: India
Notes	None

CTRI/2018/02/012236

Study name	Comparing how much vocal cord can be seen while videolaryngoscopy during general anaesthesia through direct and indirect method
Methods	RCT; parallel design
Participants	**Number of expected participants:** 62 **Inclusion criteria:** age between 18-80 years belonging to ASA score I-III undergoing elective surgeries requiring intubation; patients having Mallampati grade 1-3 **Exclusion criteria**: history of a difficult airway; potential risk factors for difficult intubation (morbidly obese patients with BMI ≥ 40 kg/m^2, Mallampati class > 3, mouth opening < 3 cm, and restricted neck movement) **Setting**: theatre
Interventions	C-MAC (indirect) vs C-MAC (direct)
Outcomes	CL grade; need for external laryngeal manoeuvres; use of intubation aides
Starting date	07 March 2017
Contact information	Study leader: Suresh G Email: gsureshbmc@gmail.com Location: India
Notes	This study compares the indirect and direct technique of intubation with the same device.

CTRI/2018/04/012941

Study name	Comparison of two types of laryngoscopes in patients undergoing tracheal intubation with neutral head and neck position under general anaesthesia
Methods	RCT; parallel design

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CTRI/2018/04/012941 *(Continued)*

Participants	**Number of expected participants:** 80 **Inclusion criteria:** age 18-60; ASA physical status grade I and II undergoing tracheal intubation for elective surgery under GA **Exclusion criteria:** patients with anticipated difficult airway (modified Mallampati class 3 and 4, thyromental distance < 6 cm, interincisor distance < 3.5 cm, inability to bring lower incisors in front of upper incisors, buck teeth and poor dentition with high risk of damage, oropharyngeal pathology or facial abnormality, restriction of neck movements and C-spine pathology BMI > 35 kg/m^2); haemodynamic or pulmonary compromise; high risk of pulmonary aspiration; pregnancy; cardiac disease and hypertension **Setting**: theatre
Interventions	Macintosh vs C-MAC D-BLADE
Outcomes	IDS; duration of laryngoscopy attempt; duration of intubation attempt; total time taken to secure the airway; success rate of intubation; number of intubation attempts; ease of insertion of device and haemodynamic changes during laryngoscopy and intubation
Starting date	29 June 2016
Contact information	Study leader: Nidhi Agrawal Email: nidhi.agrawal1970@gmail.com Location: India
Notes	None

CTRI/2018/04/013212

Study name	Comparison of two different laryngoscopes for tracheal intubation with head and neck in neutral position under general anaesthesia
Methods	RCT; parallel design
Participants	**Number of expected participants:** 80 **Inclusion criteria:** age 18-60; ASA grade I and II scheduled to undergo elective surgery requiring tracheal intubation under GA **Exclusion criteria:** patients with anticipated difficult airway (oropharyngeal pathology and facial abnormality, Mallampati class 3 and 4, thyromental distance < 6 cm, BMI > 35 kg/m^2, interincisor distance < 3.5 cm, inability to bring lower incisors in front of upper incisors, C-spine pathology or restricted neck movement, buck teeth, poor dentition with high risk of damage); haemodynamic or pulmonary compromise; high risk of pulmonary aspiration (non-fasted, gastro-oesophageal reflux); pregnancy; cardiac disease and hypertension **Setting**: theatre
Interventions	Macintosh vs King Vision
Outcomes	IDS; duration of laryngoscopy attempt; duration of intubation attempt; total time taken to secure the airway; success rate of intubation; number of intubation attempts; ease of insertion of device; haemodynamic changes

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CTRI/2018/04/013212 *(Continued)*

Starting date	04 July 2016
Contact information	Study leader: Sushil Guria Email: drsushilguria@gmail.com Location: India
Notes	None

CTRI/2018/05/013771

Study name	Compare two instruments used to visualise the windpipe and then put a tube through the windpipe in patients undergoing surgery for head and neck cancers
Methods	RCT; parallel design
Participants	**Number of expected participants:** 40 **Inclusion criteria:** age 18-60; ASA grade I or II; Mallampati grade 1 and 2; patients needing nasotracheal intubation for elective head and neck surgeries **Exclusion criteria**: refusal of consent, patients having risk factors for gastric aspiration, patients with previously documented difficult tracheal intubation, patients who had undergone previous head and neck surgery, emergency surgical procedure, patients with an anticipated difficult airway **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Time to intubation; rate of successful intubation; number of attempts needed for successful intubation; need for use of optimization manoeuvres (BURP); CL grade at laryngoscopy; percentage of difficult intubations in each group; complications
Starting date	21 May 2018
Contact information	Study leader: Reshma Ambulkar Email: rambulkar@hotmail.com Location: India
Notes	None

CTRI/2018/05/014150

Study name	Comparison of conventional laryngoscope with video laryngoscope
Methods	RCT; parallel design
Participants	**Number of expected participants:** 120 **Inclusion criteria:** patients of either sex; age 20-70; ASA grade I and II; Mallampati 1, 2, 3 and 4 **Exclusion criteria**: patient refusal; age < 20 and > 70 years; ASA III and IV; patients with pulmonary aspiration of gastric contents (e.g. pregnancy, diabetes)

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CTRI/2018/05/014150 *(Continued)*

	Setting: theatre
Interventions	Macintosh vs McGrath vs Truview
Outcomes	Duration of laryngoscopy and intubation; CL grading; evaluate ease of intubation; number of attempts and any optimization manoeuvres required for intubation, haemodynamic response; any trauma caused due to laryngoscopy
Starting date	01 November 2017
Contact information	Study leader: Gurleen Kaur Email: doctorgurleen@gmail.com Location: India
Notes	None

CTRI/2018/10/015874

Study name	Comparison of intubation conditions between three different types of laryngoscopes during rapid sequence induction intubation
Methods	RCT; parallel design
Participants	**Number of expected participants:** 300 **Inclusion criteria:** ASA I or II, age 18-60 years, both sexes, patients with normal airway parameters, patients who are posted for elective surgeries under GA requiring oral tracheal tube **Exclusion criteria:** patients with anticipated difficult intubation or difficult mask ventilation, patients with uncontrolled hypertension, cardiac disorders where haemodynamic responses to intubation may not be tolerated, patients with poor pulmonary reserve where early desaturation is expected, patients with active secreting adrenal tumours. patients with large thyroid mass or other neck masses precipitating difficult airway, patients with BMI > 30 kg/m^2, paediatric age group, pregnant women, C-spine fracture or other cervical disorders with restricted neck movement or unstable C-spine, faciomaxillary injury or anomalies, abnormalities of airway like burn contractures and cleft lip/palate, temporomandibular ankyloses, unwillingness to give consent **Setting**: theatre
Interventions	Macintosh vs McGrath vs Airtraq
Outcomes	"We hypothesized that channeled video laryngoscope would provide better visualization in lesser time and safer for use in conditions of simulated difficult airway with RSI requiring cricoid pressure as compared to non-channeled video laryngoscope and conventional laryngoscope."
Starting date	01 October 2018
Contact information	Study leader: Krishna Rao M Email: maremanda.krishnarao@gmail.com Location: India
Notes	None

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CTRI/2018/10/016006

Study name	Comparison of intubating devices in adult patients (Tuoren video laryngoscope, Airtraq and Macintosh laryngoscope)
Methods	RCT; parallel design
Participants	**Number of expected participants:** 90 **Inclusion criteria:** ASA grade I and II patients; age 20-65 years; weight 40-75 kg; patients of both sexes; patients planned for elective surgery; all classes of Mallampati grades **Exclusion criteria**: previous history of multiple /failed intubation; predicted difficult laryngoscopy; any pathology of the oral cavity that may obstruct the insertion of device; mouth opening < 2.5 cm; potentially full stomach patients (trauma, morbid obesity, pregnancy, history of gastric regurgitation and heart burn) and at risk of oesophageal reflux (hiatus hernia) **Setting**: theatre
Interventions	Macintosh vs Airtraq vs Tuoren VL
Outcomes	Number of attempts; laryngoscopy time; intubation time; ease of intubation; glottic view (CL); need for adjustment manoeuvres; changes in heart rate and mean arterial pressure; trauma; postoperative sore throat within 24 h
Starting date	15 October 2018
Contact information	Study leader: Mohit Prakash Email: mohitprakashdx@gmail.com Location: India
Notes	None

CTRI/2019/05/019391

Study name	Comparison of Kingvision & Truview videolaryngoscopes with direct laryngoscope
Methods	RCT; parallel design
Participants	**Number of expected participants:** 120 **Inclusion criteria:** patients of either sex; age 20-70; ASA grade I and II; Mallampati 1-4 **Exclusion criteria**: patient refusal; age < 20 and > 70 years; ASA III and IV; patients with risk of pulmonary aspiration of gastric contents (e.g. pregnancy, diabetes); patients with history of uncontrolled hypertension; patients with history of cardiovascular disorder; patients with raised ICP. **Setting**: theatre
Interventions	Macintosh vs King Vision vs Truview
Outcomes	Time to intubation; haemodynamic parameters
Starting date	28 May 2019
Contact information	Study leader: Humaira Bashir

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CTRI/2019/05/019391 *(Continued)*

	Email: humairabashir90@gmail.com Location: India
Notes	None

CTRI/2019/06/019526

Study name	Comparison of videolaryngoscopy and direct laryngoscopy for intubation in emergency surgeries
Methods	RCT; parallel design
Participants	**Number of expected participants:** 240 **Inclusion criteria:** age 18-60; either gender, belonging to ASA grade I-III, undergoing emergency surgeries requiring tracheal tube **Exclusion criteria:** patients with maxillo-facial trauma; suspected cervical injury requiring C-spine immobilization; known or anticipated difficult airway; patients with cardiac arrest undergoing CPR; haemodynamically unstable patients **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	First pass success rate; time to intubation; number of attempts; modified CL grading; rescue device, if needed
Starting date	15 June 2019
Contact information	Study leader: Tavishi Bansal Email: tavishi.bansal@yahoo.co.in Location: India
Notes	None

CTRI/2019/11/021953

Study name	Comparison of three devices used for placement of tube into the trachea for delivering of oxygen or anaesthesia to the lungs
Methods	RCT; parallel design
Participants	**Number of expected participants:** 90 **Inclusion criteria:** age 20-70; ASA Grade I and II patients; weight 40-70 kg; patients planned for elective surgery; all classes of Mallampati grades **Exclusion criteria**: previous history of multiple or failed intubation; predicted difficult laryngoscopy; any pathology of the oral cavity that may obstruct the insertion of device; mouth opening < 2.5 cm; potentially full stomach patients and at risk of oesophageal reflux **Setting**: theatre

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CTRI/2019/11/021953 *(Continued)*

Interventions	Macintosh vs Airtraq vs Split type Postman VL
Outcomes	Number of attempts; time to intubate; ease of intubation; need for adjustment manoeuvres; changes in HR and mean arterial BP; complications
Starting date	19 November 2019
Contact information	Study leader: Nisanth N S Email: nisanth0054@gmail.com Location: India
Notes	None

CTRI/2019/12/022303

Study name	Comparison of MacGrath videolaryngoscope with conventional Macintosh laryngosope for endo-tracheal intubation in adult population - a randomized controlled study
Methods	RCT; parallel design
Participants	**Number of expected participants:** 250 **Inclusion criteria:** age 18-60; all genders; elective surgery requiring tracheal intubation; ASA I and II; mouth opening ≥ 5 cm; Mallampati grade 1 and 2 **Exclusion criteria**: patient not willing to participate; patient with difficult intubation; abnormal airway anatomy; obesity (BMI > 30 kg/m^2); pregnancy **Setting**: theatre
Interventions	Macintosh vs McGrath
Outcomes	Intubation time; glottic view time; CL grade; number of attempts; optimization manoeuvres; vital parameters; complications
Starting date	11 December 2019
Contact information	Study leader: Dr Swati Bhatt Email: drswatibhatt2015@yahoo.com Location: India
Notes	

CTRI/2020/02/023154

Study name	Comparison of direct laryngoscopy and video laryngoscopy using C-MAC for glottic visualization in adults for elective surgery
Methods	RCT; parallel design
Participants	**Number of expected participants:** 110

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CTRI/2020/02/023154 *(Continued)*

	Inclusion criteria: adults of age 18-65 years of either gender with ASA grade I or II scheduled for elective surgery under GA with tracheal tube **Exclusion criteria**: anticipated difficult airway with BMI > 30kg/m^2; recent history of upper respiratory tract infection **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Comparison between glottic visualization using modified CL and POGO score during intubation using CMAC as DL and VL. Comparison between intubation characteristics – first attempt success rate, number of attempts, ease of insertion, total insertion time and haemodynamic response to intubation
Starting date	7 February 2020
Contact information	Study leader: Dr Rohan Khandelwal Email: Khandelwal.rohan3@gmail.com Location: India
Notes	None

CTRI/2020/04/024885

Study name	Comparative evaluation of intubation difficulty score using C-MAC video laryngoscope and Macintosh laryngoscope in obese during general anesthesia
Methods	RCT; parallel design
Participants	**Number of expected participants:** 50 **Inclusion criteria**: age 18-65, all genders, BMI > 30 kg/m^2 **Exclusion criteria**: patient refusal to take part, patients with history of reactive airway, all accepted contraindications to GA, known hypersensitivity to intravenous anaesthetic agents, patient at risk of pulmonary aspiration, gastro-oesophageal reflux disease, patients with upper airway pathology like tumours and fractures, tracheal stoma, C-spine injury and pregnancy **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	IDS; intubation time; respiratory and cardiovascular complications
Starting date	30 April 2020
Contact information	Study leader: Dr Ghazala Shabeen Email: Ghazala.Shabeena@gmail.com Location: India
Notes	Obese population

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CTRI/2020/04/024897

Study name	Comparative evaluation of King Vision video laryngoscope and Macintosh laryngoscope for anticipated difficult endotracheal intubation in patients undergoing surgery under general anaesthesia
Methods	RCT; parallel design
Participants	**Number of expected participants:** 80 **Inclusion criteria**: patient of either sex with ASA grade I and II plus any 1 or more of the following (Mallampati score grade 3 and 4; a thyromental distance < 6 cm; sternomental distance < 12 cm; abnormal upper teeth: loose or protruding upper teeth or partially missing upper teeth or canines or wide incisor gap; impaired temporomandibular joint mobility: inter incisor gap < 38 mm and inability to move the lower teeth in front of upper teeth (mandibular protrusion test grade 2 or grade 3) or limited mouth opening; limited neck movements: inability to extend or flex neck > 90° from full extension to full flexion; history of difficult laryngoscopy or intubation; BMI > 35kg/m^2; history of sleep apnoea; neck circumference > 40 cm in women and > 38 cm in men measured at thyroid cartilage **Exclusion criteria**: age < 20 years or >70 years; ASA III and IV; Mallampati score 1 and 2; patient with any contraindication to the use of succinylcholine **Setting**: theatre
Interventions	Macintosh vs King Vision
Outcomes	First pass success rate; number of attempts
Starting date	1 May 2020
Contact information	Study leader: Dr Rameez Raja Email: rameez_raja36@yahoo.com Location: India
Notes	

CTRI/2020/05/024960

Study name	Direct vs McGrath videolaryngoscope for tracheal intubation in trauma resuscitation bay - a randomized control trial
Methods	RCT; parallel design
Participants	**Number of expected participants:** 76 **Inclusion criteria**: all adult trauma victims reporting to trauma emergency and requiring definitive airway control with intubation will be enrolled in the study which includes patients with following indications; cognitive impairment (GCS ≤ 8); airway obstruction; severe hypoxaemia; hypoventilation; haemorrhagic shock **Exclusion criteria**: age < 18 years; suspecting traumatic injury to larynx; extensive maxillofacial injury requiring immediate surgical intervention; acute traumatic spinal cord injury; active vomiting; pregnant **Setting:** ED

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CTRI/2020/05/024960 *(Continued)*

Interventions	Macintosh vs McGrath
Outcomes	First-pass intubation success rate; time to intubation; hypoxic events; haemodynamic instability, peri-intubation aspiration, airway injuries, bleeding and oesophageal intubation
Starting date	1 May 2020
Contact information	Study leader: AJITH P Email: ajith.porur333@gmail.com Location: India
Notes	

CTRI/2020/06/025642

Study name	Comparative study of hemodynamic response during laryngoscopy and endotracheal intubation with MacIntosh, MacCoy and King Vision video laryngoscope in controlled hypertensive patients
Methods	RCT; parallel design
Participants	**Number of expected participants:** 102 **Inclusion criteria:** ASA grade I and II; Mallampati grade 1and 2; patients with controlled hypertension; age > 20 years and < 50 years; BMI < 30 kg/m^2; surgery lasting for 1-2 h; elective surgery under GA requiring tracheal tube **Exclusion criteria:** patient's refusal; ASA grade III and IV; Mallampati 3 and 4; anticipated difficult airway; laryngoscopy lasted for >30 s and required > 1 attempt; severe cardio-respiratory comorbidity; hepatorenal disease; neuropsychiatric disease; endocrinal disease; emergency surgeries; gastro-oesophageal reflux disease; pregnant patient; BMI > 30 kg/m^2) **Setting**: theatre
Interventions	Macintosh vs King Vision vs McCoy
Outcomes	Haemodynamic responses; time for laryngoscopy; time for intubation; postoperative complications
Starting date	9 June 2020
Contact information	Study leader: URMILA PALARIA Email: urmila_palaria@rediffmail.com Location: India
Notes	

CTRI/2020/08/027190

Study name	A clinical trial to study and compare the distance between the mouth of the laryngoscopist and the patient using a CMAC videolaryngoscope and a direct laryngoscope

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CTRI/2020/08/027190 *(Continued)*

Methods	RCT; parallel design
Participants	**Number of expected participants:** 110 **Inclusion criteria:** patients undergoing elective surgeries under GA and belonging to ASA physical status I and II **Exclusion criteria:** patients presenting for emergency surgeries and with an anticipated difficult airway **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Mouth-to-mouth distance between the laryngoscopist and patient; angle formed between the oral cavity of the laryngoscopist and patient; ease of intubation
Starting date	18 August 2020
Contact information	Study leader: Surabhi Gupta Email: sub131@gmail.com Location: India
Notes	

CTRI/2020/09/028011

Study name	Comparison of C-MAC video-laryngoscope with D-BLADE, C-MAC video-laryngoscope with standard blade, and Macintosh laryngoscopes for intubation with cervical spine immobilization: a randomized study
Methods	RCT; parallel design
Participants	**Number of expected participants:** 123 **Inclusion criteria:** patients aged 18-60 years of either gender belonging to ASA physical status I–II undergoing elective C-spine surgery requiring GA **Exclusion criteria:** patients with risk factors for difficult mask ventilation; patients with risk factors for gastric aspiration (obesity); patients with difficult airway such as previous neck surgery and mouth opening < 3 cm; anticipated difficult airway including Mallampati grade 3 and 4 airway **Setting**: theatre
Interventions	Macintosh vs C-MAC vs C-MAC D-BLADE
Outcomes	CL grade of laryngoscopic view; time taken for successful intubation; success rate of first attempt intubation; number of attempts of intubation; number of optimization manoeuvres required; complications; difficulty score laryngoscope blade will be noted; haemodynamic changes
Starting date	1 October 2020
Contact information	Study leader: Niraj Kumar Email: drnirajaiims@gmail.com

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CTRI/2020/09/028011 *(Continued)*

	Location: India
Notes	

CTRI/2020/11/029369

Study name	A comparative study of haemodynamic response following laryngoscopy and endotracheal intubation with direct laryngoscope versus video laryngoscope intubation in patients undergoing general anaesthesia
Methods	RCT; parallel design
Participants	**Number of expected participants:** 60 **Inclusion criteria:** patients undergoing elective laparoscopic surgeries under GA, patients aged > 18 and < 60 years, both genders, ASA I and II, Mallampati class 1 and 2 **Exclusion criteria**: pregnancy, BMI > 35, emergency surgery, conditions causing raised ICP, ASA > III, Mallampati 3 and 4 **Setting**: theatre
Interventions	Macintosh vs C-MAC D-BLADE
Outcomes	Haemodynamic response following laryngoscopy and tracheal tube
Starting date	30 November 2020
Contact information	Study leader: Mahalakshmi Email: deterministicmaha@gmail.com Location: India
Notes	

CTRI/2021/01/030476

Study name	A prospective randomized study to compare and evaluate the haemodynamic derangements using screen video laryngoscope and Macintosh laryngoscope as intubating devices in adult patients
Methods	RCT; parallel design
Participants	**Number of expected participants:** 80 **Inclusion criteria:** ASA grade I and II patients. Age between 20-60 years; weight between 40-70 kg; either sex; planned for elective surgery **Exclusion criteria:** patients with previous history of multiple/failed intubation; predicted difficult laryngoscopy except for all class of Mallampati grades; any pathology of the oral cavity that may obstruct the insertion of device; mouth opening < 2.5cm; potentially full stomach patients (trauma, morbid obesity, pregnancy, history of gastric regurgitation and heart burn) and at risk of oesophageal reflux (hiatus hernia) **Setting**: theatre

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CTRI/2021/01/030476 *(Continued)*

Interventions	Macintosh vs "screen video laryngoscope"
Outcomes	Haemodynamic changes; success rate of intubation; time taken for intubation; manoeuvres needed for successful intubation; ease of intubation; number of attempts taken for intubation; complications if any
Starting date	31 January 2021
Contact information	Study leader: MOHD AMIR HASAN KHAN Email: aamirhsnkhn@gmail.com Location: India
Notes	

IRCT2016062728668N1

Study name	Comparison of the intubation success rate in video laryngoscopy versus direct laryngoscopy in patients with Philadelphia collar
Methods	RCT; parallel design
Participants	**Number of expected participants:** 172 **Inclusion criteria:** patients with Philadelphia collar aged 18-60 years; ASA physical status I, II; surgery under GA **Exclusion criteria:** diabetes mellitus; rheumatoid arthritis; obstructive sleep apnoea; surgery on the head and neck; musculoskeletal disorders; poor oral health; emergency surgery; cardiovascular disease; having a beard; impaired ventilation **Setting**: theatre
Interventions	Macintosh vs "video laryngoscope"
Outcomes	Intubation success rate; neck circumference; HR; mean arterial pressure; CL grade; duration of intubation; number of intubation attempts; oral and dental injury; cough during extubation; temporomandibular distance
Starting date	22 September 2016
Contact information	Study leader: Amin Karami Email: a-karami@student.tums.ac.ir Location: Iran
Notes	

IRCT2016102718063N4

Study name	Comparing hemodynamic effects of conventional laryngoscope versus video laryngoscope in surgeries of Imam Reza hospital of Birjand in 2015

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IRCT2016102718063N4 *(Continued)*

Methods	RCT; parallel design
Participants	**Number of expected participants:** 42 **Inclusion criteria:** age 18-50 years old; would like to participate in the study after a full explanation of the research objectives and methods advantages and disadvantages; ASA I and II **Exclusion criteria:** emergency patients; patients who are diagnosed unstable in haemodynamic parameters; patients with a variety of systemic diseases (hypertension, diabetes mellitis, chronic obstructive pulmonary disease, asthma, etc.); patients with a history of drug abuse; patients with high Mallampati 2; patients with a BMI > 35; patients suffering from neck movements; difficult intubation criteria; patients who have difficulty in opening mouth **Setting**: theatre
Interventions	Macintosh vs "video laryngoscope"
Outcomes	Mean Systolic Blood Pressure; Heart Rate
Starting date	21 June 2016
Contact information	Study leader: Ali Rajabpour Sanati Email: ali.poursanati@bums.ac.ir Location: Iran
Notes	

IRCT20190614043888N1

Study name	Comparative study of complications during and after intubation in patients undergoing surgery by direct and video laryngoscopy in Fatemi hospital in 1397 and 1398
Methods	RCT; parallel design
Participants	**Number of expected participants:** 132 **Inclusion criteria**: patient needs GA by intubation; patient agrees to participate in the study; ASA I and II; candidate for elective surgery; aged 18-70 years **Exclusion criteria:** change in intubation, e.g. RSI emergent patient; anatomical disorders of mouth or tongue or face; the patient has a cardiopulmonary disease; patient has a cold **Setting**: theatre
Interventions	Macintosh vs "video laryngoscope"
Outcomes	Duration of intubation and its success rate; haemodynamic status
Starting date	6 December 2019
Contact information	Study leader: Pedram Golestaneh Email: g.golestaneh@arums.ac.ir Location: Iran

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IRCT20190614043888N1 *(Continued)*

Notes	

NCT03271008

Study name	Comparison of the Vividtrac™ and other videolaryngoscopes in clinical practice
Methods	RCT; parallel design
Participants	**Number of expected participants:** 150 **Inclusion criteria:** written informed consent; > 18 years of age; elective intervention; no anticipated difficult airway or intubation; preoperative anaesthesia risk assessment by ASA physical status classification: ASA grade I-II **Exclusion criteria:** none **Setting**: theatre
Interventions	Macintosh vs King Vision vs VividTrac
Outcomes	Intubation time; laryngoscopy time; POGO score; tube insertion time; primary intubation attempt success rate
Starting date	1 January 2017
Contact information	Study leader: Gábor László Woth Email: glwoth@gmail.com Location: Hungary
Notes	

NCT03516539

Study name	Mcgrath videolaryngoscope versus Macintosh laryngoscope in patients with manual in-line stabilization
Methods	RCT; parallel design
Participants	**Number of expected participants:** 100 **Inclusion criteria:** patients scheduled for GA requiring tracheal intubation. Patients are aged 19-70 years and are ASA I, II **Exclusion criteria:** patients requiring RSI; patients with poor teeth or high risk of aspiration pneumonia; C-spine pathology, pharyngeal pathology **Setting**: theatre
Interventions	Macintosh vs McGrath
Outcomes	Intubation success rate; time required for intubation; IDS; complications
Starting date	11 December 2017

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NCT03516539 *(Continued)*

Contact information	Study leader: Yi Hwa Choi Email: pcyhchoi@hallym.or.kr Location: South Korea
Notes	

NCT03613103

Study name	Airway injuries after intubation using videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation
Methods	RCT; parallel design
Participants	**Number of expected participants:** 716 **Inclusion criteria**: > 18 years of age; scheduled for a procedure or surgery that requires GA that requires orotracheal intubation; scheduled for non-cardiac surgery; elective surgery **Exclusion criteria**: pregnant women; patient refuses to participate in the study before surgery; patients with predictors of anticipated difficult airway; head and neck surgery; go to ICU with tracheal tube **Setting**: theatre
Interventions	Macintosh vs "highly curved" VL
Outcomes	Number of participants with an airway injury; successful intubation at the first attempt; global of successful intubation; CL visualization; time to achieve orotracheal intubation; post-anaesthetic satisfaction; hypoxaemia during induction and intubation; bradycardia during induction and intubation; cardiac arrest
Starting date	1 October 2018
Contact information	Study leader: Fabian Casas Email: fabian.casas@udea.edu.co Location: Colombia
Notes	

NCT03710096

Study name	Comparison of McGrath and Macintosh laryngoscopes for insertion of a double lumen tube by residents (MacGrathDES)
Methods	RCT; parallel design
Participants	**Number of expected participants:** 148 **Inclusion criteria**: thoracic surgery; insertion of DLT

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NCT03710096 *(Continued)*

	Exclusion criteria: emergency surgery; risk of inhalation; person unable to consent; people deprived of liberty, under guardianship or trusteeship; pregnant or lactating woman; allergy to Tracrium, propofol, sufentanil **Setting**: theatre
Interventions	Macintosh vs McGrath
Outcomes	Rate of success of intubation in both groups at the first attempt; individual determination of CL stage; rate of good positioning of DLT confirmed by fibroscopy; rate of participants with increase in SBP of > 20% compared to the measurement before insertion of the probe; intubation time; rate of participants with pharyngeal pains upon awakening
Starting date	4 November 2018
Contact information	Study leader: Jacques Desbordes Email: jacques.desbordes@chru-lille.fr Location: France
Notes	

NCT03887897

Study name	First attempt intubation rate with Airtraq vs Macintosh direct laryngoscope (FAIRAiM)
Methods	RCT; parallel design
Participants	**Number of expected participants:** 1586 **Inclusion criteria:** adult (> 18 years) patients; receiving GA that requires tracheal intubation **Exclusion criteria:** known or predicted difficult bag-mask ventilation; patients scheduled for (awake or asleep) fibreoptic intubation; patients requiring RSI; language or cognitive problems that preclude adequate informed consent being obtained; patient or anaesthetist refusal **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	First-pass success in tracheal intubation; time to successful tracheal intubation; hoarseness; sore throat; use of adjuncts during tracheal intubation; requirement of additional manoeuvres
Starting date	2 October 2019
Contact information	Study leader: Matthew TV Chan Email: mtvchan@cuhk.edu.hk Location: Hong Kong
Notes	

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NCT04185675

Study name	Comparison of two types of videolaryngoscope and direct laryngoscope in expected non-difficult airway patients
Methods	RCT; parallel design
Participants	**Number of expected participants:** 300 **Inclusion criteria:** age 18-65 years; ASA I-II; BMI 18-30 kg/m^2; scheduled to receive elective surgery under GA with expected non-difficult airway in operation rooms **Exclusion criteria:** expected difficult airway; allergy to anaesthesia induction drugs; scheduled to receive surgeries affecting vocalization; with high reflux aspiration risk; with acute and chronic cardiac or respiratory failure; with glucocorticoids medication history; with mental disorder or transferred to surgical ICU or ICU after surgery, who can not co-operate well with others; refused or have participated in other clinical trials that may have effects on the outcomes of this study **Setting**: theatre
Interventions	Macintosh vs "adjustable" VL' vs "non-adjustable" VL
Outcomes	Tracheal intubation time
Starting date	December 2019
Contact information	Study leader: Yanna Pi Email: piyanna@126.com Location: China
Notes	

NCT04386356

Study name	A comparative study of Airtraq versus Macintosh laryngoscope for endotracheal intubation by first year resident
Methods	RCT; parallel design
Participants	**Number of expected participants:** 60 **Inclusion criteria:** ASA physical status I and II; age group 16-65 years of either gender; patient requiring orotracheal intubation under GA **Exclusion criteria**: patient having respiratory tract (oropharynx, larynx) pathology; patient with predicted difficult airway (such as mouth opening < 2 cm); patient having gastro-oesophageal reflux disease, hiatus hernia, and pregnancy **Setting**: theatre
Interventions	Macintosh vs Airtraq
Outcomes	Time required for tracheal intubation; IDS; rate of successful placement of tracheal tube; number of optimization manoeuvres required to perform tracheal intubation; changes in HR before and immediately following intubation; incidence of trauma to the airway; changes in SBP, DBP and mean BP before and immediately following intubation; changes in oxygen saturation before and immediately following intubation

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NCT04386356 *(Continued)*

Starting date	1 February 2020
Contact information	Study leader: Sabin Bhandari Email: sabin7000@gmail.com Location: Nepal
Notes	

NCT04433884

Study name	Evaluation of hemodynamic response to laryngoscopy and endotracheal intubation using conventional laryngoscope versus C-MAC video laryngoscope in patients undergoing elective Coronary Artery Bypass Grafting (CABG) surgery
Methods	RCT; parallel design
Participants	**Number of expected participants:** 86 **Inclusion criteria**: age 35-65; elective CABG; ASA III/IV; unanticipated difficult airway; Mallampati 1-2 **Exclusion criteria**: obese BMI > 35 kg/m^2; left main coronary artery critical disease; recent myocardial infarction or unstable angina; left heart failure/left ventricular ejection fraction < 35%; upper lip bite test class III; thyromental distance < 6.0 cm; emergency surgery; anticipated difficult airway; respiratory diseases; bleeding diathesis; neurological deficit; limited nuchal range of motion; gastro-oesophageal reflux disease **Setting**: theatre
Interventions	Macintosh vs C-MAC
Outcomes	Changes in BP; Changes in HR; arrhythmias; perioperative myocardial ischaemia
Starting date	7 June 2020
Contact information	Study leader: Sehrish Khan Email: sehrish.khan@aku.edu Location: Pakistan
Notes	

NCT04701762

Study name	Endotracheal intubation using videolaryngoscopy versus conventional direct laryngoscopy: a randomized multiple cross-over cluster trial
Methods	RCT; cross-over design
Participants	**Number of expected participants:** 14,943 **Inclusion criteria**: elective or emergent surgery requiring oral intubation for GA

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NCT04701762 *(Continued)*

	Exclusion criteria: the attending anaesthetist prefers a specific approach for a particular patient; awake fibreoptic intubation is clinically indicated; insertion of DLT **Setting**: theatre
Interventions	Macintosh vs GlideScope
Outcomes	The number of intubation attempts with the initial laryngoscopy instrument; intubation failure; any dental or airway injury
Starting date	1 March 2021
Contact information	Study leader: Roberta Johnson Email: johnsor13@ccf.org Location: USA
Notes	

NCT04794764

Study name	Videolaryngoscopy compared to direct laryngoscopy
Methods	RCT; parallel design
Participants	**Number of expected participants:** 1000 **Inclusion criteria**: age ≥ 18 years; capacity to consent; present written informed consent of the research participant **Exclusion criteria**: age <18 years; existing pregnancy; lack of consent; inability to consent; difficult airway/defined indications for awake intubation; participation in another study **Setting**: theatre
Interventions	Macintosh vs McGrath MAC
Outcomes	First pass intubation success rate; time to ventilation; CL classification; overall success rate; IDS; adverse events; complications
Starting date	24 July 2021
Contact information	Study leader: Marc Kriege Email: MaKriege@uni-mainz.de Location: Germany
Notes	

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PACTR201802003065126

Study name	Alternative airways challenges to difficult intubation scenario in well controlled hypertensive adult patients with vocal cord polyp.comparison between Airtraq, King Vision video laryngoscope, and the Macintosh laryngoscope. A Prospective randomized study
Methods	RCT; parallel design
Participants	**Number of expected participants:** 90 **Inclusion criteria:** patients included in this study were ASA I and II with well controlled hypertension, aged 30-70 years and patients with Mallampati grade 3 and 4 were also included especially if they had mouth opening > 18 mm **Exclusion criteria:** patients at risk of pulmonary aspiration, coagulopathy, hepatic disorders with bleeding tendency, with history of any cardiac disorders, neck flexion deformity and with mouth opening < 18 mm for men and 16 mm for women **Setting**: theatre
Interventions	Macintosh vs King Vision vs Airtraq
Outcomes	The number of intubation attempts, the number of optimization manoeuvres required (use of stylet, laryngeal manipulation) to help in tracheal intubation, the duration of successful intubation attempts; the incidence of complications, such as mucosal trauma, misplacement of tube in oesophagus, dental injury or bleeding and dental injury, haemodynamics parameters (HR, mean BP) , and oxygen saturation were also recorded at baseline, post-induction, immediately after intubation and at 1, 3, 5, 10 min post-intubation
Starting date	1 February 2018
Contact information	Study leader: Sherif Arafa Email: sherifarafa1020@gmail.com Location: Egypt
Notes	

PACTR202010891239155

Study name	Hemodynamic response to oro-tracheal intubation in elderly patients: direct laryngoscopy using Macintosh blades versus McGrath® video-laryngoscopy - a randomized clinical trial
Methods	RCT; parallel design
Participants	**Number of expected participants:** 52 **Inclusion criteria:** age > 65 years; ASA I or II; elective surgery with GA and oro-tracheal intubation; predicted operative time > 30 min **Exclusion criteria:** patient refusal or withdrawal of consent; urgent surgery; difficult airway management; preoperative haemodynamic instability; suspicion of cerebral injury or intracranial hypertension **Setting**: theatre
Interventions	Macintosh vs McGrath MAC

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PACTR202010891239155 *(Continued)*

Outcomes	Increase in SBP, or mean arterial pressure after laryngoscopy; difference in HR; onset of major cardiac events; postoperative laryngeal morbidity, including sore throat and hoarseness
Starting date	1 November 2020
Contact information	Study leader: Mahdi Fourati Email: mahdifourati4593@gmail.com Location: Tunisia
Notes	

RBR-92PM68

Study name	Direct laryngoscopy or videolaryngoscopy intubation in patients without difficult airway predictors randomized trial
Methods	RCT; parallel design
Participants	**Number of expected participants:** 100 **Inclusion criteria:** patients > 18 years old; with pre-anaesthetic physical status classification according to the ASA I or II, that is, without functional limitation or slight limitation **Exclusion criteria:** refusal of the patient or guardian; C-spine surgery; head and neck tumours or anatomical deviations of the airway; mandibular joint disease; cervical mobility restriction; coagulation disorders; morbid obesity and risk of bronchoaspiration **Setting**: theatre
Interventions	Direct laryngoscopy vs video laryngoscopy
Outcomes	External assessment of intubators in terms of quality of intubation technique with a 100-point score
Starting date	5 January 2020
Contact information	Study leader: Dayse dos Santos de Almeida Rodrigues Email: dsa.arodrigues@gmail.com Location: Brazil
Notes	

ASA: American Society of Anesthesiologists (physical status classification); **BMI:** body mass index; **BP:** blood pressure; **BURP:** backwards, upwards, rightward pressure; **CABG:** coronary artery bypass graft; **CL**: Cormack-Lehane (Cormack 1984); **CPR:** cardiopulmonary respiration; **C-spine:** cervical spine; **DBP:** diastolic blood pressure; **DL:** direct laryngoscope; **DLT:** double-lumen tube; **GA:** general anaesthesia; **GCS:** Glasgow Coma Scale; **HR:** heart rate; **ICU:** intensive care unit; **ICP:** intracranial pressure; **ID:** identification; **IDS:** Intubation Difficulty Scale; **POGO:** percentage of glottic opening; **RCT:** randomized controlled trial; **RSI:** rapid sequence induction/intubation; **SBP:** systolic blood pressure; **VL:** videolaryngoscope

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DATA AND ANALYSES

Comparison 1. Macintosh-style VL versus DL

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Failed intubation	41	4615	Risk Ratio (M-H, Random, 95% CI)	0.41 [0.26, 0.65]
1.2 Hypoxaemia	16	2127	Risk Ratio (M-H, Random, 95% CI)	0.72 [0.52, 0.99]
1.3 Successful first attempt	42	7311	Risk Ratio (M-H, Random, 95% CI)	1.05 [1.02, 1.09]
1.4 Oesophageal intubation	14	2404	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.22, 1.21]
1.5 Dental trauma	18	2297	Risk Ratio (M-H, Random, 95% CI)	0.68 [0.16, 2.89]
1.6 Cormack-Lehane (CL) grade	38	13104	Risk Ratio (M-H, Random, 95% CI)	0.90 [0.81, 1.00]
1.6.1 Cormack-Lehane 1	38	4368	Risk Ratio (M-H, Random, 95% CI)	1.50 [1.39, 1.63]
1.6.2 Cormack-Lehane 2	38	4368	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.51, 0.76]
1.6.3 Cormack-Lehane 3-4	38	4368	Risk Ratio (M-H, Random, 95% CI)	0.38 [0.29, 0.48]
1.7 Time for tracheal intubation	35		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.8 Patient-reported sore throat	17	1960	Risk Ratio (M-H, Random, 95% CI)	0.85 [0.68, 1.07]
1.9 Number of attempts	31	6480	Risk Ratio (M-H, Random, 95% CI)	1.03 [0.98, 1.08]
1.9.1 1 attempt	31	3240	Risk Ratio (M-H, Random, 95% CI)	1.05 [1.01, 1.10]
1.9.2 2-4 attempts	31	3240	Risk Ratio (M-H, Random, 95% CI)	0.68 [0.46, 1.01]
1.10 Intubation Difficulty Scale (IDS)	4	801	Risk Ratio (M-H, Random, 95% CI)	1.05 [0.88, 1.25]
1.10.1 IDS 0	4	267	Risk Ratio (M-H, Random, 95% CI)	1.22 [0.87, 1.72]
1.10.2 IDS 1-5	4	267	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.84, 1.28]
1.10.3 IDS > 5	4	267	Risk Ratio (M-H, Random, 95% CI)	0.60 [0.25, 1.45]
1.11 POGO Score	5		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.12 Mortality	3	719	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.82, 1.24]
1.13 Subgroup analysis of failed intubation: airway difficulty	37	3925	Risk Ratio (M-H, Random, 95% CI)	0.40 [0.23, 0.68]

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.13.1 Predicted, known or simulated difficulty	12	1393	Risk Ratio (M-H, Random, 95% CI)	0.37 [0.19, 0.74]
1.13.2 No difficulty	25	2532	Risk Ratio (M-H, Random, 95% CI)	0.42 [0.16, 1.10]

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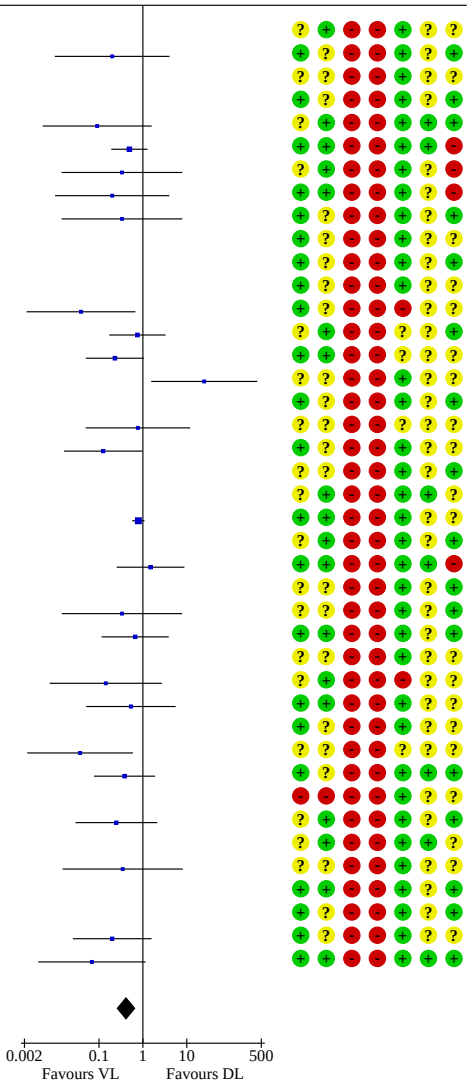
Analysis 1.1. Comparison 1: Macintosh-style VL versus DL, Outcome 1: Failed intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Aggarwal 2019	0	50	0	50		Not estimable
Akbar 2015	0	45	2	45	2.1%	0.20 [0.01 , 4.05]
Altaiee 2020	0	50	0	50		Not estimable
Anandraja 2021	0	30	0	30		Not estimable
Ander 2017	0	39	5	39	2.2%	0.09 [0.01 , 1.59]
Aziz 2012	6	149	12	147	10.7%	0.49 [0.19 , 1.28]
Bakshi 2019	0	37	1	37	1.9%	0.33 [0.01 , 7.93]
Bensghir 2010	0	34	2	34	2.1%	0.20 [0.01 , 4.02]
Bensghir 2013	0	35	1	35	1.9%	0.33 [0.01 , 7.91]
Bhat 2015	0	50	0	50		Not estimable
Blajic 2019	0	60	0	59		Not estimable
Cakir 2020	0	31	0	31		Not estimable
Cavus 2011 (1)	0	100	6	50	2.3%	0.04 [0.00 , 0.68]
Dey 2020	3	124	4	124	6.5%	0.75 [0.17 , 3.28]
Driver 2016	2	103	8	95	6.2%	0.23 [0.05 , 1.06]
Frohlich 2011	12	30	0	30	2.4%	25.00 [1.55 , 403.99]
Gupta 2013 (1)	0	60	0	60		Not estimable
Hostic 2016	1	52	1	40	2.4%	0.77 [0.05 , 11.92]
Jungbauer 2009	1	100	8	100	3.9%	0.13 [0.02 , 0.98]
Kaur 2020	0	40	0	40		Not estimable
Kido 2015	0	25	0	25		Not estimable
Kleine-Brueggeney 2017	41	120	52	120	18.5%	0.79 [0.57 , 1.09]
Kucukosman 2020	0	30	0	30		Not estimable
Lascarrou 2017	3	186	2	185	4.9%	1.49 [0.25 , 8.83]
Lee 2009	0	41	0	44		Not estimable
Lee 2012	0	25	1	25	1.9%	0.33 [0.01 , 7.81]
Lin 2012	2	85	3	85	5.0%	0.67 [0.11 , 3.89]
Maassen 2012	0	40	0	40		Not estimable
Macke 2020	0	76	3	76	2.1%	0.14 [0.01 , 2.72]
McElwain 2011	1	29	2	31	3.2%	0.53 [0.05 , 5.58]
Ninan 2016	0	30	0	30		Not estimable
Peck 2009	0	27	13	27	2.4%	0.04 [0.00 , 0.59]
Ruetzler 2020	2	66	5	63	5.8%	0.38 [0.08 , 1.90]
Sarkilar 2015	0	55	0	55		Not estimable
Serocki 2010	1	40	4	40	3.7%	0.25 [0.03 , 2.14]
Shimazaki 2018	0	20	0	20		Not estimable
Shippey 2013	0	24	1	25	1.9%	0.35 [0.01 , 8.12]
Teoh 2010	0	100	0	100		Not estimable
Wallace 2015 (1)	0	52	0	53		Not estimable
Yoo 2018	1	22	5	22	3.9%	0.20 [0.03 , 1.58]
Yumul 2016	0	30	7	31	2.3%	0.07 [0.00 , 1.15]
Total (95% CI)		**2342**		**2273**	**100.0%**	**0.41 [0.26 , 0.65]**
Total events:	76		148			

Heterogeneity: Tau² = 0.26; Chi² = 31.80, df = 23 (P = 0.10); I² = 28%
Test for overall effect: Z = 3.83 (P = 0.0001)
Test for subgroup differences: Not applicable



Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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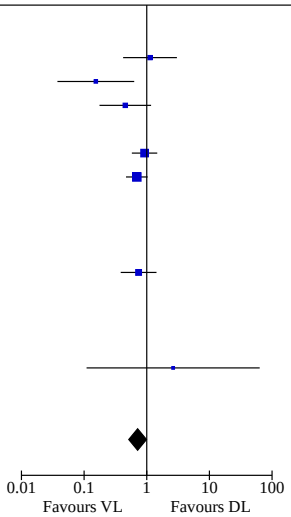
Analysis 1.2. Comparison 1: Macintosh-style VL versus DL, Outcome 2: Hypoxaemia

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Akbar 2015	0	45	0	45		Not estimable	+	?	-	-	+	?	+
Aziz 2012	8	149	7	147	9.2%	1.13 [0.42 , 3.03]	+	+	-	-	+	+	-
Bensghir 2010	2	34	13	34	4.9%	0.15 [0.04 , 0.63]	+	+	-	-	+	?	-
Bensghir 2013	5	35	11	35	9.8%	0.45 [0.18 , 1.17]	+	?	-	-	+	?	+
Bhat 2015	0	50	0	50		Not estimable	+	?	-	-	+	?	?
Driver 2016 (1)	26	103	26	95	26.6%	0.92 [0.58 , 1.47]	+	+	-	-	?	?	?
Goksu 2016 (2)	25	75	36	75	31.3%	0.69 [0.47 , 1.03]	?	+	-	-	+	?	-
Gupta 2013	0	60	0	60		Not estimable	+	?	-	-	+	?	+
Ing 2017	0	11	0	16		Not estimable	+	+	-	-	?	+	?
Kido 2015	0	25	0	25		Not estimable	?	+	-	-	+	+	?
Lascarrou 2017	14	173	19	174	17.3%	0.74 [0.38 , 1.43]	+	+	-	-	+	+	-
Lin 2012	0	83	0	82		Not estimable	+	+	-	-	+	?	+
Serocki 2010	0	40	0	40		Not estimable	?	+	-	-	+	?	+
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Thion 2018	1	65	0	57	1.0%	2.64 [0.11 , 63.47]	+	?	-	-	-	-	?
Yoo 2018	0	22	0	22		Not estimable	+	?	-	-	+	?	?
Total (95% CI)		**1070**		**1057**	**100.0%**	**0.72 [0.52 , 0.99]**							
Total events:	81		112										

Heterogeneity: Tau² = 0.05; Chi² = 8.11, df = 6 (P = 0.23); I² = 26%
Test for overall effect: Z = 2.02 (P = 0.04)
Test for subgroup differences: Not applicable



Footnotes
(1) ED intubation
(2) ED intubations.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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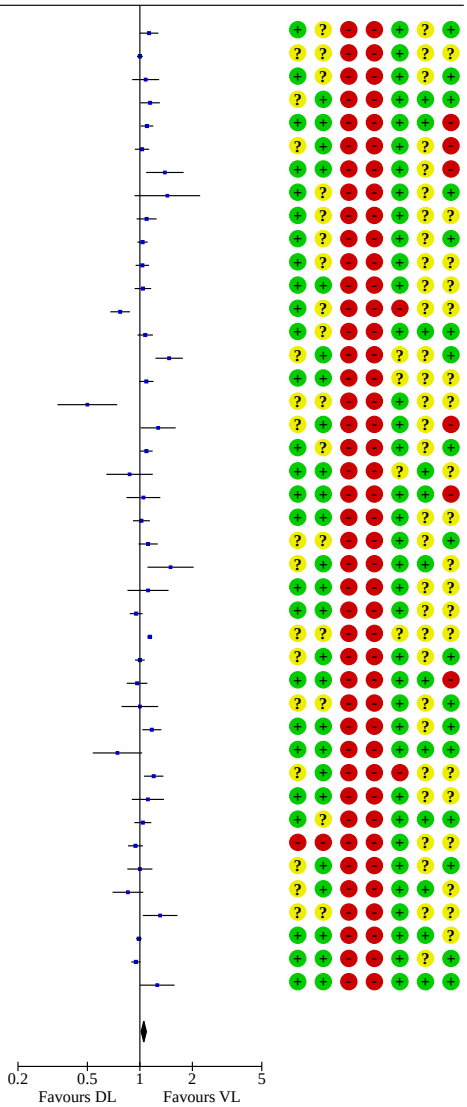
Analysis 1.3. Comparison 1: Macintosh-style VL versus DL, Outcome 3: Successful first attempt

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Akbar 2015	44	45	39	45	2.7%	1.13 [1.00 , 1.28]	+	?	-	-	+	?	+
Altaiee 2020	50	50	50	50	3.8%	1.00 [0.96 , 1.04]	?	?	-	-	+	?	?
Altun 2018 (1)	70	82	34	43	2.0%	1.08 [0.90 , 1.29]	+	?	-	-	+	?	+
Ander 2017	39	39	34	39	2.6%	1.14 [1.01 , 1.30]	?	+	-	-	+	+	+
Aziz 2012	138	149	124	147	3.3%	1.10 [1.01 , 1.19]	+	+	-	-	+	+	-
Bakshi 2019	36	37	35	37	3.1%	1.03 [0.94 , 1.13]	?	+	-	-	+	?	-
Bensghir 2010	32	34	23	34	1.3%	1.39 [1.09 , 1.78]	+	+	-	-	+	?	-
Bensghir 2013	23	35	16	35	0.6%	1.44 [0.93 , 2.22]	+	?	-	-	+	?	+
Bhat 2015	47	50	43	50	2.5%	1.09 [0.96 , 1.25]	+	?	-	-	+	?	?
Blajic 2019	59	60	56	59	3.5%	1.04 [0.97 , 1.11]	+	?	-	-	+	?	+
Cakir 2020	31	31	30	31	3.2%	1.03 [0.95 , 1.13]	+	?	-	-	+	?	?
Cattano 2013	25	25	24	25	2.9%	1.04 [0.93 , 1.16]	+	+	-	-	+	?	?
Cavus 2011 (1)	74	100	48	50	2.6%	0.77 [0.68 , 0.88]	+	?	-	-	-	?	?
Colak 2019	44	45	41	45	3.0%	1.07 [0.97 , 1.19]	+	?	-	-	+	+	+
Dey 2020	91	108	63	110	1.9%	1.47 [1.23 , 1.76]	?	+	-	-	?	?	+
Driver 2016	86	92	91	106	3.1%	1.09 [0.99 , 1.20]	+	+	-	-	?	?	?
Frohlich 2011	14	30	28	30	0.6%	0.50 [0.34 , 0.74]	?	?	-	-	+	?	?
Goksu 2016	56	75	44	75	1.4%	1.27 [1.01 , 1.60]	?	+	-	-	+	?	-
Gupta 2013 (1)	60	60	55	60	3.3%	1.09 [1.00 , 1.18]	+	?	-	-	+	?	+
Ing 2017	9	11	15	16	1.0%	0.87 [0.64 , 1.19]	+	+	-	-	?	+	?
Janz 2016	51	74	50	76	1.5%	1.05 [0.84 , 1.31]	+	+	-	-	+	+	-
Kapadia 2021	51	55	50	55	2.8%	1.02 [0.91 , 1.14]	+	+	-	-	+	?	?
Kaur 2020	39	40	35	40	2.6%	1.11 [0.98 , 1.27]	?	?	-	-	+	?	+
Kido 2015	24	25	16	25	1.0%	1.50 [1.11 , 2.03]	?	+	-	-	+	+	?
Kleine-Brueggeney 2017	59	120	53	120	1.2%	1.11 [0.85 , 1.46]	+	+	-	-	+	?	?
Kreutziger 2019	211	267	205	247	3.3%	0.95 [0.88 , 1.04]	+	+	-	-	+	?	?
Kriege 2020	1019	1084	896	1087	3.9%	1.14 [1.11 , 1.18]	?	?	-	-	?	?	?
Kucukosman 2020	30	30	30	30	3.6%	1.00 [0.94 , 1.07]	?	+	-	-	+	?	+
Lascarrou 2017	126	186	130	185	2.5%	0.96 [0.84 , 1.10]	+	+	-	-	+	+	-
Lee 2012	21	25	21	25	1.4%	1.00 [0.79 , 1.27]	?	?	-	-	+	?	+
Lin 2012	77	83	65	82	2.6%	1.17 [1.03 , 1.33]	+	+	-	-	+	?	+
Loughnan 2019	17	28	40	49	0.9%	0.74 [0.54 , 1.03]	+	+	-	-	+	+	+
Macke 2020	72	76	60	76	2.6%	1.20 [1.06 , 1.36]	?	+	-	-	-	?	?
McElwain 2011	26	29	25	31	1.6%	1.11 [0.90 , 1.37]	+	+	-	-	+	?	?
Ruetzler 2020	61	66	56	63	2.9%	1.04 [0.93 , 1.16]	+	?	-	-	+	+	+
Sarkilar 2015	50	55	53	55	3.1%	0.94 [0.86 , 1.04]	-	-	-	-	+	?	?
Serocki 2010	35	40	35	40	2.1%	1.00 [0.85 , 1.18]	?	+	-	-	+	?	+
Shimazaki 2018	17	20	20	20	1.7%	0.85 [0.70 , 1.05]	?	+	-	-	+	+	?
Shippey 2013	24	24	19	25	1.5%	1.31 [1.04 , 1.64]	?	?	-	-	+	?	?
Sulser 2016	73	74	73	73	3.9%	0.99 [0.95 , 1.02]	+	+	-	-	+	+	?
Teoh 2010	93	100	98	100	3.6%	0.95 [0.89 , 1.01]	+	+	-	-	+	?	+
Yumul 2016	28	30	23	31	1.5%	1.26 [1.00 , 1.58]	+	+	-	-	+	+	+
Total (95% CI)		**3689**		**3622**	**100.0%**	**1.05 [1.02 , 1.09]**							
Total events:	3232		2946										



Heterogeneity: Tau² = 0.01; Chi² = 181.55, df = 41 (P < 0.00001); I² = 77%
Test for overall effect: Z = 2.92 (P = 0.003)
Test for subgroup differences: Not applicable

Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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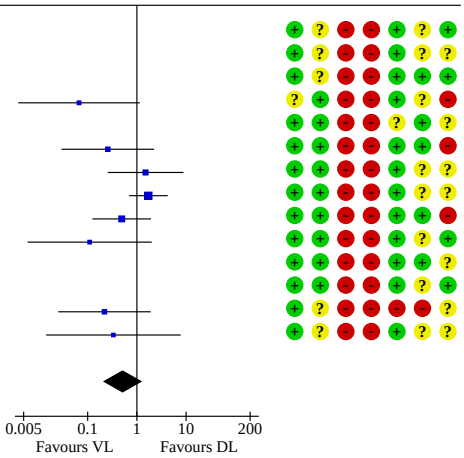
Analysis 1.4. Comparison 1: Macintosh-style VL versus DL, Outcome 4: Oesophageal intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Akbar 2015	0	45	0	45		Not estimable	+	?	-	-	+	?	+
Bhat 2015	0	50	0	50		Not estimable	+	?	-	-	+	?	?
Colak 2019	0	45	0	45		Not estimable	+	?	-	-	+	+	+
Goksu 2016	0	75	7	75	7.3%	0.07 [0.00 , 1.15]	?	+	-	-	+	?	-
Ing 2017	0	11	0	16		Not estimable	+	+	-	-	?	+	?
Janz 2016	1	74	4	76	10.9%	0.26 [0.03 , 2.24]	+	+	-	-	+	+	-
Kleine-Brueggeney 2017	3	120	2	120	14.1%	1.50 [0.26 , 8.82]	+	+	-	-	+	?	?
Kreutziger 2019	13	267	7	247	25.2%	1.72 [0.70 , 4.24]	+	+	-	-	+	?	?
Lascarrou 2017	3	184	6	181	18.5%	0.49 [0.12 , 1.94]	+	+	-	-	+	+	-
Lin 2012	0	83	4	82	7.0%	0.11 [0.01 , 2.01]	+	+	-	-	+	?	+
Sulser 2016	0	74	0	73		Not estimable	+	+	-	-	+	+	?
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Thion 2018	1	65	4	57	10.9%	0.22 [0.03 , 1.91]	+	?	-	-	-	-	?
Yoo 2018	0	22	1	22	6.2%	0.33 [0.01 , 7.76]	+	?	-	-	+	?	?
Total (95% CI)		**1215**		**1189**	**100.0%**	**0.51 [0.22 , 1.21]**							
Total events:	21		35										



Heterogeneity: Tau² = 0.55; Chi² = 11.55, df = 7 (P = 0.12); I² = 39%
Test for overall effect: Z = 1.53 (P = 0.13)
Test for subgroup differences: Not applicable

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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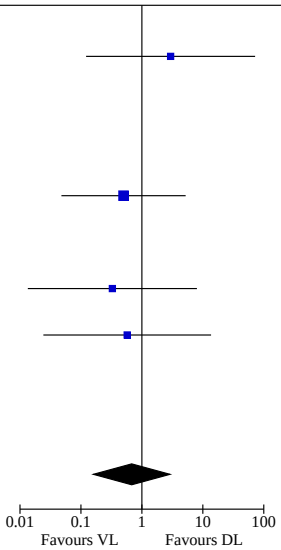
Analysis 1.5. Comparison 1: Macintosh-style VL versus DL, Outcome 5: Dental trauma

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Akbar 2015	0	45	0	45		Not estimable	+	?	-	-	+	?	+
Aziz 2012	1	149	0	147	20.6%	2.96 [0.12 , 72.08]	+	+	-	-	+	+	-
Bensghir 2010	0	34	0	34		Not estimable	+	+	-	-	+	?	-
Bensghir 2013	0	35	0	35		Not estimable	+	?	-	-	+	?	+
Bhat 2015	0	50	0	50		Not estimable	+	?	-	-	+	?	?
Cakir 2020	0	31	0	31		Not estimable	+	?	-	-	+	?	?
Cavus 2011 (1)	0	100	0	50		Not estimable	+	?	-	-	-	?	?
Frohlich 2011	1	30	2	30	38.0%	0.50 [0.05 , 5.22]	?	?	-	-	+	?	?
Gupta 2013 (1)	0	60	0	60		Not estimable	+	?	-	-	+	?	+
Ing 2017	0	11	0	16		Not estimable	+	+	-	-	?	+	?
Kleine-Brueggeney 2017	0	120	0	120		Not estimable	+	+	-	-	+	?	?
Lascarrou 2017	0	184	1	181	20.5%	0.33 [0.01 , 8.00]	+	+	-	-	+	+	-
Lee 2009	0	41	0	44		Not estimable	?	?	-	-	+	?	+
Loughnan 2019	0	28	1	49	20.9%	0.57 [0.02 , 13.65]	+	+	-	-	+	+	+
Maassen 2012	0	40	0	40		Not estimable	?	?	-	-	+	?	?
McElwain 2011	0	29	0	31		Not estimable	+	+	-	-	+	?	?
Sulser 2016	0	74	0	73		Not estimable	+	+	-	-	+	+	?
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Total (95% CI)		**1161**		**1136**	**100.0%**	**0.68 [0.16 , 2.89]**							
Total events:	2		4										

Heterogeneity: Tau² = 0.00; Chi² = 1.10, df = 3 (P = 0.78); I² = 0%
Test for overall effect: Z = 0.52 (P = 0.60)
Test for subgroup differences: Not applicable



Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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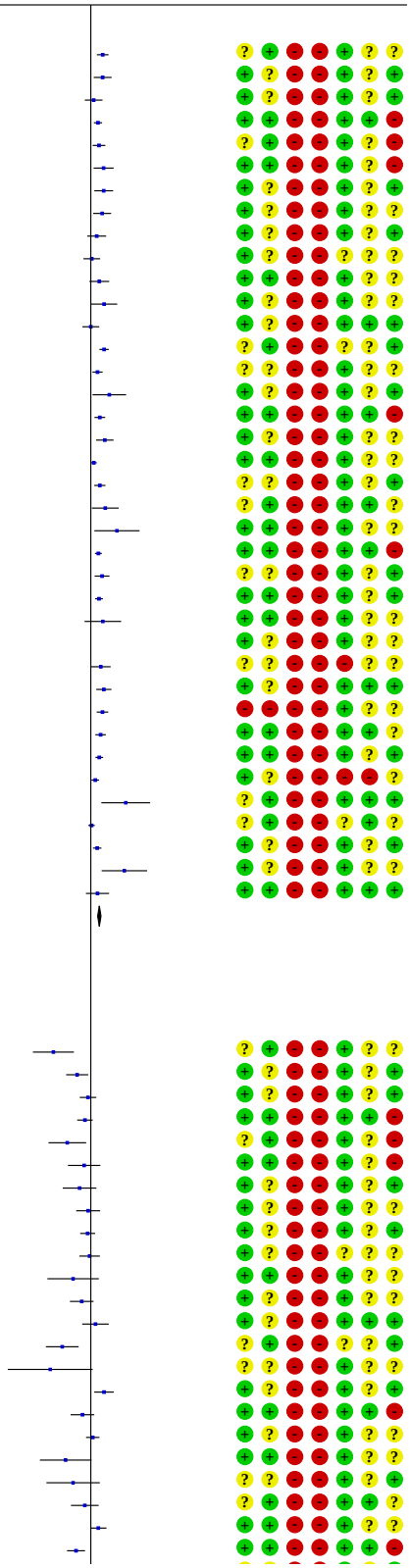
Analysis 1.6. Comparison 1: Macintosh-style VL versus DL, Outcome 6: Cormack-Lehane (CL) grade

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
1.6.1 Cormack-Lehane 1						
Aggarwal 2019	46	50	26	50	1.5%	1.77 [1.34 , 2.34]
Akbar 2015	30	45	17	45	1.3%	1.76 [1.15 , 2.71]
Altun 2018 (1)	39	80	17	40	1.3%	1.15 [0.75 , 1.75]
Aziz 2012	103	149	72	147	1.6%	1.41 [1.16 , 1.72]
Bakshi 2019	32	37	21	36	1.4%	1.48 [1.09 , 2.01]
Bensghir 2010	24	34	13	34	1.2%	1.85 [1.14 , 2.98]
Bensghir 2013	26	35	14	35	1.3%	1.86 [1.18 , 2.91]
Bhat 2015	31	50	18	50	1.3%	1.72 [1.12 , 2.64]
Blajic 2019	27	60	20	59	1.3%	1.33 [0.84 , 2.09]
Caparlar 2019	22	39	21	39	1.3%	1.05 [0.70 , 1.56]
Cattano 2013	18	25	12	25	1.2%	1.50 [0.93 , 2.41]
Chandrashekaraiah 2017	17	30	9	30	1.0%	1.89 [1.01 , 3.55]
Colak 2019	23	45	23	45	1.3%	1.00 [0.67 , 1.50]
Dey 2020	91	108	49	110	1.5%	1.89 [1.51 , 2.37]
Frohlich 2011	29	30	21	30	1.5%	1.38 [1.08 , 1.76]
Gupta 2013 (1)	17	60	7	60	0.8%	2.43 [1.09 , 5.43]
Janz 2016	57	74	38	76	1.5%	1.54 [1.19 , 1.99]
Jungbauer 2009	45	100	23	100	1.3%	1.96 [1.29 , 2.97]
Kapadia 2021	52	55	45	55	1.6%	1.16 [1.00 , 1.33]
Kaur 2020	37	40	24	40	1.5%	1.54 [1.18 , 2.02]
Kido 2015	16	25	8	25	1.0%	2.00 [1.05 , 3.80]
Kleine-Brueggeney 2017	14	120	4	120	0.6%	3.50 [1.19 , 10.33]
Lascarrou 2017	133	176	93	177	1.6%	1.44 [1.22 , 1.69]
Lee 2012	24	25	14	25	1.4%	1.71 [1.20 , 2.45]
Lin 2012	75	83	50	82	1.6%	1.48 [1.23 , 1.79]
McElwain 2011	10	29	6	31	0.8%	1.78 [0.74 , 4.28]
Ninan 2016	0	30	0	30		Not estimable
Rajasekhar 2020	21	30	13	30	1.2%	1.62 [1.01 , 2.59]
Ruetzler 2020	45	66	23	63	1.4%	1.87 [1.30 , 2.69]
Sarkilar 2015	49	55	28	55	1.5%	1.75 [1.33 , 2.31]
Sulser 2016	60	74	37	73	1.5%	1.60 [1.24 , 2.06]
Teoh 2010	87	100	58	100	1.6%	1.50 [1.25 , 1.80]
Thion 2018	58	65	41	57	1.6%	1.24 [1.03 , 1.49]
Toker 2019	16	50	3	50	0.5%	5.33 [1.66 , 17.17]
Verma 2020	28	30	27	30	1.6%	1.04 [0.89 , 1.21]
Wallace 2015	48	52	36	53	1.5%	1.36 [1.11 , 1.66]
Yoo 2018	15	22	3	22	0.6%	5.00 [1.68 , 14.87]
Yumul 2016	16	30	12	31	1.1%	1.38 [0.79 , 2.40]
Subtotal (95% CI)		**2208**		**2160**	**47.8%**	**1.50 [1.39 , 1.63]**
Total events:	1481		946			
Heterogeneity: Tau² = 0.03; Chi² = 83.58, df = 36 (P < 0.0001); I² = 57%						
Test for overall effect: Z = 10.15 (P < 0.00001)						
1.6.2 Cormack-Lehane 2						
Aggarwal 2019	4	50	24	50	0.7%	0.17 [0.06 , 0.45]
Akbar 2015	13	45	25	45	1.2%	0.52 [0.31 , 0.88]
Altun 2018 (1)	35	80	20	40	1.3%	0.88 [0.59 , 1.30]
Aziz 2012	36	149	47	147	1.4%	0.76 [0.52 , 1.09]
Bakshi 2019	5	37	15	36	0.7%	0.32 [0.13 , 0.80]
Bensghir 2010	8	34	11	34	0.9%	0.73 [0.33 , 1.58]
Bensghir 2013	7	35	12	35	0.8%	0.58 [0.26 , 1.31]
Bhat 2015	15	50	17	50	1.1%	0.88 [0.50 , 1.57]
Blajic 2019	28	60	32	59	1.4%	0.86 [0.60 , 1.23]
Caparlar 2019	17	39	18	39	1.2%	0.94 [0.58 , 1.55]
Cattano 2013	3	25	7	25	0.5%	0.43 [0.12 , 1.47]
Chandrashekaraiah 2017	11	30	17	30	1.1%	0.65 [0.37 , 1.14]
Colak 2019	15	45	12	45	1.0%	1.25 [0.66 , 2.36]
Dey 2020	7	108	28	110	0.9%	0.25 [0.12 , 0.56]
Frohlich 2011	1	30	7	30	0.2%	0.14 [0.02 , 1.09]
Gupta 2013 (1)	32	60	17	60	1.2%	1.88 [1.18 , 3.00]
Janz 2016	15	74	23	76	1.1%	0.67 [0.38 , 1.18]
Jungbauer 2009	45	100	41	100	1.4%	1.10 [0.80 , 1.51]
Kapadia 2021	3	55	10	55	0.5%	0.30 [0.09 , 1.03]
Kaur 2020	3	40	7	40	0.5%	0.43 [0.12 , 1.54]
Kido 2015	9	25	12	25	1.0%	0.75 [0.39 , 1.46]
Kleine-Brueggeney 2017 (2)	43	120	30	120	1.3%	1.43 [0.97 , 2.12]
Lascarrou 2017	25	176	51	177	1.3%	0.49 [0.32 , 0.76]



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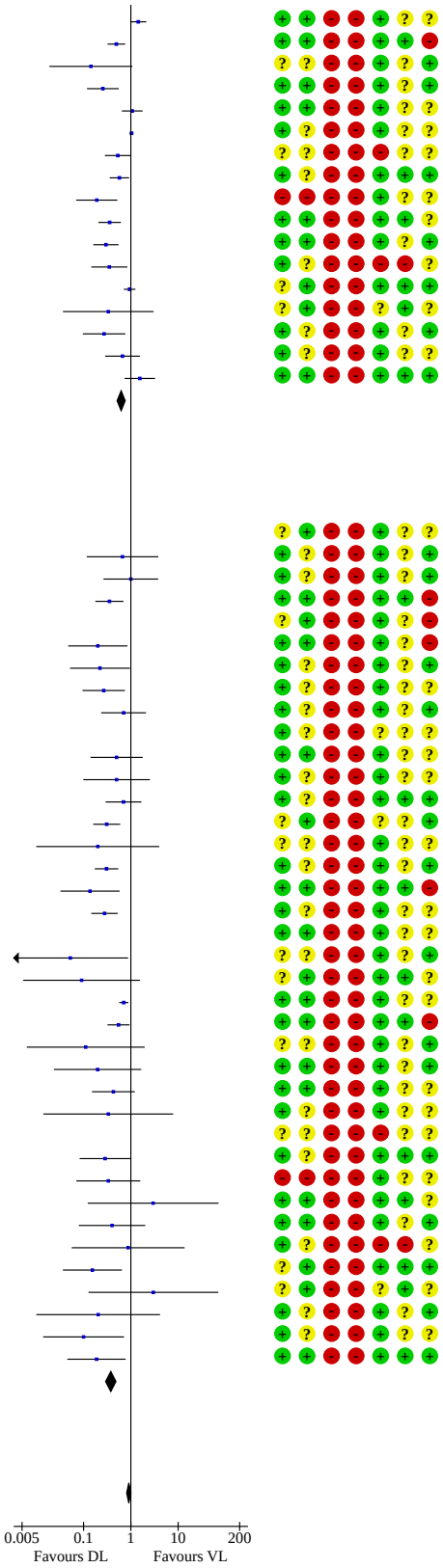
Analysis 1.6. (Continued)

Kleine-Brueggeney 2017 (2)	43	120	30	120	1.3%	1.43 [0.97 , 2.12]
Lascarrou 2017	25	176	51	177	1.3%	0.49 [0.32 , 0.76]
Lee 2012	1	25	7	25	0.2%	0.14 [0.02 , 1.08]
Lin 2012	7	83	27	82	0.9%	0.26 [0.12 , 0.55]
McElwain 2011	15	29	15	31	1.2%	1.07 [0.64 , 1.77]
Ninan 2016 (3)	30	30	29	30	1.6%	1.03 [0.94 , 1.13]
Rajasekhar 2020	9	30	17	30	1.0%	0.53 [0.28 , 0.99]
Ruetzler 2020 (2)	18	66	30	63	1.2%	0.57 [0.36 , 0.92]
Sarkilar 2015	4	55	21	55	0.7%	0.19 [0.07 , 0.52]
Sulser 2016	13	74	36	73	1.1%	0.36 [0.21 , 0.61]
Teoh 2010	11	100	37	100	1.1%	0.30 [0.16 , 0.55]
Thion 2018	6	65	15	57	0.8%	0.35 [0.15 , 0.84]
Toker 2019	32	50	34	50	1.5%	0.94 [0.71 , 1.25]
Verma 2020	1	30	3	30	0.2%	0.33 [0.04 , 3.03]
Wallace 2015	4	52	15	53	0.6%	0.27 [0.10 , 0.76]
Yoo 2018	6	22	9	22	0.8%	0.67 [0.29 , 1.56]
Yumul 2016	12	30	8	31	0.9%	1.55 [0.74 , 3.25]
Subtotal (95% CI)		**2208**		**2160**	**36.6%**	**0.62 [0.51 , 0.76]**
Total events:	549		786			
Heterogeneity: Tau² = 0.25; Chi² = 205.34, df = 37 (P < 0.00001); I² = 82%						
Test for overall effect: Z = 4.68 (P < 0.00001)						
1.6.3 Cormack-Lehane 3-4						
Aggarwal 2019	0	50	0	50		Not estimable
Akbar 2015	2	45	3	45	0.3%	0.67 [0.12 , 3.80]
Altun 2018 (1)	6	80	3	40	0.5%	1.00 [0.26 , 3.79]
Aziz 2012	10	149	28	147	1.0%	0.35 [0.18 , 0.70]
Bakshi 2019	0	37	0	36		Not estimable
Bensghir 2010	2	34	10	34	0.4%	0.20 [0.05 , 0.85]
Bensghir 2013	2	35	9	35	0.4%	0.22 [0.05 , 0.96]
Bhat 2015	4	50	15	50	0.6%	0.27 [0.10 , 0.75]
Blajic 2019	5	60	7	59	0.6%	0.70 [0.24 , 2.09]
Caparlar 2019	0	39	0	39		Not estimable
Cattano 2013	3	25	6	25	0.5%	0.50 [0.14 , 1.78]
Chandrashekaraiah 2017	2	30	4	30	0.3%	0.50 [0.10 , 2.53]
Colak 2019	7	45	10	45	0.8%	0.70 [0.29 , 1.68]
Dey 2020	10	108	33	110	1.0%	0.31 [0.16 , 0.59]
Frohlich 2011	0	30	2	30	0.1%	0.20 [0.01 , 4.00]
Gupta 2013 (1)	11	60	36	60	1.1%	0.31 [0.17 , 0.54]
Janz 2016	2	74	15	76	0.4%	0.14 [0.03 , 0.58]
Jungbauer 2009	10	100	36	100	1.0%	0.28 [0.15 , 0.53]
Kapadia 2021	0	55	0	55		Not estimable
Kaur 2020	0	40	9	40	0.1%	0.05 [0.00 , 0.87]
Kido 2015	0	25	5	25	0.1%	0.09 [0.01 , 1.56]
Kleine-Brueggeney 2017	58	120	82	120	1.5%	0.71 [0.57 , 0.88]
Lascarrou 2017	18	176	33	177	1.2%	0.55 [0.32 , 0.94]
Lee 2012	0	25	4	25	0.1%	0.11 [0.01 , 1.96]
Lin 2012	1	83	5	82	0.2%	0.20 [0.02 , 1.65]
McElwain 2011	4	29	10	31	0.6%	0.43 [0.15 , 1.21]
Ninan 2016	0	30	1	30	0.1%	0.33 [0.01 , 7.87]
Rajasekhar 2020	0	30	0	30		Not estimable
Ruetzler 2020	3	66	10	63	0.5%	0.29 [0.08 , 0.99]
Sarkilar 2015	2	55	6	55	0.4%	0.33 [0.07 , 1.58]
Sulser 2016	1	74	0	73	0.1%	2.96 [0.12 , 71.50]
Teoh 2010	2	100	5	100	0.3%	0.40 [0.08 , 2.01]
Thion 2018	1	65	1	57	0.1%	0.88 [0.06 , 13.70]
Toker 2019	2	50	13	50	0.4%	0.15 [0.04 , 0.65]
Verma 2020	1	30	0	30	0.1%	3.00 [0.13 , 70.83]
Wallace 2015	0	52	2	53	0.1%	0.20 [0.01 , 4.14]
Yoo 2018	1	22	10	22	0.2%	0.10 [0.01 , 0.72]
Yumul 2016	2	30	11	31	0.4%	0.19 [0.05 , 0.78]
Subtotal (95% CI)		**2208**		**2160**	**15.7%**	**0.38 [0.29 , 0.48]**
Total events:	172		424			
Heterogeneity: Tau² = 0.14; Chi² = 50.82, df = 32 (P = 0.02); I² = 37%						
Test for overall effect: Z = 7.58 (P < 0.00001)						
Total (95% CI)		**6624**		**6480**	**100.0%**	**0.90 [0.81 , 1.00]**
Total events:	2202		2156			
Heterogeneity: Tau² = 0.18; Chi² = 592.41, df = 107 (P < 0.00001); I² = 82%						
Test for overall effect: Z = 1.87 (P = 0.06)						
Test for subgroup differences: Chi² = 154.56, df = 2 (P < 0.00001), I² = 98.7%						



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Analysis 1.6. (Continued)

Test for overall effect: Z = 1.87 (P = 0.06) Favours DL Favours VL
Test for subgroup differences: Chi^2 = 154.56, df = 2 (P < 0.00001), I^2 = 98.7%

Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) IIa and IIb combined.
(3) IIa, IIb, IIIa and IIIb combined.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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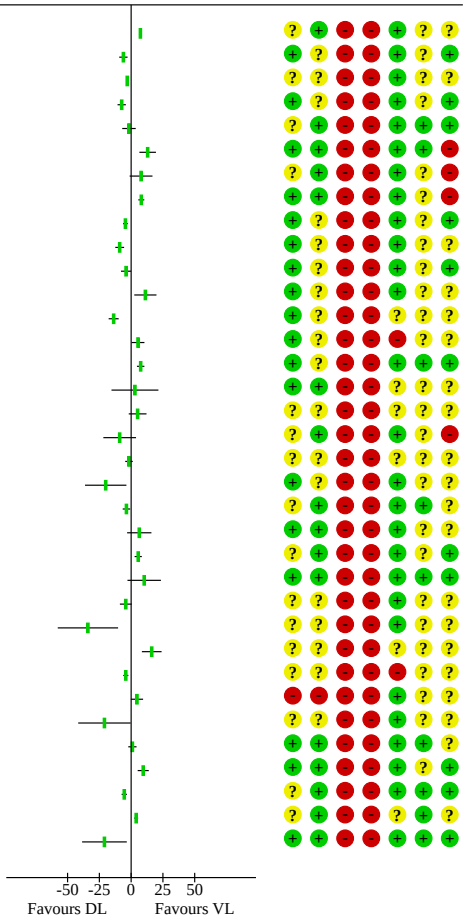
Analysis 1.7. Comparison 1: Macintosh-style VL versus DL, Outcome 7: Time for tracheal intubation

Study or Subgroup	Videolaryngoscope Mean	SD	Total	Direct laryngoscope Mean	SD	Total	Mean Difference IV, Random, 95% CI
Aggarwal 2019	22.82	1.323	50	15.53	1.53	50	7.29 [6.73 , 7.85]
Akbar 2015	32.7	6.8	45	38.8	8.9	45	-6.10 [-9.37 , -2.83]
Altaiee 2020	14.8	1.64	50	17.88	2.44	50	-3.08 [-3.89 , -2.27]
Altun 2018 (1)	16.58	9.46	80	24	8.2	40	-7.42 [-10.70 , -4.14]
Ander 2017	25	8.3	39	26.7	14.7	39	-1.70 [-7.00 , 3.60]
Aziz 2012	46	34.25	149	33	21.65	147	13.00 [6.48 , 19.52]
Bakshi 2019	64.4	24	37	56.6	14	36	7.80 [-1.18 , 16.78]
Bensghir 2010	47.9	5.4	34	39.9	4.4	34	8.00 [5.66 , 10.34]
Bensghir 2013	36.6	3.7	35	41.1	4.4	35	-4.50 [-6.40 , -2.60]
Bhat 2015	24.8	8.56	50	33.8	9.12	50	-9.00 [-12.47 , -5.53]
Blajic 2019	25	7	60	29	14	59	-4.00 [-7.99 , -0.01]
Cakir 2020	57.1	15.8	31	45.9	19.1	31	11.20 [2.47 , 19.93]
Caparlar 2019	27.74	7.2	39	41.49	10.3	39	-13.75 [-17.69 , -9.81]
Cavus 2011 (1)	16.4	16.5	100	11	14	50	5.40 [0.35 , 10.45]
Colak 2019	36.1	7.8	45	28.6	6.2	45	7.50 [4.59 , 10.41]
Driver 2016	61	80.3	103	58	49.7	95	3.00 [-15.45 , 21.45]
Foulds 2016a	42.3	24.2	52	37.2	8.7	53	5.10 [-1.88 , 12.08]
Goksu 2016	33.4	25	75	42.4	51	75	-9.00 [-21.85 , 3.85]
Hostic 2016	16.6	5.7	52	18.3	8.1	40	-1.70 [-4.65 , 1.25]
Jungbauer 2009	40	31	100	60	77	100	-20.00 [-36.27 , -3.73]
Kido 2015	17.1	4.6	25	20.8	5.9	25	-3.70 [-6.63 , -0.77]
Kreutziger 2019	46.8	59.9	267	40.4	50.5	247	6.40 [-3.15 , 15.95]
Kucukosman 2020	19.9	6.71	30	14.33	4.16	30	5.57 [2.74 , 8.40]
Loughnan 2019	51.79	26.99	28	41.51	30.53	49	10.28 [-2.87 , 23.43]
Maassen 2012	6.1	5.9	40	10.3	13.8	40	-4.20 [-8.85 , 0.45]
Marrel 2007	59	31	40	93	70	40	-34.00 [-57.72 , -10.28]
Peck 2009	38.4	18.9	27	22.2	8	27	16.20 [8.46 , 23.94]
Rabbani 2020	6.9	2.7	40	11.1	5.9	40	-4.20 [-6.21 , -2.19]
Sarkilar 2015	21.4	14.3	55	16.8	11.2	55	4.60 [-0.20 , 9.40]
Shippey 2013	52.2	20.9	24	73.2	48.1	25	-21.00 [-41.63 , -0.37]
Sulser 2016	32	11	74	31	9	73	1.00 [-2.25 , 4.25]
Teoh 2010	31.9	17.6	100	22.4	13.6	100	9.50 [5.14 , 13.86]
Toker 2019	34.7	5.2	50	40.1	5.4	50	-5.40 [-7.48 , -3.32]
Verma 2020	21.13	3.04	30	17.17	3.03	30	3.96 [2.42 , 5.50]
Yumul 2016	49	25	30	70	43	31	-21.00 [-38.58 , -3.42]



Test for subgroup differences: Not applicable

Footnotes

(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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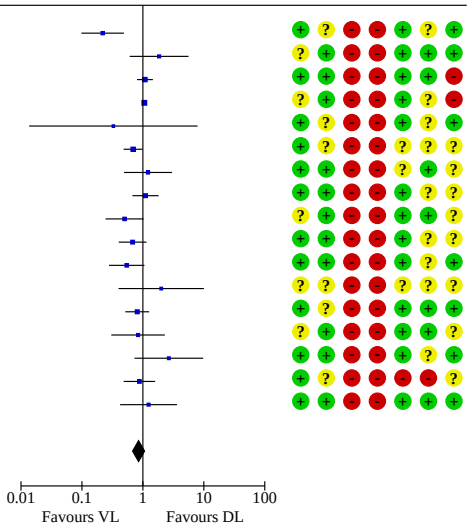
Analysis 1.8. Comparison 1: Macintosh-style VL versus DL, Outcome 8: Patient-reported sore throat

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Altun 2018 (1)	7	80	16	40	4.9%	0.22 [0.10 , 0.49]	+	?	-	-	+	?	+
Ander 2017	8	39	4	36	3.2%	1.85 [0.61 , 5.61]	?	+	-	-	+	+	+
Aziz 2012	57	149	52	147	10.6%	1.08 [0.80 , 1.46]	+	+	-	-	+	+	-
Bakshi 2019 (2)	37	37	35	37	12.7%	1.06 [0.96 , 1.16]	?	+	-	-	+	?	-
Blajic 2019	0	60	1	59	0.5%	0.33 [0.01 , 7.89]	+	?	-	-	+	?	+
Caparlar 2019	20	39	29	39	9.8%	0.69 [0.48 , 0.99]	+	?	-	-	?	?	?
Ing 2017	5	11	6	16	4.2%	1.21 [0.49 , 3.00]	+	+	-	-	?	+	?
Kapadia 2021	21	55	19	55	8.0%	1.11 [0.67 , 1.81]	+	+	-	-	+	?	?
Kido 2015	7	25	14	25	5.6%	0.50 [0.24 , 1.03]	?	+	-	-	+	+	?
Kleine-Brueggeney 2017	19	120	28	120	7.7%	0.68 [0.40 , 1.15]	+	+	-	-	+	?	?
Lin 2012	11	83	20	82	6.1%	0.54 [0.28 , 1.06]	+	+	-	-	+	?	+
Peck 2009	4	27	2	27	1.7%	2.00 [0.40 , 10.02]	?	?	-	-	?	?	?
Ruetzler 2020	22	66	26	63	8.6%	0.81 [0.51 , 1.27]	+	?	-	-	+	+	+
Shimazaki 2018	5	20	6	20	3.6%	0.83 [0.30 , 2.29]	?	+	-	-	+	+	?
Teoh 2010	8	100	3	100	2.5%	2.67 [0.73 , 9.76]	+	+	-	-	+	?	+
Thion 2018	16	65	16	57	6.9%	0.88 [0.48 , 1.59]	+	?	-	-	-	-	?
Yumul 2016	6	30	5	31	3.3%	1.24 [0.42 , 3.63]	+	+	-	-	+	+	+
Total (95% CI)		**1006**		**954**	**100.0%**	**0.85 [0.68 , 1.07]**							
Total events:	253		282										



Heterogeneity: Tau² = 0.10; Chi² = 46.06, df = 16 (P < 0.0001); I² = 65%
Test for overall effect: Z = 1.41 (P = 0.16)
Test for subgroup differences: Not applicable

Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) DLT used for intubation.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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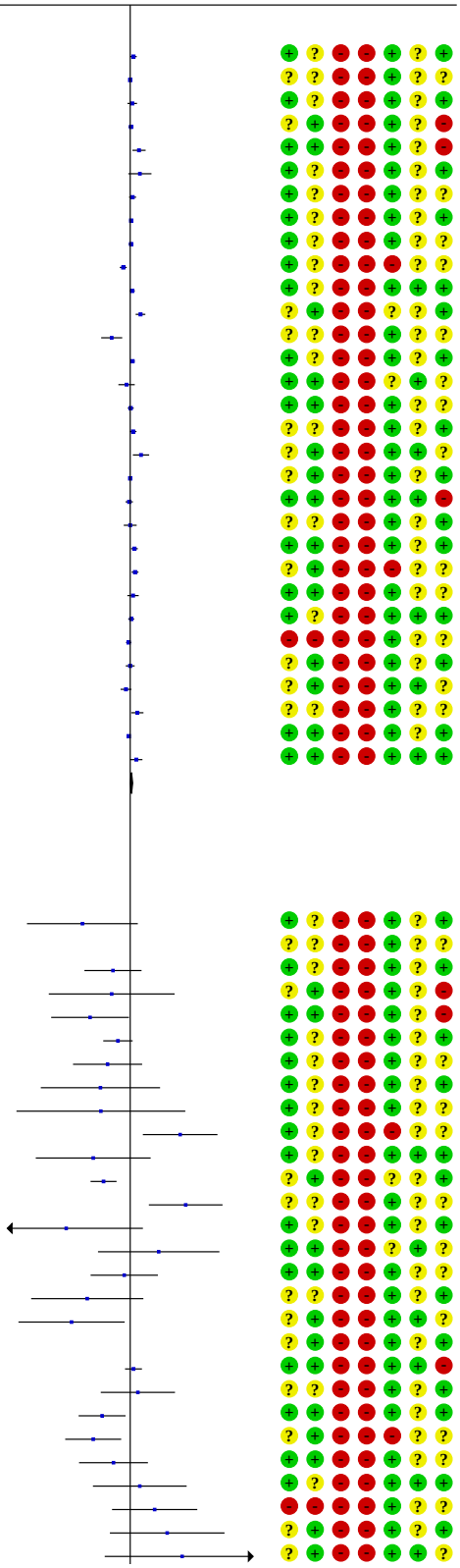
Analysis 1.9. Comparison 1: Macintosh-style VL versus DL, Outcome 9: Number of attempts

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
1.9.1 1 attempt						
Akbar 2015	44	45	39	45	3.5%	1.13 [1.00 , 1.28]
Altaiee 2020	50	50	50	50	4.4%	1.00 [0.96 , 1.04]
Altun 2018 (1)	70	82	34	43	2.8%	1.08 [0.90 , 1.29]
Bakshi 2019	36	37	35	37	3.8%	1.03 [0.94 , 1.13]
Bensghir 2010	32	34	23	34	2.1%	1.39 [1.09 , 1.78]
Bensghir 2013	23	35	16	35	1.0%	1.44 [0.93 , 2.22]
Bhat 2015	47	50	43	50	3.4%	1.09 [0.96 , 1.25]
Blajic 2019	59	60	56	59	4.1%	1.04 [0.97 , 1.11]
Cakir 2020	31	31	30	31	3.9%	1.03 [0.95 , 1.13]
Cavus 2011 (1)	74	100	48	50	3.4%	0.77 [0.68 , 0.88]
Colak 2019	44	45	41	45	3.8%	1.07 [0.97 , 1.19]
Dey 2020	91	108	63	110	2.8%	1.47 [1.23 , 1.76]
Frohlich 2011	14	30	28	30	1.1%	0.50 [0.34 , 0.74]
Gupta 2013 (1)	60	60	55	60	4.0%	1.09 [1.00 , 1.18]
Ing 2017	9	11	15	16	1.6%	0.87 [0.64 , 1.19]
Kapadia 2021	51	55	50	55	3.6%	1.02 [0.91 , 1.14]
Kaur 2020	39	40	35	40	3.4%	1.11 [0.98 , 1.27]
Kido 2015	24	25	16	25	1.6%	1.50 [1.11 , 2.03]
Kucukosman 2020	30	30	30	30	4.2%	1.00 [0.94 , 1.07]
Lascarrou 2017	126	186	130	185	3.3%	0.96 [0.84 , 1.10]
Lee 2012	21	25	21	25	2.1%	1.00 [0.79 , 1.27]
Lin 2012	77	83	65	82	3.4%	1.17 [1.03 , 1.33]
Macke 2020	72	76	60	76	3.4%	1.20 [1.06 , 1.36]
McElwain 2011	26	29	25	31	2.4%	1.11 [0.90 , 1.37]
Ruetzler 2020	61	66	56	63	3.6%	1.04 [0.93 , 1.16]
Sarkilar 2015	50	55	53	55	3.8%	0.94 [0.86 , 1.04]
Serocki 2010	35	40	35	40	2.9%	1.00 [0.85 , 1.18]
Shimazaki 2018	17	20	20	20	2.5%	0.85 [0.70 , 1.05]
Shippey 2013	24	24	19	25	2.2%	1.31 [1.04 , 1.64]
Teoh 2010	93	100	98	100	4.2%	0.95 [0.89 , 1.01]
Yumul 2016	28	30	23	31	2.2%	1.26 [1.00 , 1.58]
Subtotal (95% CI)		**1662**		**1578**	**94.6%**	**1.05 [1.01 , 1.10]**
Total events:	1458		1312			
Heterogeneity: Tau² = 0.01; Chi² = 114.06, df = 30 (P < 0.00001); I² = 74%						
Test for overall effect: Z = 2.31 (P = 0.02)						
1.9.2 2-4 attempts						
Akbar 2015	1	45	6	45	0.1%	0.17 [0.02 , 1.33]
Altaiee 2020	0	50	0	50		Not estimable
Altun 2018 (1)	6	82	6	43	0.2%	0.52 [0.18 , 1.53]
Bakshi 2019	1	37	2	37	0.0%	0.50 [0.05 , 5.28]
Bensghir 2010	2	34	9	34	0.1%	0.22 [0.05 , 0.95]
Bensghir 2013	12	35	19	35	0.7%	0.63 [0.36 , 1.09]
Bhat 2015	3	50	7	50	0.1%	0.43 [0.12 , 1.56]
Blajic 2019	1	60	3	59	0.0%	0.33 [0.04 , 3.06]
Cakir 2020	0	31	1	31	0.0%	0.33 [0.01 , 7.88]
Cavus 2011 (1)	26	100	2	50	0.1%	6.50 [1.61 , 26.30]
Colak 2019	1	45	4	45	0.0%	0.25 [0.03 , 2.15]
Dey 2020	17	108	47	110	0.8%	0.37 [0.23 , 0.60]
Frohlich 2011	16	30	2	30	0.1%	8.00 [2.01 , 31.80]
Gupta 2013 (1)	0	60	5	60	0.0%	0.09 [0.01 , 1.61]
Ing 2017	2	11	1	16	0.0%	2.91 [0.30 , 28.28]
Kapadia 2021	4	55	5	55	0.1%	0.80 [0.23 , 2.82]
Kaur 2020	1	40	5	40	0.1%	0.20 [0.02 , 1.64]
Kido 2015	1	25	9	25	0.1%	0.11 [0.02 , 0.81]
Kucukosman 2020	0	30	0	30		Not estimable
Lascarrou 2017	58	186	51	185	1.5%	1.13 [0.82 , 1.55]
Lee 2012	4	25	3	25	0.1%	1.33 [0.33 , 5.36]
Lin 2012	6	83	17	82	0.3%	0.35 [0.14 , 0.84]
Macke 2020	4	76	16	76	0.2%	0.25 [0.09 , 0.71]
McElwain 2011	3	29	6	31	0.1%	0.53 [0.15 , 1.94]
Ruetzler 2020	3	66	2	63	0.1%	1.43 [0.25 , 8.29]
Sarkilar 2015	5	55	2	55	0.1%	2.50 [0.51 , 12.34]
Serocki 2010	4	40	1	40	0.0%	4.00 [0.47 , 34.24]
Shimazaki 2018	3	20	0	20	0.0%	7.00 [0.38 , 127.32]



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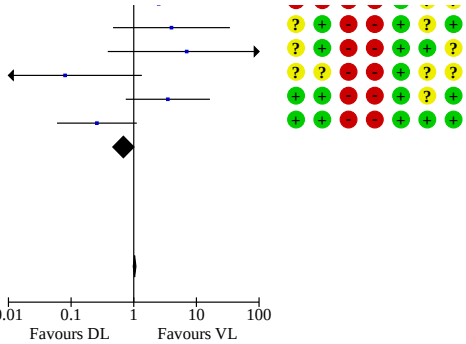
Analysis 1.9. (Continued)

Serocki 2010	4	40	1	40	0.0%	4.00 [0.47 , 34.24]
Shimazaki 2018	3	20	0	20	0.0%	7.00 [0.38 , 127.32]
Shippey 2013	0	24	6	25	0.0%	0.08 [0.00 , 1.35]
Teoh 2010	7	100	2	100	0.1%	3.50 [0.75 , 16.44]
Yumul 2016	2	30	8	31	0.1%	0.26 [0.06 , 1.12]
Subtotal (95% CI)		**1662**		**1578**	**5.4%**	**0.68 [0.46 , 1.01]**
Total events:	193		247			
Heterogeneity: Tau² = 0.53; Chi² = 75.32, df = 28 (P < 0.00001); I² = 63%						
Test for overall effect: Z = 1.92 (P = 0.05)						
Total (95% CI)		**3324**		**3156**	**100.0%**	**1.03 [0.98 , 1.08]**
Total events:	1651		1559			
Heterogeneity: Tau² = 0.01; Chi² = 193.51, df = 59 (P < 0.00001); I² = 70%						
Test for overall effect: Z = 1.25 (P = 0.21)						
Test for subgroup differences: Chi² = 4.67, df = 1 (P = 0.03), I² = 78.6%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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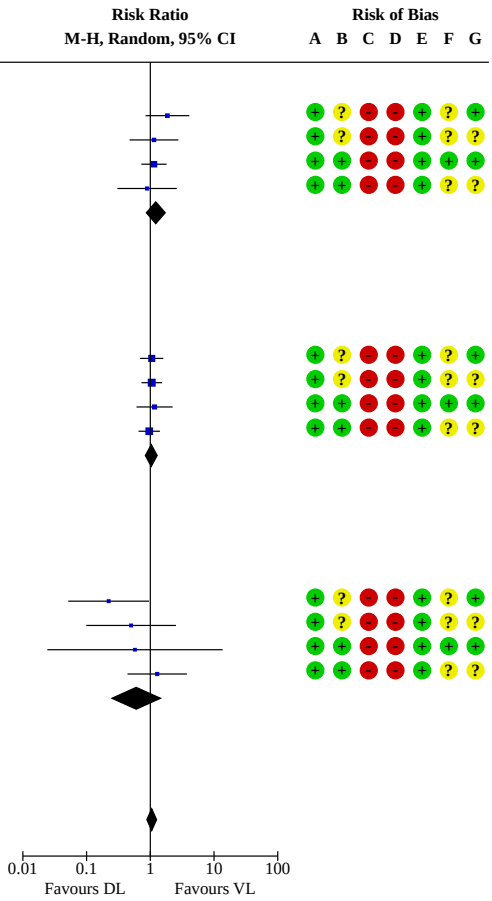
Analysis 1.10. Comparison 1: Macintosh-style VL versus DL, Outcome 10: Intubation Difficulty Scale (IDS)

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
1.10.1 IDS 0						
Bensghir 2013	13	35	7	35	4.9%	1.86 [0.84 , 4.09]
Chandrashekaraiah 2017	8	30	7	30	4.0%	1.14 [0.47 , 2.75]
Loughnan 2019	15	28	23	49	14.9%	1.14 [0.72 , 1.80]
McElwain 2011	5	29	6	31	2.7%	0.89 [0.30 , 2.61]
Subtotal (95% CI)		**122**		**145**	**26.5%**	**1.22 [0.87 , 1.72]**
Total events:	41		43			
Heterogeneity: Tau² = 0.00; Chi² = 1.53, df = 3 (P = 0.68); I² = 0%						
Test for overall effect: Z = 1.14 (P = 0.26)						
1.10.2 IDS 1-5						
Bensghir 2013	20	35	19	35	17.7%	1.05 [0.69 , 1.60]
Chandrashekaraiah 2017	20	30	19	30	22.3%	1.05 [0.73 , 1.53]
Loughnan 2019	10	28	15	49	7.3%	1.17 [0.61 , 2.24]
McElwain 2011	18	29	20	31	20.7%	0.96 [0.65 , 1.42]
Subtotal (95% CI)		**122**		**145**	**67.9%**	**1.04 [0.84 , 1.28]**
Total events:	68		73			
Heterogeneity: Tau² = 0.00; Chi² = 0.29, df = 3 (P = 0.96); I² = 0%						
Test for overall effect: Z = 0.32 (P = 0.75)						
1.10.3 IDS > 5						
Bensghir 2013	2	35	9	35	1.4%	0.22 [0.05 , 0.96]
Chandrashekaraiah 2017	2	30	4	30	1.2%	0.50 [0.10 , 2.53]
Loughnan 2019	0	28	1	49	0.3%	0.57 [0.02 , 13.65]
McElwain 2011	6	29	5	31	2.7%	1.28 [0.44 , 3.75]
Subtotal (95% CI)		**122**		**145**	**5.6%**	**0.60 [0.25 , 1.45]**
Total events:	10		19			
Heterogeneity: Tau² = 0.18; Chi² = 3.81, df = 3 (P = 0.28); I² = 21%						
Test for overall effect: Z = 1.14 (P = 0.26)						
Total (95% CI)		**366**		**435**	**100.0%**	**1.05 [0.88 , 1.25]**
Total events:	119		135			
Heterogeneity: Tau² = 0.00; Chi² = 8.04, df = 11 (P = 0.71); I² = 0%						
Test for overall effect: Z = 0.57 (P = 0.57)						
Test for subgroup differences: Chi² = 2.30, df = 2 (P = 0.32), I² = 12.9%						



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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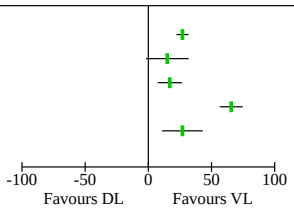
Analysis 1.11. Comparison 1: Macintosh-style VL versus DL, Outcome 11: POGO Score

Study or Subgroup	Videolaryngoscopy Mean	SD	Total	Direct laryngoscopy Mean	SD	Total	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Dey 2020	81	11	108	54	23	110	27.00 [22.23 , 31.77]	?	+	-	-	?	?	+
Hostic 2016	74	35	52	59	45	40	15.00 [-1.88 , 31.88]	?	?	-	-	?	?	?
Kido 2015	88.4	13.7	25	71.4	20.4	25	17.00 [7.37 , 26.63]	?	+	-	-	+	+	?
Peck 2009	77.3	26.5	54	11.7	21.3	54	65.60 [56.53 , 74.67]	?	?	-	-	?	?	?
Yumul 2016	84	20	30	57	41	31	27.00 [10.89 , 43.11]	+	+	-	-	+	+	+

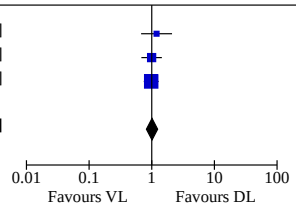


Test for subgroup differences: Not applicable

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 1.12. Comparison 1: Macintosh-style VL versus DL, Outcome 12: Mortality

Study or Subgroup	Videolaryngoscope Events	Total	Direct laryngoscope Events	Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Driver 2016	22	103	17	95	13.1%	1.19 [0.68 , 2.11]	+	+	-	-	?	?	?
Janz 2016	31	74	32	76	29.9%	0.99 [0.68 , 1.45]	+	+	-	-	+	+	-
Lascarrou 2017	66	186	67	185	57.0%	0.98 [0.75 , 1.29]	+	+	-	-	+	+	-
Total (95% CI)		**363**		**356**	**100.0%**	**1.01 [0.82 , 1.24]**							
Total events:	119		116										



Heterogeneity: Tau² = 0.00; Chi² = 0.39, df = 2 (P = 0.82); I² = 0%
Test for overall effect: Z = 0.10 (P = 0.92)
Test for subgroup differences: Not applicable

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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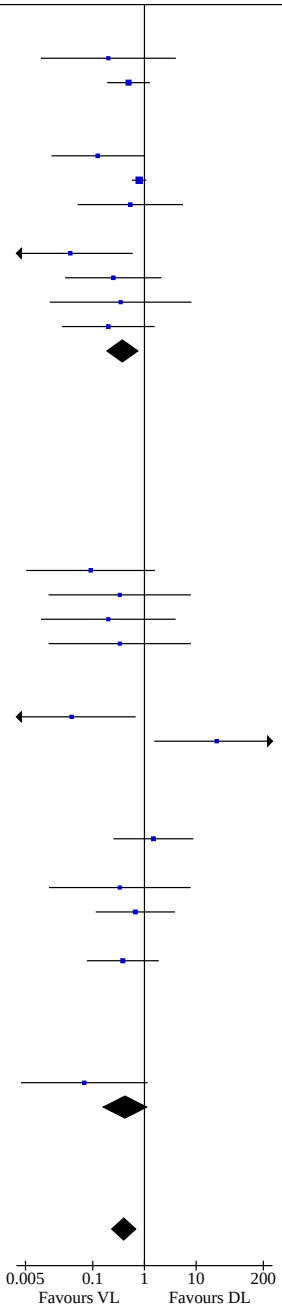
Analysis 1.13. Comparison 1: Macintosh-style VL versus DL, Outcome 13: Subgroup analysis of failed intubation: airway difficulty

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
1.13.1 Predicted, known or simulated difficulty													
Akbar 2015	0	45	2	45	2.7%	0.20 [0.01 , 4.05]	+	?	-	-	+	?	+
Aziz 2012	6	149	12	147	12.2%	0.49 [0.19 , 1.28]	+	+	-	-	+	+	-
Bhat 2015	0	50	0	50		Not estimable	+	?	-	-	+	?	?
Gupta 2013	0	60	0	60		Not estimable	+	?	-	-	+	?	+
Jungbauer 2009	1	100	8	100	5.0%	0.13 [0.02 , 0.98]	+	?	-	-	+	?	?
Kleine-Brueggeney 2017	41	120	52	120	18.7%	0.79 [0.57 , 1.09]	+	+	-	-	+	?	?
McElwain 2011	1	29	2	31	4.1%	0.53 [0.05 , 5.58]	+	+	-	-	+	?	?
Ninan 2016	0	30	0	30		Not estimable	+	?	-	-	+	?	?
Peck 2009	0	27	13	27	3.1%	0.04 [0.00 , 0.59]	?	?	-	-	?	?	?
Serocki 2010	1	40	4	40	4.7%	0.25 [0.03 , 2.14]	?	+	-	-	+	?	+
Shippey 2013	0	24	1	25	2.5%	0.35 [0.01 , 8.12]	?	?	-	-	+	?	?
Yoo 2018	1	22	5	22	5.0%	0.20 [0.03 , 1.58]	+	?	-	-	+	?	?
Subtotal (95% CI)		**696**		**697**	**58.1%**	**0.37 [0.19 , 0.74]**							
Total events:	51		99										
Heterogeneity: Tau² = 0.35; Chi² = 13.39, df = 8 (P = 0.10); I² = 40%													
Test for overall effect: Z = 2.81 (P = 0.005)													
1.13.2 No difficulty													
Aggarwal 2019	0	50	0	50		Not estimable	?	+	-	-	+	?	?
Altaiee 2020	0	50	0	50		Not estimable	?	?	-	-	+	?	?
Anandraja 2021	0	30	0	30		Not estimable	+	?	-	-	+	?	+
Ander 2017	0	39	5	39	3.0%	0.09 [0.01 , 1.59]	?	+	-	-	+	+	+
Bakshi 2019	0	37	1	37	2.5%	0.33 [0.01 , 7.93]	?	+	-	-	+	?	-
Bensghir 2010	0	34	2	34	2.7%	0.20 [0.01 , 4.02]	+	+	-	-	+	?	-
Bensghir 2013	0	35	1	35	2.5%	0.33 [0.01 , 7.91]	+	?	-	-	+	?	+
Blajic 2019	0	60	0	59		Not estimable	+	?	-	-	+	?	+
Cakir 2020	0	31	0	31		Not estimable	+	?	-	-	+	?	?
Cavus 2011 (1)	0	100	6	50	3.0%	0.04 [0.00 , 0.68]	+	?	-	-	-	?	?
Frohlich 2011	12	30	0	30	3.1%	25.00 [1.55 , 403.99]	?	?	-	-	+	?	?
Kaur 2020	0	40	0	40		Not estimable	?	?	-	-	+	?	+
Kido 2015	0	25	0	25		Not estimable	?	+	-	-	+	+	?
Kucukosman 2020	0	30	0	30		Not estimable	?	+	-	-	+	?	+
Lascarrou 2017	3	186	2	185	6.2%	1.49 [0.25 , 8.83]	+	+	-	-	+	+	-
Lee 2009	0	41	0	44		Not estimable	?	?	-	-	+	?	+
Lee 2012	0	25	1	25	2.5%	0.33 [0.01 , 7.81]	?	?	-	-	+	?	+
Lin 2012	2	85	3	85	6.3%	0.67 [0.11 , 3.89]	+	+	-	-	+	?	+
Maassen 2012	0	40	0	40		Not estimable	?	?	-	-	+	?	?
Ruetzler 2020	2	66	5	63	7.1%	0.38 [0.08 , 1.90]	+	?	-	-	+	+	+
Sarkilar 2015	0	55	0	55		Not estimable	-	-	-	-	+	?	?
Shimazaki 2018	0	20	0	20		Not estimable	?	+	-	-	+	+	?
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Wallace 2015	0	52	0	53		Not estimable	+	?	-	-	+	?	+
Yumul 2016	0	30	7	31	3.0%	0.07 [0.00 , 1.15]	+	+	-	-	+	+	+
Subtotal (95% CI)		**1291**		**1241**	**41.9%**	**0.42 [0.16 , 1.10]**							
Total events:	19		33										
Heterogeneity: Tau² = 0.99; Chi² = 16.50, df = 10 (P = 0.09); I² = 39%													
Test for overall effect: Z = 1.77 (P = 0.08)													
Total (95% CI)		**1987**		**1938**	**100.0%**	**0.40 [0.23 , 0.68]**							
Total events:	70		132										
Heterogeneity: Tau² = 0.37; Chi² = 29.05, df = 19 (P = 0.07); I² = 35%													
Test for overall effect: Z = 3.40 (P = 0.0007)													
Test for subgroup differences: Chi² = 0.04, df = 1 (P = 0.85), I² = 0%													



Footnotes

(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)

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Analysis 1.13. (Continued)

(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Comparison 2. Hyperangulated VL versus DL

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Failed intubation	63	7146	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.34, 0.76]
2.2 Hypoxaemia	15	1691	Risk Ratio (M-H, Random, 95% CI)	0.49 [0.22, 1.11]
2.3 Successful first attempt	66	8086	Risk Ratio (M-H, Random, 95% CI)	1.03 [1.00, 1.05]
2.4 Oesophageal intubation	14	1968	Risk Ratio (M-H, Random, 95% CI)	0.39 [0.18, 0.81]
2.5 Dental trauma	30	3497	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.16, 1.59]
2.6 Cormack-Lehane (CL) grade	54	18174	Risk Ratio (M-H, Random, 95% CI)	0.83 [0.74, 0.94]
2.6.1 Cormack-Lehane 1	54	6058	Risk Ratio (M-H, Random, 95% CI)	1.77 [1.56, 2.01]
2.6.2 Cormack-Lehane 2	54	6058	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.46, 0.63]
2.6.3 Cormack-Lehane 3-4	54	6058	Risk Ratio (M-H, Random, 95% CI)	0.15 [0.10, 0.24]
2.7 Time for tracheal intubation	59		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.8 Patient-reported sore throat	31	3725	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.66, 1.00]
2.9 Number of attempts	50	11004	Risk Ratio (M-H, Random, 95% CI)	1.02 [0.99, 1.04]
2.9.1 1 attempt	50	5502	Risk Ratio (M-H, Random, 95% CI)	1.02 [1.00, 1.05]
2.9.2 2-4 attempts	50	5502	Risk Ratio (M-H, Random, 95% CI)	0.84 [0.66, 1.08]
2.10 Intubation Difficulty Scale (IDS)	10		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2.10.1 IDS 0	10		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2.10.2 IDS 1-5	10		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2.10.3 IDS > 5	10		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2.11 POGO Score	14		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.12 Mortality	3	826	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.73, 1.79]

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.13 Subgroup analysis of failed intubation: airway difficulty	59	6607	Risk Ratio (M-H, Random, 95% CI)	0.45 [0.30, 0.68]
2.13.1 Predicted, known or simulated difficulty	15	1520	Risk Ratio (M-H, Random, 95% CI)	0.29 [0.17, 0.48]
2.13.2 No difficulty	44	5087	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.38, 1.06]

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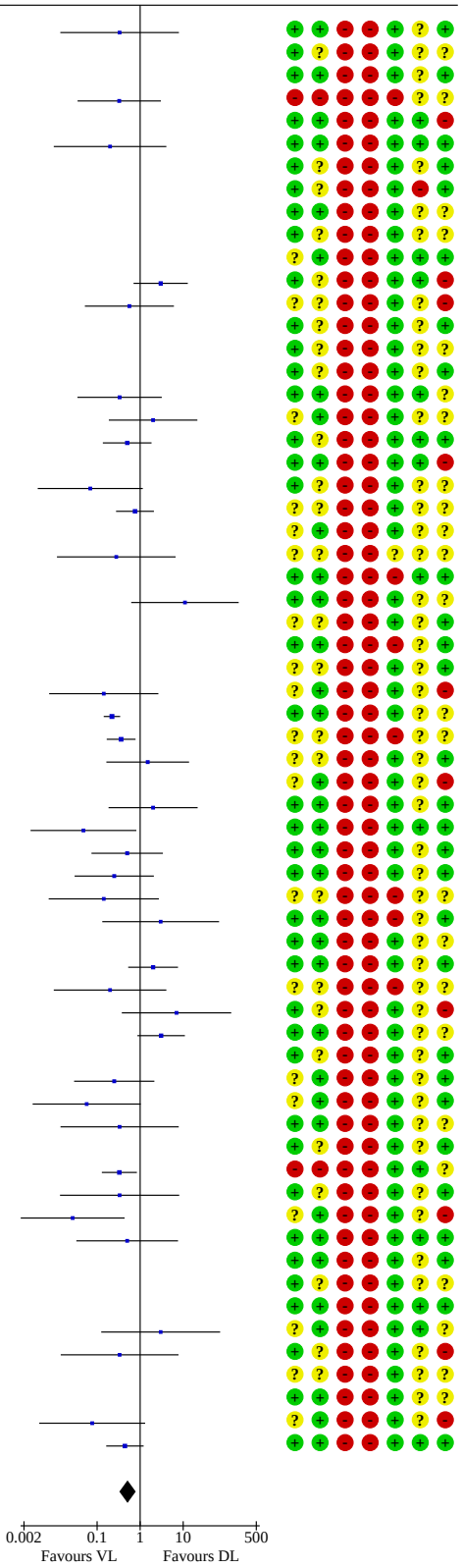
Analysis 2.1. Comparison 2: Hyperangulated VL versus DL, Outcome 1: Failed intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgalel 2018	0	40	1	40	1.3%	0.33 [0.01 , 7.95]
Abdelgawad 2015	0	40	0	40		Not estimable
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015	1	49	3	48	2.4%	0.33 [0.04 , 3.03]
Al-Ghamdi 2016	0	21	0	22		Not estimable
Andersen 2011	0	50	2	50	1.5%	0.20 [0.01 , 4.06]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (1)	0	54	0	54		Not estimable
Arslan 2017 (2)	0	80	0	40		Not estimable
Bakshi 2015 (3)	12	84	2	42	4.1%	3.00 [0.70 , 12.79]
Barak 2007	1	80	2	90	2.1%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Chen 2019	1	220	3	220	2.3%	0.33 [0.03 , 3.18]
Colak 2015	2	50	1	50	2.2%	2.00 [0.19 , 21.36]
Cordovani 2019	3	24	5	20	4.6%	0.50 [0.14 , 1.84]
El-Tahan 2017b	0	66	0	32		Not estimable
Foulds 2016b	0	24	7	25	1.6%	0.07 [0.00 , 1.15]
Gao 2018	6	81	8	82	5.7%	0.76 [0.28 , 2.09]
Gunes 2020	0	90	0	90		Not estimable
Hostic 2016	0	48	1	40	1.3%	0.28 [0.01 , 6.66]
Hu 2017 (4)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	1.6%	11.00 [0.62 , 194.90]
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Kaur 2020	0	40	0	40		Not estimable
Kill 2013	0	30	3	30	1.5%	0.14 [0.01 , 2.65]
Kleine-Brueggeney 2017 (2)	23	240	52	120	8.1%	0.22 [0.14 , 0.34]
Koennecke 2014 (2)	10	83	10	30	6.7%	0.36 [0.17 , 0.78]
Lee 2012 (2)	3	50	1	25	2.4%	1.50 [0.16 , 13.70]
Lim 2005	0	30	0	30		Not estimable
Liu 2016	2	90	1	90	2.1%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	1.6%	0.05 [0.00 , 0.82]
Malik 2008 (2)	2	60	2	30	2.9%	0.50 [0.07 , 3.38]
Malik 2009b	1	25	4	25	2.5%	0.25 [0.03 , 2.08]
Nakayama 2010	0	80	3	80	1.5%	0.14 [0.01 , 2.72]
Nandakumar 2018	1	15	0	15	1.4%	3.00 [0.13 , 68.26]
Paik 2020	0	20	0	20		Not estimable
Pournajafian 2014	6	52	3	52	4.5%	2.00 [0.53 , 7.57]
Rovsing 2010	0	50	2	50	1.5%	0.20 [0.01 , 4.06]
Russell 2013	3	35	0	35	1.5%	7.00 [0.37 , 130.69]
Sanguanwit 2021	9	78	3	80	4.7%	3.08 [0.87 , 10.94]
Sargin 2016	0	50	0	50		Not estimable
Serocki 2010	1	40	4	40	2.5%	0.25 [0.03 , 2.14]
Serocki 2013 (2)	0	63	4	32	1.6%	0.06 [0.00 , 1.03]
Shah 2016 (5)	0	30	1	30	1.4%	0.33 [0.01 , 7.87]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	6.0%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	1.3%	0.33 [0.01 , 8.09]
Taylor 2013	0	44	18	44	1.7%	0.03 [0.00 , 0.43]
Tempe 2016	1	40	1	20	1.7%	0.50 [0.03 , 7.59]
Teoh 2010	0	100	0	100		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Walker 2009	1	60	0	60	1.3%	3.00 [0.12 , 72.20]
Wasinwong 2017	0	23	1	23	1.4%	0.33 [0.01 , 7.78]
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	1.6%	0.08 [0.00 , 1.31]
Yumul 2016	6	60	7	31	5.7%	0.44 [0.16 , 1.20]
Total (95% CI)		**3786**		**3360**	**100.0%**	**0.51 [0.34 , 0.76]**
Total events:	105		188			

Heterogeneity: Tau² = 0.46; Chi² = 60.94, df = 36 (P = 0.006); I² = 41%
Test for overall effect: Z = 3.32 (P = 0.0009)



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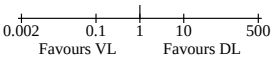
Analysis 2.1. (Continued)

Total events: 105 108

Heterogeneity: Tau² = 0.46; Chi² = 60.94, df = 36 (P = 0.006); I² = 41%

Test for overall effect: Z = 3.32 (P = 0.0009)

Test for subgroup differences: Not applicable



Footnotes

(1) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(2) Multi-arm study. Data combined for each VL group.
(3) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(4) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(5) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

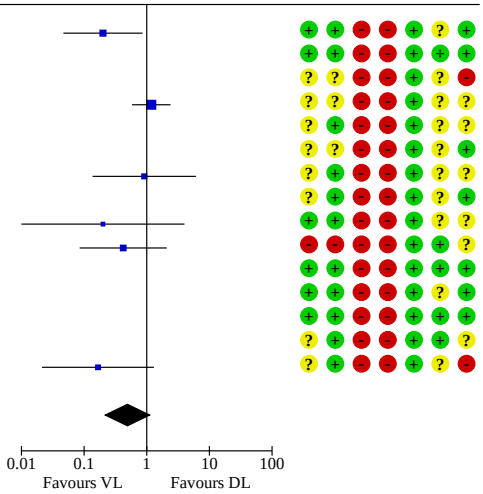
Analysis 2.2. Comparison 2: Hyperangulated VL versus DL, Outcome 2: Hypoxaemia

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgalel 2018 (1)	2	40	10	40	18.6%	0.20 [0.05 , 0.86]
Andersen 2011	0	50	0	50		Not estimable
Barak 2007	0	80	0	90		Not estimable
Gao 2018 (1)	14	81	12	82	33.7%	1.18 [0.58 , 2.40]
Gunes 2020	0	90	0	90		Not estimable
Inal 2016	0	50	0	50		Not estimable
Risse 2020	2	34	2	31	13.1%	0.91 [0.14 , 6.09]
Serocki 2010	0	40	0	40		Not estimable
Shah 2016	0	30	2	30	6.4%	0.20 [0.01 , 4.00]
Silverberg 2015 (1)	2	57	5	60	16.5%	0.42 [0.09 , 2.08]
Tempe 2016	0	39	0	19		Not estimable
Teoh 2010	0	100	0	100		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Walker 2009	0	60	0	60		Not estimable
Yousef 2012 (2)	1	30	6	30	11.7%	0.17 [0.02 , 1.30]
Total (95% CI)		**850**		**841**	**100.0%**	**0.49 [0.22 , 1.11]**
Total events:	21		37			

Heterogeneity: Tau² = 0.38; Chi² = 8.24, df = 5 (P = 0.14); I² = 39%

Test for overall effect: Z = 1.70 (P = 0.09)

Test for subgroup differences: Not applicable



Footnotes

(1) ICU population
(2) Morbidly obese population

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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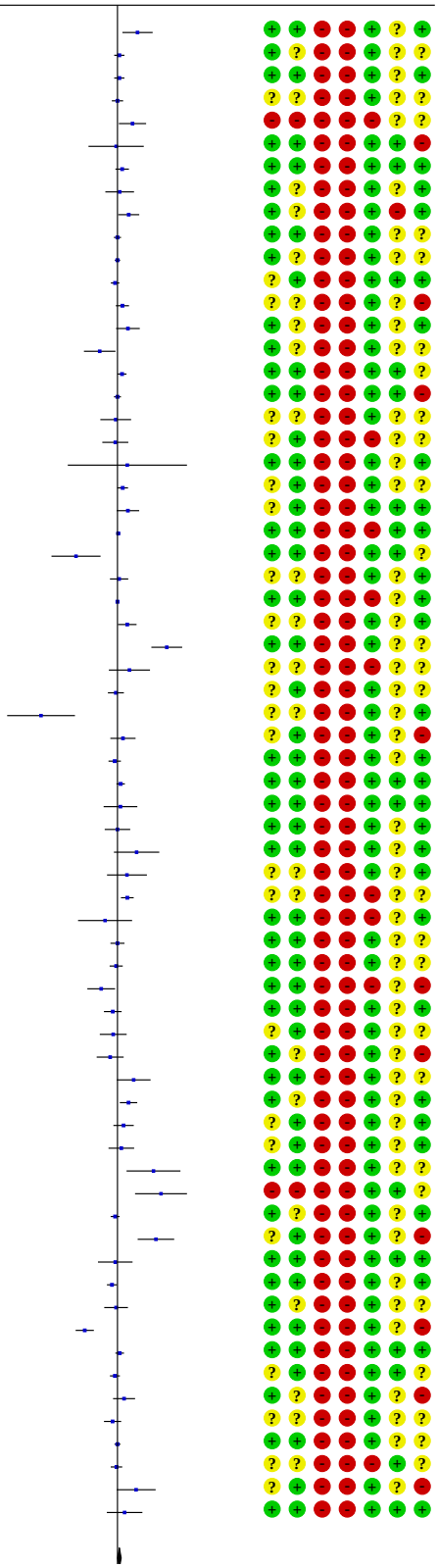
Analysis 2.3. Comparison 2: Hyperangulated VL versus DL, Outcome 3: Successful first attempt

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	A	B	C	D	E	F	G
Abdelgalel 2018	38	40	29	40	1.0%	1.31 [1.07 , 1.61]	+	+	-	-	+	?	+
Abdelgawad 2015	40	40	39	40	2.3%	1.03 [0.96 , 1.10]	+	?	-	-	+	?	?
Agrawal 2020	40	40	39	40	2.3%	1.03 [0.96 , 1.10]	+	+	-	-	+	?	+
Ahmad 2015	25	25	25	25	2.2%	1.00 [0.93 , 1.08]	?	?	-	-	+	?	?
Ahmadi 2015	45	49	36	48	1.1%	1.22 [1.02 , 1.47]	-	-	-	-	-	?	?
Al-Ghamdi 2016	15	21	16	22	0.4%	0.98 [0.68 , 1.43]	+	+	-	-	+	+	-
Andersen 2011	49	50	46	50	2.1%	1.07 [0.97 , 1.17]	+	+	-	-	+	+	+
Aqil 2016	34	40	33	40	1.0%	1.03 [0.85 , 1.25]	+	?	-	-	+	?	+
Aqil 2017	64	70	55	70	1.5%	1.16 [1.01 , 1.34]	+	?	-	-	+	-	+
Arici 2014	40	40	40	40	2.6%	1.00 [0.95 , 1.05]	+	+	-	-	+	?	?
Arora 2013	54	54	54	54	2.7%	1.00 [0.96 , 1.04]	+	?	-	-	+	?	?
Arslan 2017 (1)	77	80	40	40	2.5%	0.97 [0.91 , 1.03]	?	+	-	-	+	+	+
Barak 2007	76	80	80	90	2.1%	1.07 [0.98 , 1.17]	?	?	-	-	+	?	-
Bashir 2020	38	40	33	40	1.3%	1.15 [0.98 , 1.35]	+	?	-	-	+	?	+
Bilehjani 2009	29	40	35	38	0.9%	0.79 [0.64 , 0.97]	+	?	-	-	+	?	?
Chen 2019	205	219	191	217	2.4%	1.06 [1.00 , 1.13]	+	+	-	-	+	+	?
El-Tahan 2017b	66	66	32	32	2.6%	1.00 [0.95 , 1.05]	+	+	-	-	+	+	-
Gao 2018	55	81	57	82	0.9%	0.98 [0.79 , 1.20]	?	?	-	-	+	?	?
Golboyu 2016	34	40	35	40	1.2%	0.97 [0.82 , 1.16]	?	+	-	-	-	?	?
Griesdale 2012a	8	20	7	20	0.1%	1.14 [0.51 , 2.55]	+	+	-	-	+	?	+
Gunes 2020	88	90	82	90	2.3%	1.07 [1.00 , 1.15]	?	+	-	-	+	?	?
Hsu 2012	30	30	26	30	1.4%	1.15 [0.99 , 1.34]	?	+	-	-	+	+	+
Hu 2017	100	100	95	96	2.8%	1.01 [0.98 , 1.04]	+	+	-	-	-	+	+
Huang 2020 (1)	27	59	24	30	0.5%	0.57 [0.41 , 0.80]	+	+	-	-	+	+	?
Inal 2016	46	50	45	50	1.7%	1.02 [0.90 , 1.16]	?	?	-	-	+	?	+
Jafra 2018	100	100	100	100	2.8%	1.00 [0.98 , 1.02]	+	+	-	-	-	?	+
Kaur 2020	40	40	35	40	1.6%	1.14 [1.01 , 1.29]	?	?	-	-	+	?	+
Kleine-Brueggeney 2017 (1)	206	240	53	120	0.9%	1.94 [1.58 , 2.39]	+	+	-	-	+	?	?
Koennecke 2014 (1)	65	83	20	30	0.6%	1.17 [0.89 , 1.55]	?	?	-	-	-	?	?
Kurnaz 2016	46	50	47	50	1.8%	0.98 [0.88 , 1.09]	?	+	-	-	+	?	?
Lee 2012 (1)	15	50	21	25	0.3%	0.36 [0.23 , 0.56]	?	?	-	-	+	?	+
Lim 2005	28	30	26	30	1.2%	1.08 [0.91 , 1.28]	?	+	-	-	+	?	-
Liu 2016	80	88	84	89	2.2%	0.96 [0.89 , 1.05]	+	+	-	-	+	?	+
Liu 2019	172	181	163	179	2.5%	1.04 [0.99 , 1.10]	+	+	-	-	+	+	+
Loughnan 2019	17	20	40	49	0.8%	1.04 [0.83 , 1.31]	+	+	-	-	+	+	+
Malik 2008 (1)	52	60	26	30	1.2%	1.00 [0.84 , 1.19]	+	+	-	-	+	?	+
Malik 2009b	22	25	17	25	0.5%	1.29 [0.95 , 1.76]	+	+	-	-	+	?	+
Masoumifar 2020	25	30	22	30	0.6%	1.14 [0.87 , 1.49]	?	?	-	-	+	?	+
Nakayama 2010	80	80	70	80	2.1%	1.14 [1.05 , 1.24]	?	?	-	-	-	?	?
Nandakumar 2018	11	15	13	15	0.4%	0.85 [0.59 , 1.22]	+	+	-	-	-	?	+
Paik 2020	20	20	20	20	2.0%	1.00 [0.91 , 1.10]	+	+	-	-	+	?	?
Pappu 2020	57	60	29	30	2.1%	0.98 [0.90 , 1.07]	+	+	-	-	+	?	?
Parasa 2016	24	30	30	30	1.1%	0.80 [0.67 , 0.97]	+	+	-	-	-	?	-
Pournajafian 2014	46	52	49	52	1.7%	0.94 [0.83 , 1.06]	+	+	-	-	+	?	+
Risse 2020	29	34	28	31	1.1%	0.94 [0.79 , 1.13]	?	+	-	-	+	?	?
Russell 2013	29	35	32	35	1.1%	0.91 [0.76 , 1.09]	+	?	-	-	+	?	-
Sanguanwit 2021	57	78	47	80	0.8%	1.24 [0.99 , 1.56]	+	+	-	-	+	?	?
Sargin 2016	50	50	43	50	1.7%	1.16 [1.03 , 1.31]	+	?	-	-	+	?	+
Serocki 2010	38	40	35	40	1.5%	1.09 [0.95 , 1.25]	?	+	-	-	+	?	+
Serocki 2013 (1)	56	63	27	32	1.2%	1.05 [0.89 , 1.25]	?	+	-	-	+	?	+
Shah 2016	26	30	16	30	0.4%	1.63 [1.13 , 2.34]	+	+	-	-	+	?	?
Silverberg 2015	41	57	24	60	0.4%	1.80 [1.27 , 2.55]	-	-	-	-	+	+	?
Sun 2005	94	100	97	100	2.4%	0.97 [0.91 , 1.03]	+	?	-	-	+	?	+
Taylor 2013	44	44	26	44	0.7%	1.68 [1.31 , 2.15]	?	+	-	-	+	?	-
Tempe 2016	33	40	17	20	0.8%	0.97 [0.77 , 1.23]	+	+	-	-	+	+	+
Teoh 2010	91	100	98	100	2.4%	0.93 [0.87 , 0.99]	+	+	-	-	+	?	+
Tosh 2018	53	65	54	65	1.3%	0.98 [0.84 , 1.15]	+	?	-	-	+	?	?
Trimmel 2016 (2)	104	168	152	158	1.7%	0.64 [0.57 , 0.73]	+	+	-	-	+	?	-
Tsan 2020	68	69	66	69	2.5%	1.03 [0.97 , 1.09]	+	+	-	-	+	+	+
Walker 2009	57	60	59	60	2.4%	0.97 [0.90 , 1.03]	?	+	-	-	+	+	?
Wasinwong 2017	23	23	21	23	1.4%	1.09 [0.94 , 1.27]	+	?	-	-	+	?	-
Xue 2007	28	30	27	27	1.7%	0.94 [0.83 , 1.05]	?	?	-	-	+	?	?
Yao 2015	48	48	48	48	2.7%	1.00 [0.96 , 1.04]	+	+	-	-	+	?	?
Yeatts 2013	242	303	259	320	2.2%	0.99 [0.91 , 1.07]	?	?	-	-	-	+	?
Yousef 2012	27	30	21	30	0.7%	1.29 [0.99 , 1.67]	?	+	-	-	+	?	-
Yumul 2016	49	60	23	31	0.8%	1.10 [0.87 , 1.40]	+	+	-	-	+	+	+
Total (95% CI)		**4245**		**3841**	**100.0%**	**1.03 [1.00 , 1.05]**							



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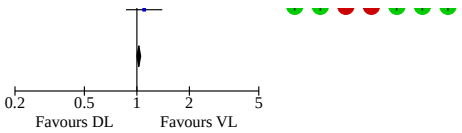
Analysis 2.3. (Continued)

Yuhai 2016	45	60	25	31	0.8%	1.16 [0.87 , 1.46]
Total (95% CI)		**4245**		**3841**	**100.0%**	**1.03 [1.00 , 1.05]**
Total events:	3716		3279			

Heterogeneity: Tau² = 0.01; Chi² = 276.04, df = 65 (P < 0.00001); I² = 76%
Test for overall effect: Z = 2.04 (P = 0.04)
Test for subgroup differences: Not applicable



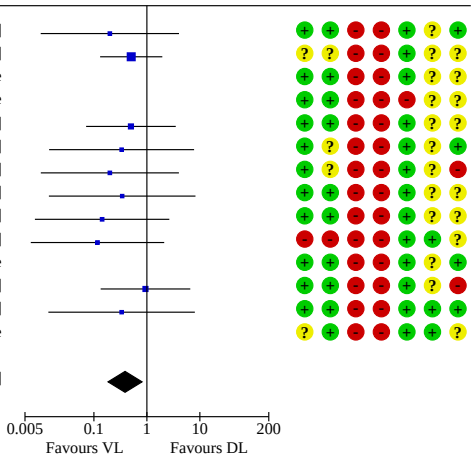
Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) Prehospital study.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 2.4. Comparison 2: Hyperangulated VL versus DL, Outcome 4: Oesophageal intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgalel 2018	0	40	2	40	6.0%	0.20 [0.01 , 4.04]
Gao 2018	3	81	6	82	29.9%	0.51 [0.13 , 1.96]
Inangil 2018	0	35	0	35		Not estimable
Ithnin 2009	0	30	0	30		Not estimable
Kleine-Brueggeney 2017	2	240	2	120	14.4%	0.50 [0.07 , 3.51]
Russell 2012	0	23	1	23	5.5%	0.33 [0.01 , 7.78]
Russell 2013	0	35	2	35	6.1%	0.20 [0.01 , 4.02]
Sanguanwit 2021	0	78	1	80	5.4%	0.34 [0.01 , 8.26]
Shah 2016	0	30	3	30	6.4%	0.14 [0.01 , 2.65]
Silverberg 2015	0	57	4	60	6.5%	0.12 [0.01 , 2.12]
Teoh 2010	0	100	0	100		Not estimable
Trimmel 2016	2	168	2	158	14.4%	0.94 [0.13 , 6.60]
Tsan 2020	0	69	1	69	5.4%	0.33 [0.01 , 8.04]
Walker 2009	0	60	0	60		Not estimable
Total (95% CI)		**1046**		**922**	**100.0%**	**0.39 [0.18 , 0.81]**
Total events:	7		24			

Heterogeneity: Tau² = 0.00; Chi² = 2.59, df = 9 (P = 0.98); I² = 0%
Test for overall effect: Z = 2.52 (P = 0.01)
Test for subgroup differences: Not applicable



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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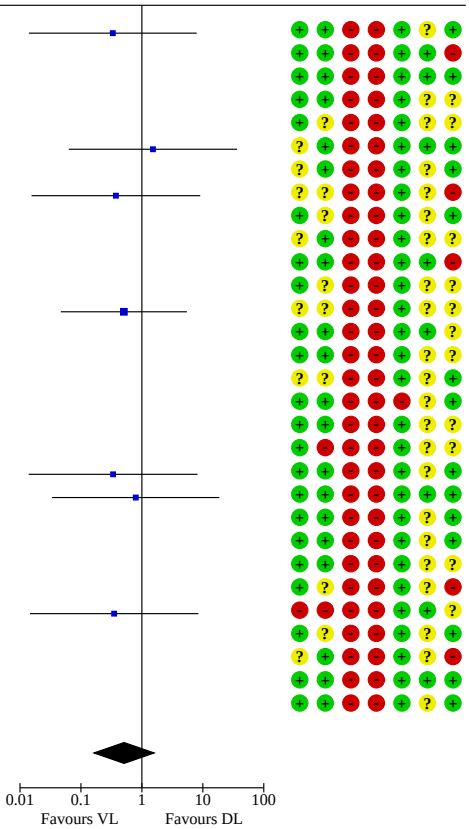
Analysis 2.5. Comparison 2: Hyperangulated VL versus DL, Outcome 5: Dental trauma

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdelgalel 2018	0	40	1	40	12.9%	0.33 [0.01 , 7.95]	+	+	−	−	+	?	+
Al-Ghamdi 2016 (1)	0	21	0	22		Not estimable	+	+	−	−	+	+	−
Andersen 2011	0	50	0	50		Not estimable	+	+	−	−	+	+	+
Arici 2014	0	40	0	40		Not estimable	+	+	−	−	+	?	?
Arora 2013	0	54	0	54		Not estimable	+	?	−	−	+	?	?
Arslan 2017 (2)	1	80	0	40	12.8%	1.52 [0.06 , 36.46]	?	+	−	−	+	+	+
Bag 2014	0	100	0	100		Not estimable	?	+	−	−	+	?	+
Barak 2007 (3)	0	80	1	90	12.8%	0.37 [0.02 , 9.06]	?	?	−	−	+	?	−
Carassiti 2013	0	15	0	15		Not estimable	+	?	−	−	+	?	+
Colak 2015	0	48	0	49		Not estimable	?	+	−	−	+	?	?
El-Tahan 2017b	0	66	0	32		Not estimable	+	+	−	−	+	+	−
Foulds 2016b	0	48	0	50		Not estimable	+	?	−	−	+	?	?
Gao 2018	1	81	2	82	22.9%	0.51 [0.05 , 5.47]	?	?	−	−	+	?	?
Huang 2020 (2)	0	59	0	30		Not estimable	+	+	−	−	+	+	?
Ilyas 2014	0	64	0	64		Not estimable	+	+	−	−	+	?	?
Inal 2016 (4)	0	50	0	50		Not estimable	?	?	−	−	+	?	+
Jafra 2018	0	100	0	100		Not estimable	+	+	−	−	−	?	+
Kleine-Brueggeney 2017 (2)	0	240	0	120		Not estimable	+	+	−	−	+	?	?
Laosuwan 2015	0	11	0	11		Not estimable	+	−	−	−	+	?	?
Liu 2016	0	88	1	89	12.8%	0.34 [0.01 , 8.16]	+	+	−	−	+	?	+
Loughnan 2019	0	20	1	49	13.0%	0.79 [0.03 , 18.70]	+	+	−	−	+	+	+
Malik 2008 (2)	0	60	0	30		Not estimable	+	+	−	−	+	?	+
Malik 2009b	0	25	0	25		Not estimable	+	+	−	−	+	?	+
Pappu 2020	0	60	0	30		Not estimable	+	+	−	−	+	?	?
Russell 2013	0	35	0	35		Not estimable	+	?	−	−	+	?	−
Silverberg 2015	0	57	1	60	12.8%	0.35 [0.01 , 8.43]	−	−	−	−	+	+	?
Sun 2005	0	100	0	100		Not estimable	+	?	−	−	+	?	+
Taylor 2013	0	44	0	44		Not estimable	?	+	−	−	+	?	−
Tempe 2016	0	40	0	20		Not estimable	+	+	−	−	+	+	+
Teoh 2010	0	100	0	100		Not estimable	+	+	−	−	+	?	+
Total (95% CI)		**1876**		**1621**	**100.0%**	**0.51 [0.16 , 1.59]**							
Total events:	2		7										



Heterogeneity: Tau² = 0.00; Chi² = 0.75, df = 6 (P = 0.99); I² = 0%
Test for overall effect: Z = 1.16 (P = 0.25)
Test for subgroup differences: Not applicable

Footnotes

(1) We included data only for mucosal trauma to avoid unit of analysis issues.
(2) Multi-arm study. Data combined for each VL group.
(3) We included data only for soft tissue damage to avoid unit of analysis issues.
(4) We included data only for minor lacerations to avoid unit of analysis issues.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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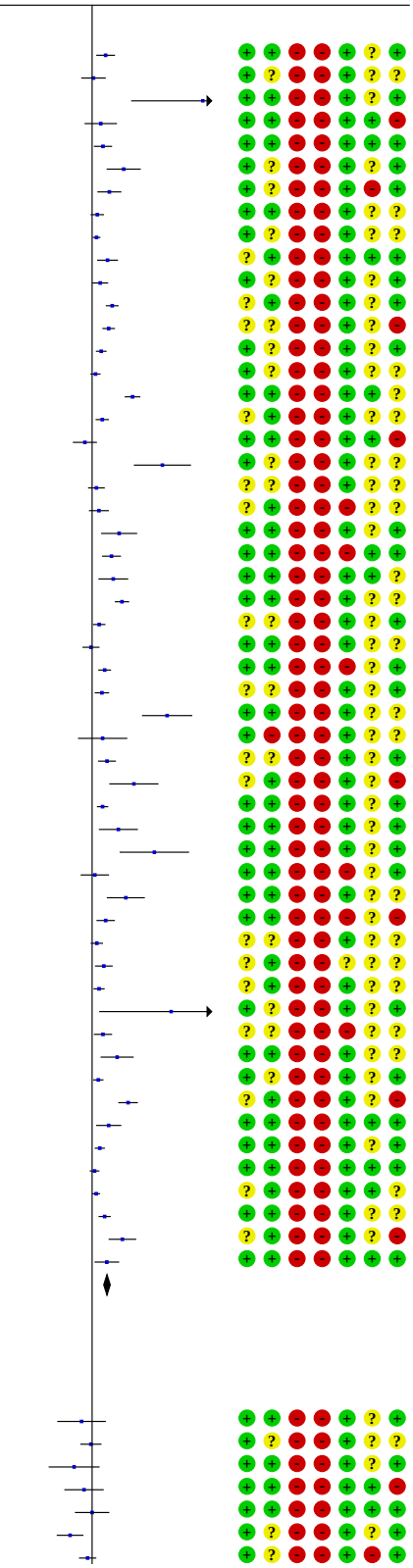
Analysis 2.6. Comparison 2: Hyperangulated VL versus DL, Outcome 6: Cormack-Lehane (CL) grade

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
2.6.1 Cormack-Lehane 1						
Abdelgalel 2018	32	40	19	40	1.0%	1.68 [1.17 , 2.42]
Abdelgawad 2015	19	40	18	40	0.9%	1.06 [0.66 , 1.69]
Agrawal 2020	35	40	0	40	0.2%	71.00 [4.51 , 1118.97]
Al-Ghamdi 2016	12	21	9	22	0.8%	1.40 [0.75 , 2.61]
Andersen 2011	35	50	23	50	1.0%	1.52 [1.07 , 2.16]
Aqil 2016	27	40	8	40	0.8%	3.38 [1.75 , 6.50]
Aqil 2017	35	70	18	70	0.9%	1.94 [1.23 , 3.09]
Arici 2014	33	40	27	40	1.0%	1.22 [0.94 , 1.58]
Arora 2013	51	54	43	54	1.0%	1.19 [1.02 , 1.38]
Arslan 2017 (1)	58	80	16	40	1.0%	1.81 [1.21 , 2.71]
Avula 2019	26	30	19	30	1.0%	1.37 [1.01 , 1.86]
Bag 2014	89	100	41	100	1.0%	2.17 [1.70 , 2.77]
Barak 2007	69	80	41	90	1.0%	1.89 [1.49 , 2.41]
Bashir 2020	40	40	28	40	1.0%	1.42 [1.16 , 1.75]
Bilehjani 2009	36	40	30	38	1.0%	1.14 [0.94 , 1.38]
Chen 2019	177	219	37	217	1.0%	4.74 [3.51 , 6.40]
Colak 2015	42	48	29	49	1.0%	1.48 [1.14 , 1.91]
El-Tahan 2017b	25	66	16	32	0.9%	0.76 [0.48 , 1.21]
Foulds 2016b	45	49	3	49	0.6%	15.00 [5.00 , 45.04]
Gao 2018	42	81	36	82	1.0%	1.18 [0.86 , 1.63]
Golboyu 2016	26	40	20	40	1.0%	1.30 [0.89 , 1.91]
Griesdale 2012a	17	20	6	20	0.8%	2.83 [1.42 , 5.67]
Hu 2017	57	100	27	100	1.0%	2.11 [1.47 , 3.04]
Huang 2020 (1)	40	59	9	30	0.9%	2.26 [1.27 , 4.01]
Ilyas 2014	117	127	37	127	1.0%	3.16 [2.40 , 4.17]
Inal 2016	42	50	32	50	1.0%	1.31 [1.03 , 1.67]
Inangil 2018	23	35	24	35	1.0%	0.96 [0.69 , 1.33]
Jafra 2018	73	100	45	100	1.0%	1.62 [1.27 , 2.08]
Kaur 2020	35	40	24	40	1.0%	1.46 [1.10 , 1.93]
Kleine-Brueggeney 2017 (1)	144	240	4	120	0.6%	18.00 [6.83 , 47.44]
Laosuwan 2015	6	11	4	11	0.7%	1.50 [0.58 , 3.88]
Lee 2012 (1)	50	50	14	25	1.0%	1.78 [1.26 , 2.50]
Lim 2005	20	30	4	30	0.7%	5.00 [1.94 , 12.89]
Liu 2016	71	88	48	89	1.0%	1.50 [1.20 , 1.86]
Malik 2008 (1)	33	60	6	30	0.8%	2.75 [1.30 , 5.83]
Malik 2009b	22	25	2	25	0.5%	11.00 [2.89 , 41.89]
Nandakumar 2018	10	15	9	15	0.9%	1.11 [0.64 , 1.92]
Pappu 2020	44	60	6	30	0.8%	3.67 [1.76 , 7.62]
Parasa 2016	27	30	16	30	1.0%	1.69 [1.18 , 2.41]
Pazur 2016	24	26	20	26	1.0%	1.20 [0.95 , 1.52]
Postaci 2015	33	42	21	42	1.0%	1.57 [1.12 , 2.21]
Risse 2020	33	34	23	31	1.0%	1.31 [1.05 , 1.62]
Robitaille 2008	10	20	0	20	0.2%	21.00 [1.31 , 335.74]
Rovsing 2010	35	50	23	50	1.0%	1.52 [1.07 , 2.16]
Shah 2016	21	30	8	30	0.8%	2.63 [1.39 , 4.97]
Sun 2005	75	100	59	100	1.0%	1.27 [1.04 , 1.55]
Taylor 2013	84	88	21	88	1.0%	4.00 [2.75 , 5.83]
Tempe 2016	35	39	9	19	0.9%	1.89 [1.17 , 3.08]
Teoh 2010	78	100	58	100	1.0%	1.34 [1.10 , 1.64]
Tsan 2020	55	69	50	69	1.0%	1.10 [0.91 , 1.33]
Walker 2009	55	60	47	60	1.0%	1.17 [1.00 , 1.36]
Yao 2015	47	48	29	48	1.0%	1.62 [1.28 , 2.05]
Yousef 2012	30	30	9	30	0.9%	3.21 [1.89 , 5.46]
Yumul 2016 (1)	41	60	12	31	0.9%	1.77 [1.10 , 2.84]
Subtotal (95% CI)		**3204**		**2854**	**48.7%**	**1.77 [1.56 , 2.01]**
Total events:	2441		1187			
Heterogeneity: Tau² = 0.17; Chi² = 417.56, df = 53 (P < 0.00001); I² = 87%						
Test for overall effect: Z = 8.93 (P < 0.00001)						
2.6.2 Cormack-Lehane 2						
Abdelgalel 2018	6	40	9	40	0.7%	0.67 [0.26 , 1.70]
Abdelgawad 2015	21	40	22	40	1.0%	0.95 [0.64 , 1.43]
Agrawal 2020	5	40	10	40	0.6%	0.50 [0.19 , 1.33]
Al-Ghamdi 2016	7	21	10	22	0.8%	0.73 [0.34 , 1.57]
Andersen 2011	13	50	13	50	0.8%	1.00 [0.52 , 1.94]
Aqil 2016	12	40	28	40	0.9%	0.43 [0.26 , 0.72]
Aqil 2017	32	70	38	70	1.0%	0.84 [0.60 , 1.18]



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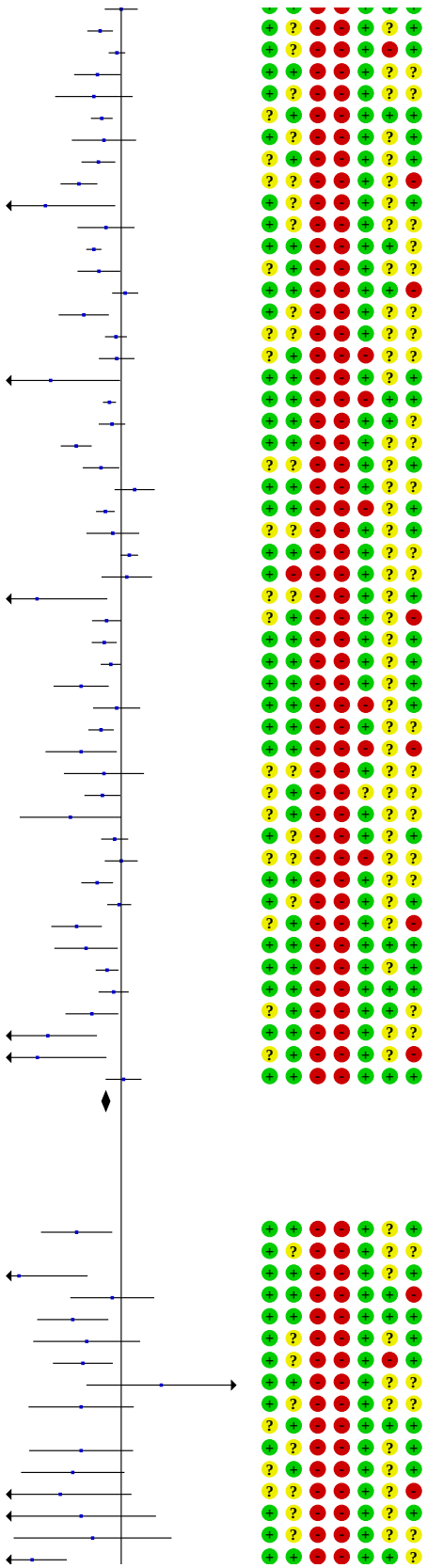
Analysis 2.6. (Continued)

Aqil 2016	12	40	28	40	0.9%	0.43 [0.26 , 0.72]
Aqil 2017	32	70	38	70	1.0%	0.84 [0.60 , 1.18]
Arici 2014	5	40	13	40	0.7%	0.38 [0.15 , 0.98]
Arora 2013	2	54	6	54	0.4%	0.33 [0.07 , 1.58]
Arslan 2017 (1)	22	80	24	40	0.9%	0.46 [0.30 , 0.71]
Avula 2019	3	30	6	30	0.5%	0.50 [0.14 , 1.82]
Bag 2014	10	100	25	100	0.8%	0.40 [0.20 , 0.79]
Barak 2007	7	80	43	90	0.8%	0.18 [0.09 , 0.38]
Bashir 2020	0	40	10	40	0.2%	0.05 [0.00 , 0.79]
Bilehjani 2009	4	40	7	38	0.6%	0.54 [0.17 , 1.71]
Chen 2019	40	219	119	217	1.0%	0.33 [0.25 , 0.45]
Colak 2015	6	48	15	49	0.7%	0.41 [0.17 , 0.96]
El-Tahan 2017b	29	66	12	32	0.9%	1.17 [0.69 , 1.98]
Foulds 2016b	4	49	18	49	0.6%	0.22 [0.08 , 0.61]
Gao 2018	24	81	30	82	0.9%	0.81 [0.52 , 1.26]
Golboyu 2016	10	40	12	40	0.8%	0.83 [0.41 , 1.70]
Griesdale 2012a	0	20	8	20	0.2%	0.06 [0.00 , 0.96]
Hu 2017 (2)	43	100	69	100	1.0%	0.62 [0.48 , 0.81]
Huang 2020 (3)	19	59	14	30	0.9%	0.69 [0.41 , 1.18]
Ilyas 2014	10	127	61	127	0.8%	0.16 [0.09 , 0.31]
Inal 2016	8	50	18	50	0.8%	0.44 [0.21 , 0.93]
Inangil 2018	12	35	7	35	0.7%	1.71 [0.77 , 3.84]
Jafra 2018 (2)	27	100	51	100	1.0%	0.53 [0.36 , 0.77]
Kaur 2020	5	40	7	40	0.6%	0.71 [0.25 , 2.06]
Kleine-Brueggeney 2017 (3)	83	240	30	120	1.0%	1.38 [0.97 , 1.97]
Laosuwan 2015	5	11	4	11	0.6%	1.25 [0.45 , 3.45]
Lee 2012	0	50	7	25	0.2%	0.03 [0.00 , 0.57]
Lim 2005	10	30	18	30	0.9%	0.56 [0.31 , 1.00]
Liu 2016	17	88	34	89	0.9%	0.51 [0.31 , 0.84]
Malik 2008 (1)	25	60	19	30	1.0%	0.66 [0.44 , 0.99]
Malik 2009b	3	25	15	25	0.6%	0.20 [0.07 , 0.61]
Nandakumar 2018	5	15	6	15	0.7%	0.83 [0.32 , 2.15]
Pappu 2020	16	60	18	30	0.9%	0.44 [0.27 , 0.74]
Parasa 2016	2	30	10	30	0.4%	0.20 [0.05 , 0.84]
Pazur 2016	2	26	4	26	0.4%	0.50 [0.10 , 2.50]
Postaci 2015	8	42	17	42	0.8%	0.47 [0.23 , 0.97]
Risse 2020	1	34	7	31	0.3%	0.13 [0.02 , 1.00]
Robitaille 2008	10	20	13	20	0.9%	0.77 [0.45 , 1.32]
Rovsing 2010	13	50	13	50	0.8%	1.00 [0.52 , 1.94]
Shah 2016 (2)	8	30	21	30	0.8%	0.38 [0.20 , 0.72]
Sun 2005	24	100	26	100	0.9%	0.92 [0.57 , 1.49]
Taylor 2013	4	88	24	88	0.6%	0.17 [0.06 , 0.46]
Tempe 2016	3	39	6	19	0.5%	0.24 [0.07 , 0.87]
Teoh 2010	21	100	37	100	0.9%	0.57 [0.36 , 0.90]
Tsan 2020	14	69	19	69	0.8%	0.74 [0.40 , 1.35]
Walker 2009	4	60	13	60	0.6%	0.31 [0.11 , 0.89]
Yao 2015	1	48	19	48	0.3%	0.05 [0.01 , 0.38]
Yousef 2012	0	30	14	30	0.2%	0.03 [0.00 , 0.55]
Yumul 2016 (1)	17	60	8	31	0.8%	1.10 [0.53 , 2.26]
Subtotal (95% CI)		**3204**		**2854**	**38.2%**	**0.54 [0.46 , 0.63]**
Total events:	682		1107			
Heterogeneity: Tau² = 0.20; Chi² = 162.59, df = 53 (P < 0.00001); I² = 67%						
Test for overall effect: Z = 7.50 (P < 0.00001)						
2.6.3 Cormack-Lehane 3-4						
Abdelgalel 2018	2	40	12	40	0.4%	0.17 [0.04 , 0.70]
Abdelgawad 2015	0	40	0	40		Not estimable
Agrawal 2020	0	40	30	40	0.2%	0.02 [0.00 , 0.26]
Al-Ghamdi 2016	2	21	3	22	0.4%	0.70 [0.13 , 3.77]
Andersen 2011	2	50	14	50	0.4%	0.14 [0.03 , 0.60]
Aqil 2016	1	40	4	40	0.3%	0.25 [0.03 , 2.14]
Aqil 2017	3	70	14	70	0.5%	0.21 [0.06 , 0.71]
Arici 2014	2	40	0	40	0.1%	5.00 [0.25 , 100.97]
Arora 2013	1	54	5	54	0.3%	0.20 [0.02 , 1.66]
Arslan 2017 (1)	0	80	0	40		Not estimable
Avula 2019	1	30	5	30	0.3%	0.20 [0.02 , 1.61]
Bag 2014	1	100	7	100	0.3%	0.14 [0.02 , 1.14]
Barak 2007	0	80	6	90	0.2%	0.09 [0.00 , 1.51]
Bashir 2020	0	40	2	40	0.1%	0.20 [0.01 , 4.04]
Bilehjani 2009	0	40	1	38	0.1%	0.32 [0.01 , 7.55]
Chen 2019	2	219	71	217	0.5%	0.03 [0.01 , 0.11]



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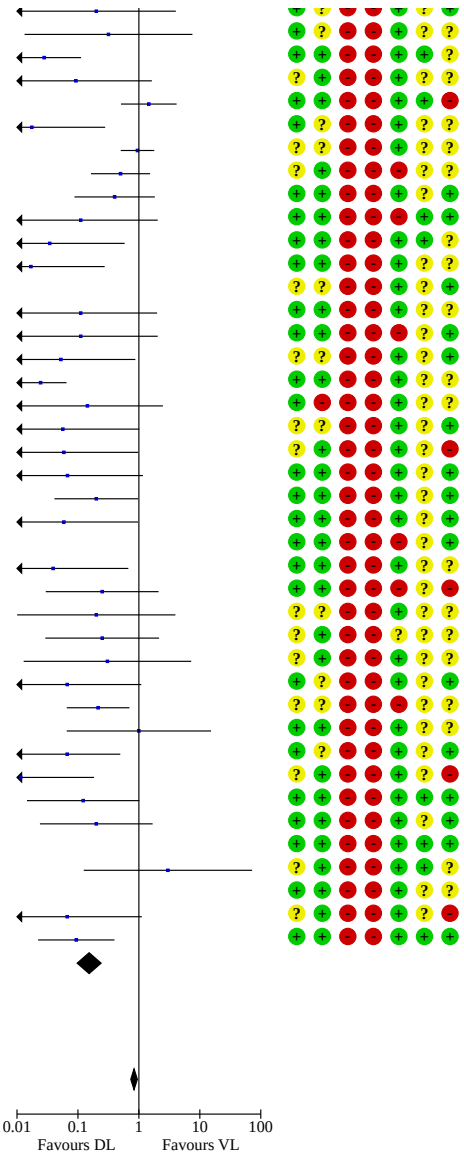
Analysis 2.6. (Continued)

Basim 2020	0	40	2	40	0.1%	0.20 [0.01 , 4.04]
Bilehjani 2009	0	40	1	38	0.1%	0.32 [0.01 , 7.55]
Chen 2019	2	219	71	217	0.5%	0.03 [0.01 , 0.11]
Colak 2015	0	48	5	49	0.2%	0.09 [0.01 , 1.63]
El-Tahan 2017b	12	66	4	32	0.6%	1.45 [0.51 , 4.16]
Foulds 2016b	0	49	28	49	0.2%	0.02 [0.00 , 0.28]
Gao 2018	15	81	16	82	0.8%	0.95 [0.50 , 1.79]
Golboyu 2016	4	40	8	40	0.6%	0.50 [0.16 , 1.53]
Griesdale 2012a	2	20	5	20	0.4%	0.40 [0.09 , 1.83]
Hu 2017	0	100	4	100	0.2%	0.11 [0.01 , 2.04]
Huang 2020 (1)	0	59	7	30	0.2%	0.03 [0.00 , 0.58]
Ilyas 2014	0	127	29	127	0.2%	0.02 [0.00 , 0.27]
Inal 2016	0	50	0	50		Not estimable
Inangil 2018	0	35	4	35	0.2%	0.11 [0.01 , 1.99]
Jafra 2018	0	100	4	100	0.2%	0.11 [0.01 , 2.04]
Kaur 2020	0	40	9	40	0.2%	0.05 [0.00 , 0.87]
Kleine-Brueggeney 2017 (1)	4	240	82	120	0.6%	0.02 [0.01 , 0.06]
Laosuwan 2015	0	11	3	11	0.2%	0.14 [0.01 , 2.48]
Lee 2012 (1)	0	50	4	25	0.2%	0.06 [0.00 , 1.01]
Lim 2005	0	30	8	30	0.2%	0.06 [0.00 , 0.98]
Liu 2016	0	88	7	89	0.2%	0.07 [0.00 , 1.16]
Malik 2008 (1)	2	60	5	30	0.4%	0.20 [0.04 , 0.97]
Malik 2009b	0	25	8	25	0.2%	0.06 [0.00 , 0.97]
Nandakumar 2018	0	15	0	15		Not estimable
Pappu 2020	0	60	6	30	0.2%	0.04 [0.00 , 0.67]
Parasa 2016	1	30	4	30	0.3%	0.25 [0.03 , 2.11]
Pazur 2016	0	26	2	26	0.1%	0.20 [0.01 , 3.97]
Postaci 2015	1	42	4	42	0.3%	0.25 [0.03 , 2.14]
Risse 2020	0	34	1	31	0.1%	0.30 [0.01 , 7.22]
Robitaille 2008	0	20	7	20	0.2%	0.07 [0.00 , 1.09]
Rovsing 2010	3	50	14	50	0.5%	0.21 [0.07 , 0.70]
Shah 2016	1	30	1	30	0.2%	1.00 [0.07 , 15.26]
Sun 2005	1	100	15	100	0.3%	0.07 [0.01 , 0.50]
Taylor 2013	0	88	43	88	0.2%	0.01 [0.00 , 0.18]
Tempe 2016	1	39	4	19	0.3%	0.12 [0.01 , 1.02]
Teoh 2010	1	100	5	100	0.3%	0.20 [0.02 , 1.68]
Tsan 2020	0	69	0	69		Not estimable
Walker 2009	1	60	0	60	0.1%	3.00 [0.12 , 72.20]
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	7	30	0.2%	0.07 [0.00 , 1.12]
Yumul 2016 (1)	2	60	11	31	0.4%	0.09 [0.02 , 0.40]
Subtotal (95% CI)		**3204**		**2854**	**13.1%**	**0.15 [0.10 , 0.24]**
Total events:	68		538			
Heterogeneity: Tau² = 1.30; Chi² = 117.65, df = 47 (P < 0.00001); I² = 60%						
Test for overall effect: Z = 8.13 (P < 0.00001)						
Total (95% CI)		**9612**		**8562**	**100.0%**	**0.83 [0.74 , 0.94]**
Total events:	3191		2832			
Heterogeneity: Tau² = 0.38; Chi² = 1214.72, df = 155 (P < 0.00001); I² = 87%						
Test for overall effect: Z = 2.88 (P = 0.004)						
Test for subgroup differences: Chi² = 201.65, df = 2 (P < 0.00001), I² = 99.0%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.
(2) Data for IIa and IIb view combined.
(3) Multi-arm study. Data combined for each VL group. Data for IIa and IIb view combined.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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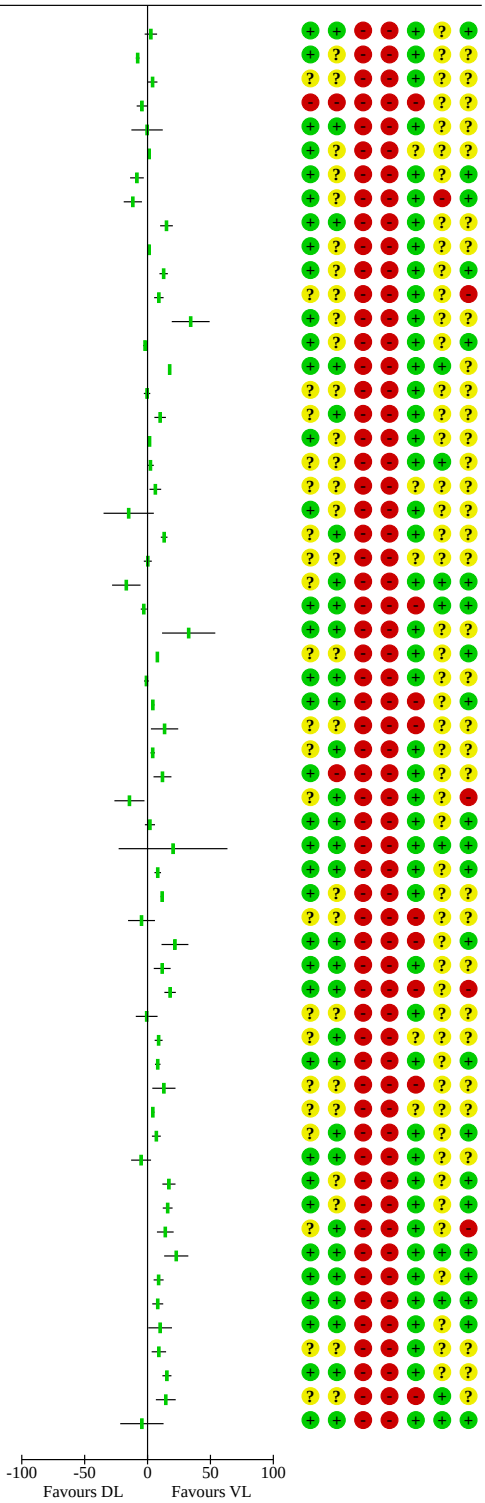
Analysis 2.7. Comparison 2: Hyperangulated VL versus DL, Outcome 7: Time for tracheal intubation

Study or Subgroup	Videolaryngoscope Mean	SD	Total	Direct laryngoscope Mean	SD	Total	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdelgalel 2018	31.45	12.17	40	28.8	10.27	40	2.65 [-2.28 , 7.58]	+	+	-	-	+	?	+
Abdelgawad 2015	19.1	3.1	40	26.95	3.7	40	-7.85 [-9.35 , -6.35]	+	?	-	-	+	?	?
Ahmad 2015	20.12	8.05	25	16.12	5.67	25	4.00 [0.14 , 7.86]	?	?	-	-	+	?	?
Ahmadi 2015	20.31	7.14	49	24.75	13.06	48	-4.44 [-8.64 , -0.24]	-	-	-	-	-	?	?
Akbarzadeh 2017	10.8	23.82	34	11.18	28.44	34	-0.38 [-12.85 , 12.09]	+	+	-	-	+	?	?
Amini 2015	10.6	1.7	35	9.3	1.4	35	1.30 [0.57 , 2.03]	+	?	-	-	?	?	?
Aqil 2016	32.9	8.69	40	41.33	15.29	40	-8.43 [-13.88 , -2.98]	+	?	-	-	+	?	+
Aqil 2017	36.1	12.9	70	47.8	28.1	70	-11.70 [-18.94 , -4.46]	+	?	-	-	+	-	+
Arici 2014	47.25	14.92	40	32.2	6.58	40	15.05 [10.00 , 20.10]	+	+	-	-	+	?	?
Arora 2013	12.1	3.8	54	10.9	2.1	54	1.20 [0.04 , 2.36]	+	?	-	-	+	?	?
Avula 2019	42.77	7.59	30	29.97	5.37	30	12.80 [9.47 , 16.13]	+	?	-	-	+	?	+
Barak 2007	33	12	80	24	13	90	9.00 [5.24 , 12.76]	?	?	-	-	+	?	-
Bilehjani 2009	48.8	47.82	40	14.5	8.3	38	34.30 [19.25 , 49.35]	+	?	-	-	+	?	?
Carassiti 2013	20	1	15	22	3	15	-2.00 [-3.60 , -0.40]	+	?	-	-	+	?	+
Chen 2019	43.99	0.72	219	26.4	0.53	217	17.59 [17.47 , 17.71]	+	+	-	-	+	+	?
Choi 2011	18.2	5	30	18.6	5.1	30	-0.40 [-2.96 , 2.16]	?	?	-	-	+	?	?
Colak 2015	23.6	15.23	48	13.59	5.49	49	10.01 [5.44 , 14.58]	?	+	-	-	+	?	?
Dashti 2014	9.8	1.29	30	8.2	1.17	29	1.60 [0.97 , 2.23]	+	?	-	-	+	?	?
Dostalova 2019	20.5	6	45	18.2	6.7	45	2.30 [-0.33 , 4.93]	?	?	-	-	+	+	?
Echeverri 2020	28	8.8	41	21.8	12.3	41	6.20 [1.57 , 10.83]	?	?	-	-	?	?	?
Foulds 2016b	45	48.1	24	60	13.7	25	-15.00 [-34.98 , 4.98]	+	?	-	-	+	?	?
Gunes 2020	35.3	10.3	90	22.1	7.7	90	13.20 [10.54 , 15.86]	?	+	-	-	+	?	?
Hostic 2016	18.5	6.8	48	18.3	8.1	40	0.20 [-2.96 , 3.36]	?	?	-	-	?	?	?
Hsu 2012	45.6	10.7	30	62.5	29.7	30	-16.90 [-28.20 , -5.60]	?	+	-	-	+	+	+
Hu 2017	23	9	100	26	8	96	-3.00 [-5.38 , -0.62]	+	+	-	-	-	+	+
Ilyas 2014	82.7	80	64	50	32.6	64	32.70 [11.54 , 53.86]	+	+	-	-	+	?	?
Inal 2016	13.8	3.3	50	6	1.9	50	7.80 [6.74 , 8.86]	?	?	-	-	+	?	+
Inangil 2018	13.2	4.2	35	14.1	4	35	-0.90 [-2.82 , 1.02]	+	+	-	-	+	?	?
Jafra 2018	24.89	5.574	100	20.68	3.637	100	4.21 [2.91 , 5.51]	+	+	-	-	-	?	+
Koennecke 2014 (1)	68.53	34.7	83	55	22	30	13.53 [2.68 , 24.38]	?	?	-	-	-	?	?
Kurnaz 2016	21	4.9	50	16.9	4.2	50	4.10 [2.31 , 5.89]	?	+	-	-	+	?	?
Laosuwan 2015	35.07	9.49	11	23.21	7.42	11	11.86 [4.74 , 18.98]	+	-	-	-	+	?	?
Lim 2005	41.8	20.2	30	56.2	26.6	30	-14.40 [-26.35 , -2.45]	?	+	-	-	+	?	-
Liu 2016	30.6	14.8	88	28.7	12.3	89	1.90 [-2.11 , 5.91]	+	+	-	-	+	?	+
Loughnan 2019	61.78	96.76	20	41.51	30.53	49	20.27 [-22.99 , 63.53]	+	+	-	-	+	+	+
Malik 2008 (1)	19.7	5.86	60	11.6	6	30	8.10 [5.49 , 10.71]	+	+	-	-	+	?	+
Najafi 2014	37.2	6.4	150	25.6	4.1	150	11.60 [10.38 , 12.82]	+	?	-	-	+	?	?
Nakayama 2010	69.4	28.4	80	74.2	39.7	80	-4.80 [-15.50 , 5.90]	?	?	-	-	-	?	?
Nandakumar 2018	53.6	19.27	15	31.81	8.57	15	21.79 [11.12 , 32.46]	+	+	-	-	-	?	+
Pappu 2020	41.37	20.75	60	29.73	11.65	30	11.64 [4.94 , 18.34]	+	+	-	-	+	?	?
Parasa 2016	45.7	11.65	30	27.77	5.12	30	17.93 [13.38 , 22.48]	+	+	-	-	-	?	-
Pazur 2016	33.6	16.7	26	34.3	15.1	26	-0.70 [-9.35 , 7.95]	?	?	-	-	+	?	?
Postaci 2015	23.4	9.3	42	14.6	4.7	42	8.80 [5.65 , 11.95]	?	+	-	-	?	?	?
Pournajafian 2014	15.9	6.7	46	7.8	3.7	49	8.10 [5.90 , 10.30]	+	+	-	-	+	?	+
Rovsing 2010	51	23	50	38	24	50	13.00 [3.79 , 22.21]	?	?	-	-	-	?	?
Sandhu 2014	24.9	5.6	100	20.7	3.6	100	4.20 [2.90 , 5.50]	?	?	-	-	?	?	?
Serocki 2013 (1)	18.19	11.92	63	11.2	5.6	32	6.99 [3.46 , 10.52]	?	+	-	-	+	?	+
Shah 2016	32.27	11.13	30	37.41	18.8	29	-5.14 [-13.06 , 2.78]	+	+	-	-	+	?	?
Siddiqui 2009	30.9	9	20	13.9	7.8	20	17.00 [11.78 , 22.22]	+	?	-	-	+	?	+
Sun 2005	46	15	96	30	12.69	99	16.00 [12.09 , 19.91]	+	?	-	-	+	?	+
Taylor 2013	35.8	20.4	44	21.7	9.4	44	14.10 [7.46 , 20.74]	?	+	-	-	+	?	-
Tempe 2016	47.34	26.26	39	24.53	10.94	19	22.81 [13.21 , 32.41]	+	+	-	-	+	+	+
Teoh 2010	31.2	15	100	22.4	13.6	100	8.80 [4.83 , 12.77]	+	+	-	-	+	?	+
Tsan 2020	44.33	11.53	69	36.23	14.41	69	8.10 [3.75 , 12.45]	+	+	-	-	+	+	+
Turkstra 2005	27	12	9	17	8	9	10.00 [0.58 , 19.42]	+	+	-	-	+	?	+
Xue 2007	37.4	9.9	28	28.4	11.7	27	9.00 [3.26 , 14.74]	?	?	-	-	+	?	?
Yao 2015	39.7	10.5	48	24.3	7.1	48	15.40 [11.81 , 18.99]	+	+	-	-	+	?	?
Yeatts 2013	71	50.62	303	56.5	49.74	320	14.50 [6.61 , 22.39]	?	?	-	-	-	+	?
Yumul 2016	65.5	32.5	60	70	43	31	-4.50 [-21.73 , 12.73]	+	+	-	-	+	+	+



Test for subgroup differences: Not applicable

Footnotes

(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend

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Analysis 2.7. (Continued)

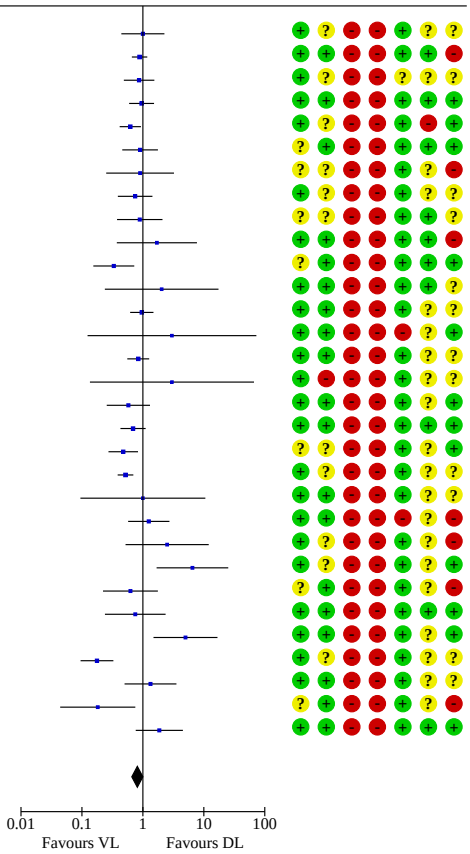
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 2.8. Comparison 2: Hyperangulated VL versus DL, Outcome 8: Patient-reported sore throat

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgawad 2015	9	40	9	40	3.4%	1.00 [0.44 , 2.26]
Al-Ghamdi 2016	16	21	19	22	6.1%	0.88 [0.66 , 1.18]
Amini 2015	13	35	15	35	4.5%	0.87 [0.49 , 1.54]
Andersen 2011	20	50	21	50	5.1%	0.95 [0.59 , 1.52]
Aqil 2017	23	70	37	70	5.5%	0.62 [0.42 , 0.93]
Arslan 2017 (1)	18	80	10	40	4.0%	0.90 [0.46 , 1.76]
Barak 2007	4	80	5	90	1.9%	0.90 [0.25 , 3.24]
Bilehjani 2009	11	40	14	38	4.1%	0.75 [0.39 , 1.43]
Dostalova 2019	8	45	9	45	3.2%	0.89 [0.38 , 2.10]
El-Tahan 2017b	7	66	2	32	1.5%	1.70 [0.37 , 7.71]
Hsu 2012	6	30	18	30	3.5%	0.33 [0.15 , 0.72]
Huang 2020 (1)	4	59	1	30	0.8%	2.03 [0.24 , 17.40]
Ilyas 2014	24	64	25	64	5.3%	0.96 [0.62 , 1.49]
Jafra 2018	1	100	0	100	0.4%	3.00 [0.12 , 72.77]
Kleine-Brueggeney 2017 (1)	47	240	28	120	5.4%	0.84 [0.56 , 1.27]
Laosuwan 2015	1	11	0	11	0.4%	3.00 [0.14 , 66.53]
Liu 2016	8	88	14	89	3.3%	0.58 [0.26 , 1.31]
Liu 2019	24	177	35	178	5.1%	0.69 [0.43 , 1.11]
Masoumifar 2020	10	30	21	30	4.6%	0.48 [0.27 , 0.83]
Najafi 2014	42	150	81	150	6.0%	0.52 [0.39 , 0.70]
Pappu 2020	2	60	1	30	0.7%	1.00 [0.09 , 10.59]
Parasa 2016	10	30	8	30	3.5%	1.25 [0.57 , 2.73]
Russell 2013	5	35	2	35	1.4%	2.50 [0.52 , 12.03]
Siddiqui 2009	13	20	2	20	1.8%	6.50 [1.68 , 25.16]
Taylor 2013	5	44	8	44	2.5%	0.63 [0.22 , 1.76]
Tempe 2016	6	40	4	20	2.2%	0.75 [0.24 , 2.36]
Teoh 2010	15	100	3	100	2.1%	5.00 [1.49 , 16.74]
Tosh 2018	9	65	51	65	4.3%	0.18 [0.09 , 0.33]
Yao 2015	8	48	6	48	2.7%	1.33 [0.50 , 3.55]
Yousef 2012	2	30	11	30	1.6%	0.18 [0.04 , 0.75]
Yumul 2016	18	60	5	31	3.0%	1.86 [0.76 , 4.53]
Total (95% CI)		**2008**		**1717**	**100.0%**	**0.81 [0.66 , 1.00]**
Total events:	389		465			

Heterogeneity: Tau² = 0.17; Chi² = 75.87, df = 30 (P < 0.00001); I² = 60%
Test for overall effect: Z = 1.97 (P = 0.05)
Test for subgroup differences: Not applicable



Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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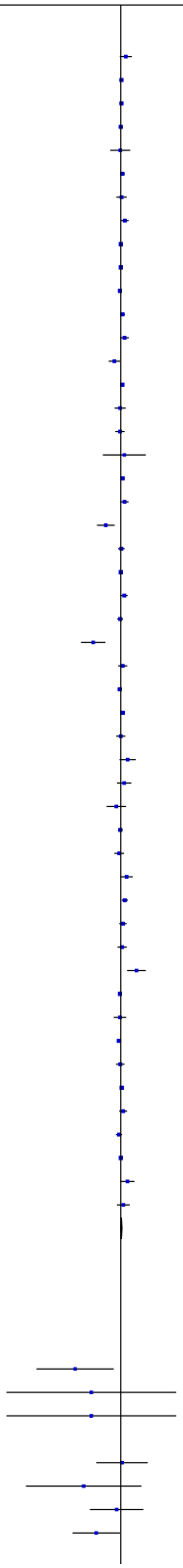
Analysis 2.9. Comparison 2: Hyperangulated VL versus DL, Outcome 9: Number of attempts

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
2.9.1 1 attempt													
Abdelgalel 2018	35	40	29	40	1.0%	1.21 [0.96 , 1.51]	+	+	-	-	+	?	+
Abdelgawad 2015	40	40	39	40	3.2%	1.03 [0.96 , 1.10]	+	?	-	-	+	?	?
Agrawal 2020	40	40	39	40	3.2%	1.03 [0.96 , 1.10]	+	+	-	-	+	?	+
Ahmad 2015	25	25	25	25	3.0%	1.00 [0.93 , 1.08]	?	?	-	-	+	?	?
Al-Ghamdi 2016	15	21	16	22	0.4%	0.98 [0.68 , 1.43]	+	+	-	-	+	+	-
Andersen 2011	49	50	46	50	2.7%	1.07 [0.97 , 1.17]	+	+	-	-	+	+	+
Aqil 2016	34	40	33	40	1.2%	1.03 [0.85 , 1.25]	+	?	-	-	+	?	+
Aqil 2017	64	70	55	70	1.8%	1.16 [1.01 , 1.34]	+	?	-	-	+	-	+
Arici 2014	40	40	40	40	3.6%	1.00 [0.95 , 1.05]	+	+	-	-	+	?	?
Arora 2013	54	54	54	54	3.8%	1.00 [0.96 , 1.04]	+	?	-	-	+	?	?
Arslan 2017 (1)	77	80	40	40	3.4%	0.97 [0.91 , 1.03]	?	+	-	-	+	+	+
Barak 2007	76	80	80	90	2.7%	1.07 [0.98 , 1.17]	?	?	-	-	+	?	-
Bashir 2020	38	40	33	40	1.5%	1.15 [0.98 , 1.35]	+	?	-	-	+	?	+
Bilehjani 2009	29	40	35	38	1.0%	0.79 [0.64 , 0.97]	+	?	-	-	+	?	?
Chen 2019	205	219	191	217	3.4%	1.06 [1.00 , 1.13]	+	+	-	-	+	+	?
Gao 2018	55	81	57	82	1.1%	0.98 [0.79 , 1.20]	?	?	-	-	+	?	?
Golboyu 2016	34	40	35	40	1.4%	0.97 [0.82 , 1.16]	?	+	-	-	-	?	?
Griesdale 2012a	8	20	7	20	0.1%	1.14 [0.51 , 2.55]	+	+	-	-	+	?	+
Gunes 2020	88	90	82	90	3.1%	1.07 [1.00 , 1.15]	?	+	-	-	+	?	?
Hsu 2012	30	30	26	30	1.6%	1.15 [0.99 , 1.34]	?	+	-	-	+	+	+
Huang 2020	27	59	24	30	0.5%	0.57 [0.41 , 0.80]	+	+	-	-	+	+	?
Inal 2016	46	50	45	50	2.1%	1.02 [0.90 , 1.16]	?	?	-	-	+	?	+
Jafra 2018	100	100	100	100	4.1%	1.00 [0.98 , 1.02]	+	+	-	-	-	?	+
Kaur 2020	40	40	35	40	2.0%	1.14 [1.01 , 1.29]	?	?	-	-	+	?	+
Kurnaz 2016	46	50	47	50	2.3%	0.98 [0.88 , 1.09]	?	+	-	-	+	?	?
Lee 2012 (1)	15	50	21	25	0.3%	0.36 [0.23 , 0.56]	?	?	-	-	+	?	+
Lim 2005	28	30	26	30	1.4%	1.08 [0.91 , 1.28]	?	+	-	-	+	?	-
Liu 2016	80	88	84	89	2.8%	0.96 [0.89 , 1.05]	+	+	-	-	+	?	+
Liu 2019	172	179	163	181	3.4%	1.07 [1.01 , 1.13]	+	+	-	-	+	+	+
Malik 2008 (1)	52	60	26	30	1.4%	1.00 [0.84 , 1.19]	+	+	-	-	+	?	+
Malik 2009b	22	25	17	25	0.6%	1.29 [0.95 , 1.76]	+	+	-	-	+	?	+
Masoumifar 2020	25	30	22	30	0.7%	1.14 [0.87 , 1.49]	?	?	-	-	+	?	+
Nandakumar 2018	11	15	13	15	0.4%	0.85 [0.59 , 1.22]	+	+	-	-	-	?	+
Pappu 2020	57	60	29	30	2.7%	0.98 [0.90 , 1.07]	+	+	-	-	+	?	?
Risse 2020	29	34	28	31	1.3%	0.94 [0.79 , 1.13]	?	+	-	-	+	?	?
Sanguanwit 2021	57	78	47	80	0.9%	1.24 [0.99 , 1.56]	+	+	-	-	+	?	?
Sargin 2016	50	50	43	50	2.2%	1.16 [1.03 , 1.31]	+	?	-	-	+	?	+
Serocki 2010	38	40	35	40	1.8%	1.09 [0.95 , 1.25]	?	+	-	-	+	?	+
Serocki 2013 (1)	56	63	27	32	1.4%	1.05 [0.89 , 1.25]	?	+	-	-	+	?	+
Silverberg 2015	41	57	24	60	0.5%	1.80 [1.27 , 2.55]	-	-	-	-	+	+	?
Sun 2005	94	100	97	100	3.3%	0.97 [0.91 , 1.03]	+	?	-	-	+	?	+
Tempe 2016	33	40	17	20	0.9%	0.97 [0.77 , 1.23]	+	+	-	-	+	+	+
Teoh 2010	91	100	98	100	3.2%	0.93 [0.87 , 0.99]	+	+	-	-	+	?	+
Tosh 2018	53	65	54	65	1.5%	0.98 [0.84 , 1.15]	+	?	-	-	+	?	?
Tsan 2020	68	69	66	69	3.4%	1.03 [0.97 , 1.09]	+	+	-	-	+	+	+
Wasinwong 2017	23	23	21	23	1.7%	1.09 [0.94 , 1.27]	+	?	-	-	+	?	-
Xue 2007	28	30	27	27	2.2%	0.94 [0.83 , 1.05]	?	?	-	-	+	?	?
Yao 2015	48	48	48	48	3.8%	1.00 [0.96 , 1.04]	+	+	-	-	+	?	?
Yousef 2012	27	30	21	30	0.7%	1.29 [0.99 , 1.67]	?	+	-	-	+	?	-
Yumul 2016	49	60	23	31	0.9%	1.10 [0.87 , 1.40]	+	+	-	-	+	+	+
Subtotal (95% CI)		**2863**		**2639**	**97.5%**	**1.02 [1.00 , 1.05]**							
Total events:	2542		2290										
Heterogeneity: Tau² = 0.00; Chi² = 122.41, df = 49 (P < 0.00001); I² = 60%													
Test for overall effect: Z = 2.05 (P = 0.04)													
2.9.2 2-4 attempts													
Abdelgalel 2018	2	40	11	40	0.0%	0.18 [0.04 , 0.77]	+	+	-	-	+	?	+
Abdelgawad 2015	0	40	1	40	0.0%	0.33 [0.01 , 7.95]	+	?	-	-	+	?	?
Agrawal 2020	0	40	1	40	0.0%	0.33 [0.01 , 7.95]	+	+	-	-	+	?	+
Ahmad 2015	0	25	0	25		Not estimable	?	?	-	-	+	?	?
Al-Ghamdi 2016	6	21	6	22	0.1%	1.05 [0.40 , 2.74]	+	+	-	-	+	+	-
Andersen 2011	1	50	4	50	0.0%	0.25 [0.03 , 2.16]	+	+	-	-	+	+	+
Aqil 2016	6	40	7	40	0.1%	0.86 [0.32 , 2.33]	+	?	-	-	+	?	+
Aqil 2017	6	70	15	70	0.1%	0.40 [0.16 , 0.97]	+	?	-	-	+	-	+
Arici 2014	0	40	0	40		Not estimable	+	+	-	-	+	?	?



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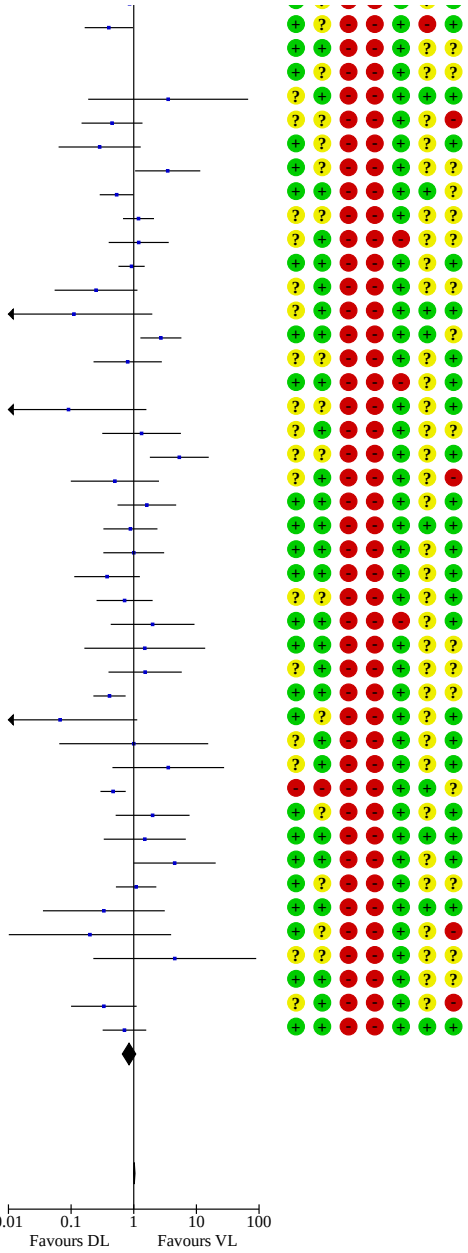
Analysis 2.9. (Continued)

Aqil 2017	6	70	15	70	0.1%	0.40 [0.16 , 0.97]
Arici 2014	0	40	0	40		Not estimable
Arora 2013	0	54	0	54		Not estimable
Arslan 2017 (1)	3	80	0	40	0.0%	3.54 [0.19 , 66.97]
Barak 2007	4	80	10	90	0.0%	0.45 [0.15 , 1.38]
Bashir 2020	2	40	7	40	0.0%	0.29 [0.06 , 1.29]
Bilehjani 2009	11	40	3	38	0.0%	3.48 [1.05 , 11.53]
Chen 2019	14	219	26	217	0.2%	0.53 [0.29 , 0.99]
Gao 2018	20	81	17	82	0.2%	1.19 [0.67 , 2.10]
Golboyu 2016	6	40	5	40	0.1%	1.20 [0.40 , 3.62]
Griesdale 2012a	12	20	13	20	0.3%	0.92 [0.57 , 1.49]
Gunes 2020	2	90	8	90	0.0%	0.25 [0.05 , 1.14]
Hsu 2012	0	30	4	30	0.0%	0.11 [0.01 , 1.98]
Huang 2020	32	59	6	30	0.1%	2.71 [1.28 , 5.76]
Inal 2016	4	50	5	50	0.0%	0.80 [0.23 , 2.81]
Jafra 2018	0	100	0	100		Not estimable
Kaur 2020	0	40	5	40	0.0%	0.09 [0.01 , 1.59]
Kurnaz 2016	4	50	3	50	0.0%	1.33 [0.31 , 5.65]
Lee 2012 (1)	32	50	3	25	0.1%	5.33 [1.81 , 15.73]
Lim 2005	2	30	4	30	0.0%	0.50 [0.10 , 2.53]
Liu 2016	8	88	5	89	0.1%	1.62 [0.55 , 4.75]
Liu 2019	7	179	8	181	0.1%	0.88 [0.33 , 2.39]
Malik 2008 (1)	8	60	4	30	0.0%	1.00 [0.33 , 3.06]
Malik 2009b	3	25	8	25	0.0%	0.38 [0.11 , 1.25]
Masoumifar 2020 (2)	5	30	7	30	0.1%	0.71 [0.25 , 2.00]
Nandakumar 2018	4	15	2	15	0.0%	2.00 [0.43 , 9.32]
Pappu 2020	3	60	1	30	0.0%	1.50 [0.16 , 13.82]
Risse 2020	5	34	3	31	0.0%	1.52 [0.40 , 5.84]
Sanguanwit 2021	12	78	30	80	0.2%	0.41 [0.23 , 0.74]
Sargin 2016	0	50	7	50	0.0%	0.07 [0.00 , 1.14]
Serocki 2010	1	40	1	40	0.0%	1.00 [0.06 , 15.44]
Serocki 2013 (1)	7	63	1	32	0.0%	3.56 [0.46 , 27.66]
Silverberg 2015	16	57	36	60	0.3%	0.47 [0.29 , 0.74]
Sun 2005	6	100	3	100	0.0%	2.00 [0.51 , 7.78]
Tempe 2016	6	40	2	20	0.0%	1.50 [0.33 , 6.77]
Teoh 2010	9	100	2	100	0.0%	4.50 [1.00 , 20.31]
Tosh 2018	12	65	11	65	0.1%	1.09 [0.52 , 2.29]
Tsan 2020	1	69	3	69	0.0%	0.33 [0.04 , 3.13]
Wasinwong 2017	0	23	2	23	0.0%	0.20 [0.01 , 3.95]
Xue 2007	2	30	0	27	0.0%	4.52 [0.23 , 90.08]
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	3	30	9	30	0.0%	0.33 [0.10 , 1.11]
Yumul 2016	11	60	8	31	0.1%	0.71 [0.32 , 1.58]
Subtotal (95% CI)		**2863**		**2639**	**2.5%**	**0.84 [0.66 , 1.08]**
Total events:	298		317			
Heterogeneity: Tau² = 0.27; Chi² = 85.27, df = 44 (P = 0.0002); I² = 48%						
Test for overall effect: Z = 1.38 (P = 0.17)						
Total (95% CI)		**5726**		**5278**	**100.0%**	**1.02 [0.99 , 1.04]**
Total events:	2840		2607			
Heterogeneity: Tau² = 0.00; Chi² = 204.95, df = 94 (P < 0.00001); I² = 54%						
Test for overall effect: Z = 1.49 (P = 0.14)						
Test for subgroup differences: Chi² = 2.44, df = 1 (P = 0.12), I² = 58.9%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.
(2) One case missing in Macintosh arm.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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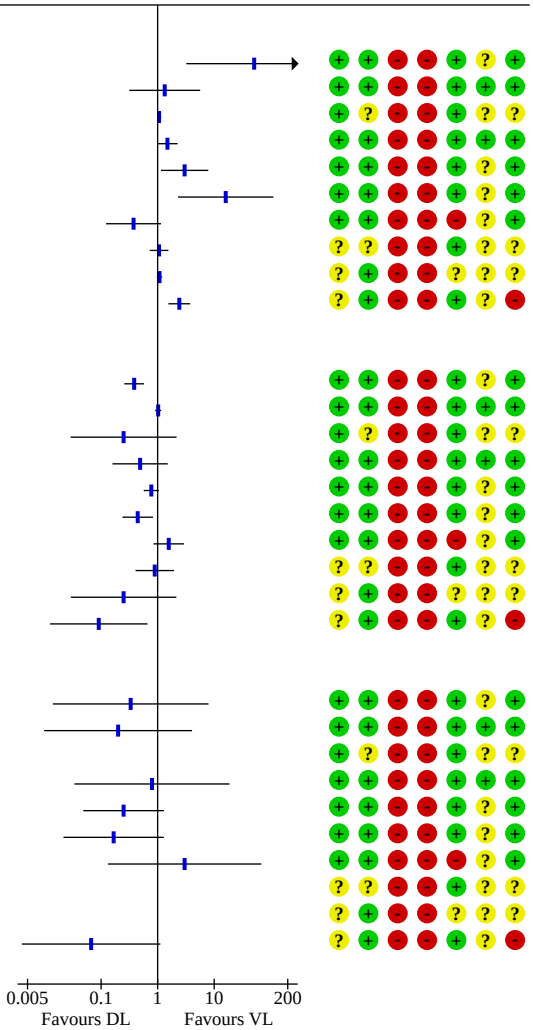
Analysis 2.10. Comparison 2: Hyperangulated VL versus DL, Outcome 10: Intubation Difficulty Scale (IDS)

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
2.10.1 IDS 0												
Agrawal 2020	25	40	0	40	51.00 [3.21 , 809.97]	+	+	-	-	+	?	+
Andersen 2011	4	50	3	50	1.33 [0.31 , 5.65]	+	+	-	-	+	+	+
Arora 2013	53	54	50	54	1.06 [0.97 , 1.15]	+	?	-	-	+	?	?
Loughnan 2019	14	20	23	49	1.49 [0.99 , 2.25]	+	+	-	-	+	+	+
Malik 2008 (1)	24	60	4	30	3.00 [1.14 , 7.86]	+	+	-	-	+	?	+
Malik 2009b	16	25	1	25	16.00 [2.29 , 111.65]	+	+	-	-	+	?	+
Nandakumar 2018	3	15	8	15	0.38 [0.12 , 1.15]	+	+	-	-	-	?	+
Pazur 2016	18	26	17	26	1.06 [0.72 , 1.55]	?	?	-	-	+	?	?
Postaci 2015	41	42	38	42	1.08 [0.97 , 1.20]	?	+	-	-	?	?	?
Yousef 2012	29	30	12	30	2.42 [1.55 , 3.76]	?	+	-	-	+	?	-
2.10.2 IDS 1-5												
Agrawal 2020	15	40	39	40	0.38 [0.26 , 0.58]	+	+	-	-	+	?	+
Andersen 2011	46	50	45	50	1.02 [0.90 , 1.16]	+	+	-	-	+	+	+
Arora 2013	1	54	4	54	0.25 [0.03 , 2.16]	+	?	-	-	+	?	?
Loughnan 2019	3	20	15	49	0.49 [0.16 , 1.51]	+	+	-	-	+	+	+
Malik 2008 (1)	34	60	22	30	0.77 [0.57 , 1.05]	+	+	-	-	+	?	+
Malik 2009b	8	25	18	25	0.44 [0.24 , 0.83]	+	+	-	-	+	?	+
Nandakumar 2018	11	15	7	15	1.57 [0.84 , 2.92]	+	+	-	-	-	?	+
Pazur 2016	8	26	9	26	0.89 [0.41 , 1.94]	?	?	-	-	+	?	?
Postaci 2015	1	42	4	42	0.25 [0.03 , 2.14]	?	+	-	-	?	?	?
Yousef 2012	1	30	11	30	0.09 [0.01 , 0.66]	?	+	-	-	+	?	-
2.10.3 IDS > 5												
Agrawal 2020	0	40	1	40	0.33 [0.01 , 7.95]	+	+	-	-	+	?	+
Andersen 2011	0	50	2	50	0.20 [0.01 , 4.06]	+	+	-	-	+	+	+
Arora 2013	0	54	0	54	Not estimable	+	?	-	-	+	?	?
Loughnan 2019	0	20	1	49	0.79 [0.03 , 18.70]	+	+	-	-	+	+	+
Malik 2008 (1)	2	60	4	30	0.25 [0.05 , 1.29]	+	+	-	-	+	?	+
Malik 2009b	1	25	6	25	0.17 [0.02 , 1.29]	+	+	-	-	+	?	+
Nandakumar 2018	1	15	0	15	3.00 [0.13 , 68.26]	+	+	-	-	-	?	+
Pazur 2016	0	26	0	26	Not estimable	?	?	-	-	+	?	?
Postaci 2015	0	42	0	42	Not estimable	?	+	-	-	?	?	?
Yousef 2012	0	30	7	30	0.07 [0.00 , 1.12]	?	+	-	-	+	?	-



Footnotes

(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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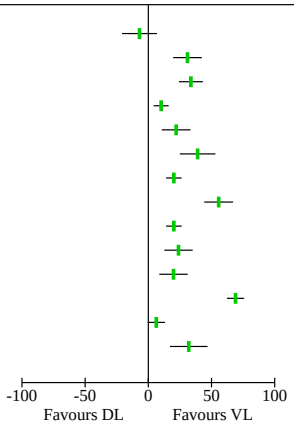
Analysis 2.11. Comparison 2: Hyperangulated VL versus DL, Outcome 11: POGO Score

Study or Subgroup	Videolaryngoscope Mean	SD	Total	Direct laryngoscope Mean	SD	Total	Mean Difference IV, Random, 95% CI
Akbarzadeh 2017	62	28	34	69	30	34	-7.00 [-20.79 , 6.79]
Aqil 2016	88.25	22.06	40	57.25	29.26	40	31.00 [19.64 , 42.36]
Aqil 2017	77.1	28.9	70	43.4	28.2	70	33.70 [24.24 , 43.16]
Arici 2014	94.5	8.82	40	84.37	17.1	40	10.13 [4.17 , 16.09]
Choi 2011	89.6	20	30	67.6	24.7	30	22.00 [10.63 , 33.37]
Hostic 2016	98	7	48	59	45	40	39.00 [24.91 , 53.09]
Jafra 2018	94.4	10.476	100	74.2	29.514	100	20.20 [14.06 , 26.34]
Koennecke 2014 (1)	80.67	28.37	83	25	27	30	55.67 [44.24 , 67.10]
Sandhu 2014	94.4	10.5	100	74.2	29.5	100	20.20 [14.06 , 26.34]
Sargin 2016	84.67	19.39	50	60.8	35.49	50	23.87 [12.66 , 35.08]
Shah 2016	88	19.9	30	68.1	24.29	30	19.90 [8.66 , 31.14]
Taylor 2013	82	23	88	13	23	88	69.00 [62.20 , 75.80]
Tsan 2020	86.45	18.83	69	80.14	22.03	69	6.31 [-0.53 , 13.15]
Yumul 2016	89	13.8	60	57	41	31	32.00 [17.15 , 46.85]



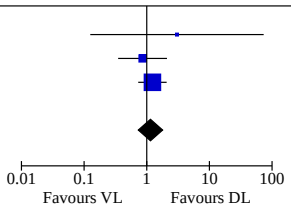
Test for subgroup differences: Not applicable

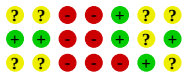
Footnotes
(1) Multi-arm study. Data combined for each VL device.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 2.12. Comparison 2: Hyperangulated VL versus DL, Outcome 12: Mortality

Study or Subgroup	Videolaryngoscope Events	Total	Direct laryngoscope Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Gao 2018 (1)	1	81	0	82	2.0%	3.04 [0.13 , 73.46]
Griesdale 2012a (1)	6	20	7	20	24.8%	0.86 [0.35 , 2.10]
Yeatts 2013 (2)	28	303	24	320	73.2%	1.23 [0.73 , 2.08]
Total (95% CI)		**404**		**422**	**100.0%**	**1.15 [0.73 , 1.79]**
Total events:	35		31			





Heterogeneity: Tau² = 0.00; Chi² = 0.85, df = 2 (P = 0.65); I² = 0%
Test for overall effect: Z = 0.60 (P = 0.55)
Test for subgroup differences: Not applicable

Footnotes
(1) ICU population.
(2) ED trauma patients.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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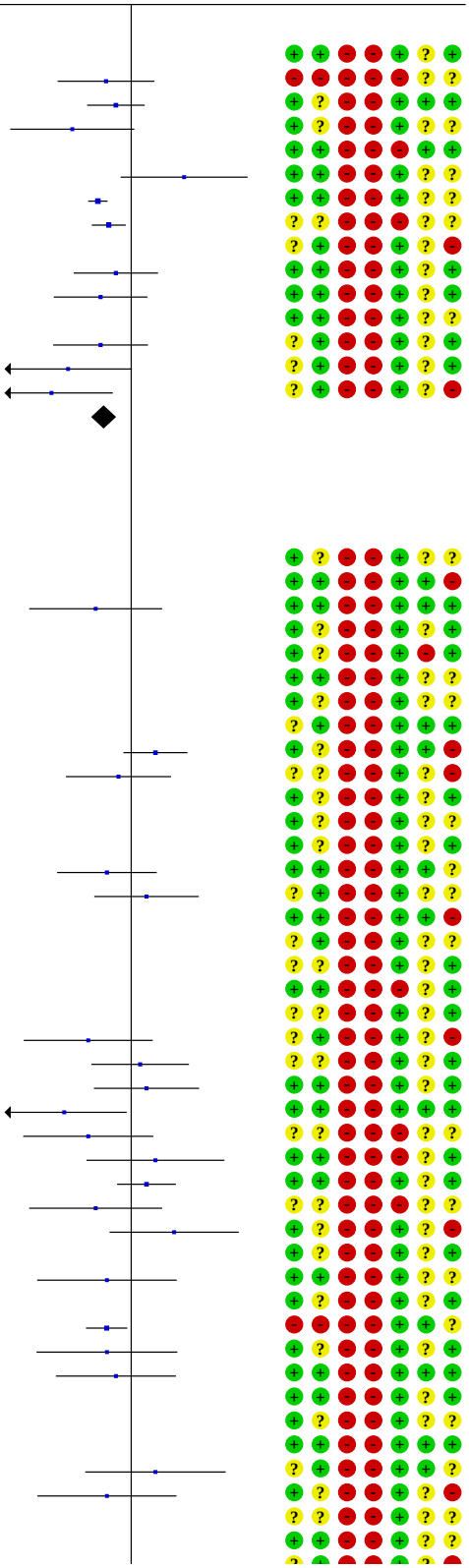
Analysis 2.13. Comparison 2: Hyperangulated VL versus DL, Outcome 13: Subgroup analysis of failed intubation: airway difficulty

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
2.13.1 Predicted, known or simulated difficulty						
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015 (1)	1	24	3	23	2.7%	0.32 [0.04 , 2.85]
Cordovani 2019	3	24	5	20	5.4%	0.50 [0.14 , 1.84]
Foulds 2016b	0	24	7	25	1.8%	0.07 [0.00 , 1.15]
Hu 2017 (2)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	1.7%	11.00 [0.62 , 194.90]
Kleine-Brueggeney 2017 (3)	23	240	52	120	10.4%	0.22 [0.14 , 0.34]
Koennecke 2014 (3)	10	83	10	30	8.3%	0.36 [0.17 , 0.78]
Lim 2005	0	30	0	30		Not estimable
Malik 2008 (3)	2	60	2	30	3.3%	0.50 [0.07 , 3.38]
Malik 2009b	1	25	4	25	2.8%	0.25 [0.03 , 2.08]
Paik 2020	0	20	0	20		Not estimable
Serocki 2010	1	40	4	40	2.8%	0.25 [0.03 , 2.14]
Serocki 2013 (3)	0	63	4	32	1.7%	0.06 [0.00 , 1.03]
Taylor 2013	0	44	18	44	1.8%	0.03 [0.00 , 0.43]
Subtotal (95% CI)		**881**		**639**	**42.7%**	**0.29 [0.17 , 0.48]**
Total events:	46		109			
Heterogeneity: Tau² = 0.18; Chi² = 13.68, df = 10 (P = 0.19); I² = 27%						
Test for overall effect: Z = 4.66 (P < 0.00001)						
2.13.2 No difficulty						
Abdelgawad 2015	0	40	0	40		Not estimable
Al-Ghamdi 2016	0	21	0	22		Not estimable
Andersen 2011	0	50	2	50	1.6%	0.20 [0.01 , 4.06]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (4)	0	54	0	54		Not estimable
Arslan 2017 (3)	0	80	0	40		Not estimable
Bakshi 2015 (5)	12	84	2	42	4.7%	3.00 [0.70 , 12.79]
Barak 2007	1	80	2	90	2.4%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Chen 2019	1	220	3	220	2.6%	0.33 [0.03 , 3.18]
Colak 2015	2	50	1	50	2.4%	2.00 [0.19 , 21.36]
El-Tahan 2017b	0	66	0	32		Not estimable
Gunes 2020	0	90	0	90		Not estimable
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Kaur 2020	0	40	0	40		Not estimable
Kill 2013	0	30	3	30	1.7%	0.14 [0.01 , 2.65]
Lee 2012 (3)	3	50	1	25	2.6%	1.50 [0.16 , 13.70]
Liu 2016	2	90	1	90	2.3%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	1.8%	0.05 [0.00 , 0.82]
Nakayama 2010	0	80	3	80	1.6%	0.14 [0.01 , 2.72]
Nandakumar 2018	1	15	0	15	1.5%	3.00 [0.13 , 68.26]
Pournajafian 2014	6	52	3	52	5.2%	2.00 [0.53 , 7.57]
Rovsing 2010	0	50	2	50	1.6%	0.20 [0.01 , 4.06]
Russell 2013	3	35	0	35	1.7%	7.00 [0.37 , 130.69]
Sargin 2016	0	50	0	50		Not estimable
Shah 2016 (6)	0	30	1	30	1.5%	0.33 [0.01 , 7.87]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	7.3%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	1.4%	0.33 [0.01 , 8.09]
Tempe 2016	1	40	1	20	1.9%	0.50 [0.03 , 7.59]
Teoh 2010	0	100	0	100		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Walker 2009	1	60	0	60	1.4%	3.00 [0.12 , 72.20]
Wasinwong 2017	0	23	1	23	1.5%	0.33 [0.01 , 7.78]
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	1.8%	0.08 [0.00 , 1.31]



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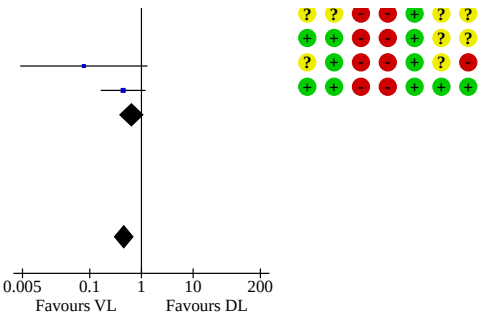
Analysis 2.13. (Continued)

Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	1.8%	0.08 [0.00 , 1.31]
Yumul 2016	6	60	7	31	6.9%	0.44 [0.16 , 1.20]
Subtotal (95% CI)		**2633**		**2454**	**57.3%**	**0.64 [0.38 , 1.06]**
Total events:	44		66			
Heterogeneity: Tau² = 0.25; Chi² = 25.88, df = 21 (P = 0.21); I² = 19%						
Test for overall effect: Z = 1.72 (P = 0.09)						
Total (95% CI)		**3514**		**3093**	**100.0%**	**0.45 [0.30 , 0.68]**
Total events:	90		175			
Heterogeneity: Tau² = 0.37; Chi² = 49.09, df = 32 (P = 0.03); I² = 35%						
Test for overall effect: Z = 3.79 (P = 0.0002)						
Test for subgroup differences: Chi² = 4.60, df = 1 (P = 0.03), I² = 78.2%						



Footnotes

(1) For the purposes of this subgroup analysis we extracted data only for the predicted difficult airways for this study.
(2) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(3) Multi-arm study. Data combined for each VL group.
(4) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(5) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(6) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Comparison 3. Channelled VL versus DL

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Failed intubation	53	5367	Risk Ratio (M-H, Random, 95% CI)	0.43 [0.30, 0.61]
3.2 Hypoxaemia	15	1966	Risk Ratio (M-H, Random, 95% CI)	0.25 [0.12, 0.50]
3.3 Successful first attempt	47	5210	Risk Ratio (M-H, Random, 95% CI)	1.10 [1.05, 1.15]
3.4 Oesophageal intubation	16	1756	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.17, 1.75]
3.5 Dental trauma	29	2375	Risk Ratio (M-H, Random, 95% CI)	0.52 [0.13, 2.12]
3.6 Cormack-Lehane (CL) grade	40	11865	Risk Ratio (M-H, Random, 95% CI)	0.70 [0.58, 0.85]
3.6.1 Cormack-Lehane 1	40	3955	Risk Ratio (M-H, Random, 95% CI)	2.01 [1.75, 2.31]
3.6.2 Cormack-Lehane 2	40	3955	Risk Ratio (M-H, Random, 95% CI)	0.24 [0.17, 0.35]
3.6.3 Cormack-Lehane 3-4	40	3955	Risk Ratio (M-H, Random, 95% CI)	0.14 [0.09, 0.21]
3.7 Time for tracheal intubation	57		Mean Difference (IV, Random, 95% CI)	Subtotals only

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.8 Patient-reported sore throat	18	1666	Risk Ratio (M-H, Random, 95% CI)	0.91 [0.73, 1.14]
3.9 Number of attempts	38	8314	Risk Ratio (M-H, Random, 95% CI)	1.05 [1.00, 1.10]
3.9.1 1 attempt	38	4157	Risk Ratio (M-H, Random, 95% CI)	1.09 [1.04, 1.14]
3.9.2 2-4 attempts	38	4157	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.33, 0.68]
3.10 Intubation Difficulty Scale (IDS)	16	3012	Risk Ratio (M-H, Random, 95% CI)	0.84 [0.59, 1.19]
3.10.1 IDS 0	16	1004	Risk Ratio (M-H, Random, 95% CI)	3.34 [2.43, 4.60]
3.10.2 IDS 1-5	16	1004	Risk Ratio (M-H, Random, 95% CI)	0.38 [0.27, 0.53]
3.10.3 IDS > 5	16	1004	Risk Ratio (M-H, Random, 95% CI)	0.21 [0.12, 0.37]
3.11 POGO Score	5		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.12 Subgroup analysis of failed intubation: airway difficulty	52	5287	Risk Ratio (M-H, Random, 95% CI)	0.42 [0.29, 0.62]
3.12.1 Predicted, known or simulated difficulty	20	1433	Risk Ratio (M-H, Random, 95% CI)	0.22 [0.10, 0.49]
3.12.2 No difficulty	32	3854	Risk Ratio (M-H, Random, 95% CI)	0.53 [0.32, 0.88]

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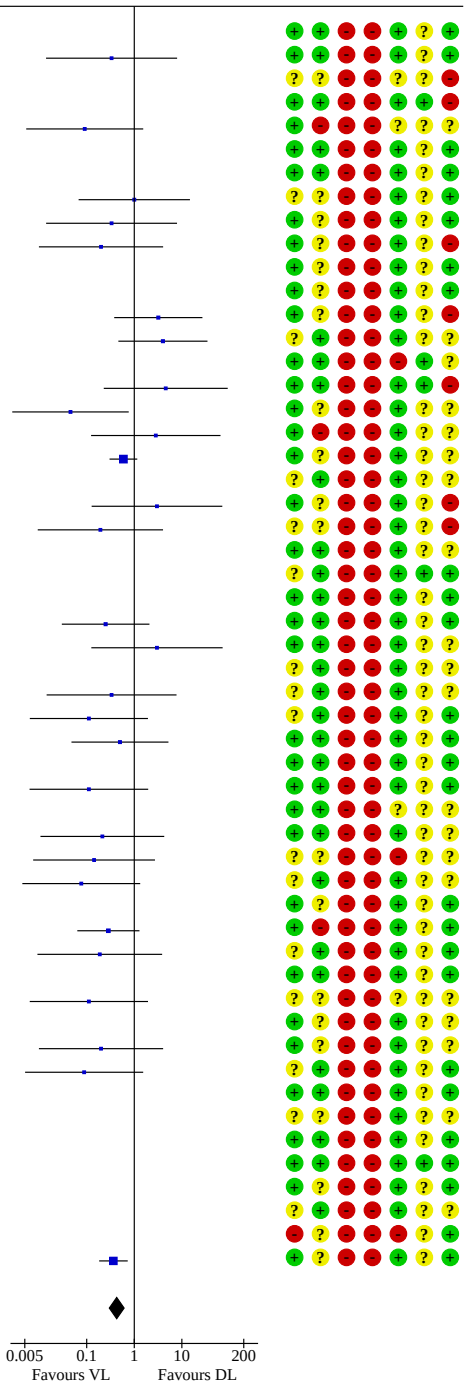
Analysis 3.1. Comparison 3: Channelled VL versus DL, Outcome 1: Failed intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdallah 2019	0	35	0	35		Not estimable
Abdelgalel 2018	0	40	1	40	1.3%	0.33 [0.01 , 7.95]
Acarel 2018	0	30	0	30		Not estimable
Al-Ghamdi 2016 (1)	0	44	0	22		Not estimable
Aleksandrowicz 2018	0	20	5	20	1.6%	0.09 [0.01 , 1.54]
Ali 2017	0	30	0	30		Not estimable
Amor 2013	0	60	0	60		Not estimable
Aoi 2010	1	18	1	18	1.8%	1.00 [0.07 , 14.79]
Bensghir 2013	0	35	1	35	1.3%	0.33 [0.01 , 7.91]
Bhandari 2013	0	40	2	40	1.4%	0.20 [0.01 , 4.04]
Blajic 2019	0	59	0	59		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Chalkeidis 2010	4	35	1	28	2.8%	3.20 [0.38 , 27.04]
Colak 2015 (1)	4	50	1	50	2.7%	4.00 [0.46 , 34.54]
El-Tahan 2017a	0	14	0	15		Not estimable
El-Tahan 2017b	2	35	0	32	1.4%	4.58 [0.23 , 92.00]
Enomoto 2008	0	99	11	104	1.6%	0.05 [0.00 , 0.76]
Erden 2010	1	17	0	16	1.3%	2.83 [0.12 , 64.89]
Erdivanli 2018	13	388	22	388	27.4%	0.59 [0.30 , 1.16]
Erturk 2015	0	40	0	40		Not estimable
Ferrando 2011	1	30	0	30	1.3%	3.00 [0.13 , 70.83]
Hirabayashi 2009	0	264	2	256	1.4%	0.19 [0.01 , 4.02]
Hosalli 2017	0	30	0	30		Not estimable
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Koh 2010	1	25	4	25	2.8%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	1.3%	3.00 [0.13 , 71.92]
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	1.3%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	1.6%	0.11 [0.01 , 1.94]
Malik 2008	1	30	2	30	2.3%	0.50 [0.05 , 5.22]
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	0	25	4	25	1.5%	0.11 [0.01 , 1.96]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	0	29	2	31	1.4%	0.21 [0.01 , 4.26]
Nakayama 2010	0	80	3	80	1.5%	0.14 [0.01 , 2.72]
Ndoko 2008	0	53	6	53	1.6%	0.08 [0.00 , 1.33]
Nishikawa 2009	0	20	0	20		Not estimable
Park 2010	2	37	7	37	5.6%	0.29 [0.06 , 1.29]
Ranieri 2012	0	68	2	64	1.4%	0.19 [0.01 , 3.85]
Reena 2019	0	50	0	50		Not estimable
Sansone 2012	0	21	4	21	1.6%	0.11 [0.01 , 1.94]
Saracoglu 2014	0	30	0	30		Not estimable
Shukla 2017	0	40	2	40	1.4%	0.20 [0.01 , 4.04]
Takenaka 2011	0	35	5	34	1.6%	0.09 [0.01 , 1.54]
Teoh 2010	0	100	0	100		Not estimable
Tolon 2012	0	20	0	20		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Woo 2012	0	50	0	109		Not estimable
Zhao 2014	9	74	25	75	25.9%	0.36 [0.18 , 0.73]
Total (95% CI)		**2672**		**2695**	**100.0%**	**0.43 [0.30 , 0.61]**
Total events:	40		118			

Heterogeneity: Tau² = 0.00; Chi² = 27.11, df = 27 (P = 0.46); I² = 0%
Test for overall effect: Z = 4.66 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)

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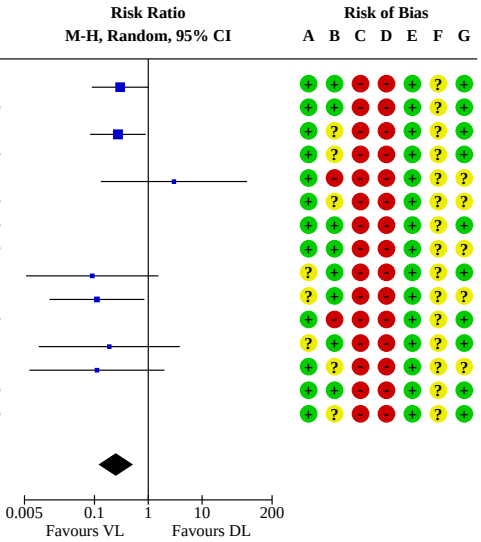
Analysis 3.1. (Continued)

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 3.2. Comparison 3: Channelled VL versus DL, Outcome 2: Hypoxaemia

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgalel 2018 (1)	3	40	10	40	32.5%	0.30 [0.09 , 1.01]
Ali 2017	0	30	0	30		Not estimable
Bensghir 2013	3	35	11	35	34.0%	0.27 [0.08 , 0.89]
Castillo-Monzon 2017	0	23	0	23		Not estimable
Erden 2010	1	16	0	16	4.9%	3.00 [0.13 , 68.57]
Erdivanli 2018	0	388	0	388		Not estimable
Gupta 2020	0	40	0	40		Not estimable
Komatsu 2010	0	50	0	50		Not estimable
Maharaj 2008 (2)	0	20	5	20	6.0%	0.09 [0.01 , 1.54]
Ndoko 2008 (3)	1	53	9	53	11.6%	0.11 [0.01 , 0.85]
Park 2010	0	37	0	37		Not estimable
Ranieri 2012	0	68	2	64	5.3%	0.19 [0.01 , 3.85]
Shukla 2017	0	40	4	40	5.7%	0.11 [0.01 , 2.00]
Teoh 2010	0	100	0	100		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Total (95% CI)		**985**		**981**	**100.0%**	**0.25 [0.12 , 0.50]**
Total events:	8		41			

Heterogeneity: Tau² = 0.00; Chi² = 4.01, df = 6 (P = 0.68); I² = 0%
Test for overall effect: Z = 3.94 (P < 0.0001)
Test for subgroup differences: Not applicable



Footnotes
(1) This is a study of an ICU population, so results might be skewed.
(2) Difficult airways.
(3) Morbidly obese population.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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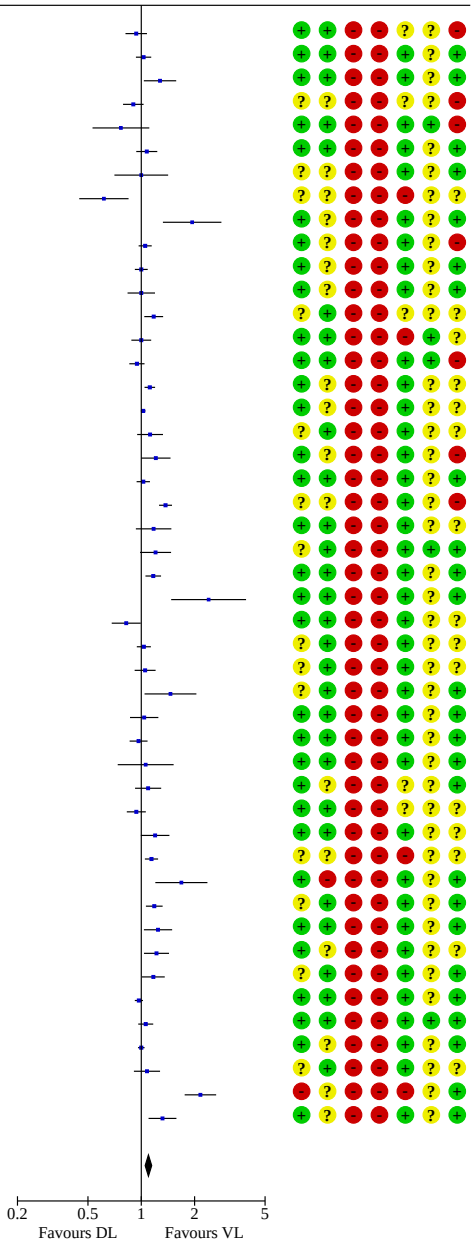
Analysis 3.3. Comparison 3: Channelled VL versus DL, Outcome 3: Successful first attempt

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdallah 2011	43	50	45	49	2.3%	0.94 [0.81 , 1.08]
Abdallah 2019	34	35	33	35	2.7%	1.03 [0.93 , 1.14]
Abdelgalel 2018	37	40	29	40	1.8%	1.28 [1.03 , 1.57]
Acarel 2018	27	30	30	30	2.4%	0.90 [0.79 , 1.03]
Al-Ghamdi 2016 (1)	24	43	16	22	0.9%	0.77 [0.53 , 1.11]
Ali 2017	29	30	27	30	2.4%	1.07 [0.94 , 1.23]
Aoi 2010	14	18	14	18	1.0%	1.00 [0.71 , 1.42]
Arima 2014	26	56	40	53	1.1%	0.62 [0.45 , 0.85]
Bensghir 2013	31	35	16	35	0.9%	1.94 [1.32 , 2.83]
Bhandari 2013	40	40	38	40	2.8%	1.05 [0.97 , 1.15]
Blajic 2019	56	59	56	59	2.8%	1.00 [0.92 , 1.09]
Castillo-Monzon 2017	21	23	21	23	2.0%	1.00 [0.84 , 1.20]
Dharanindra 2020	67	70	57	70	2.5%	1.18 [1.04 , 1.33]
El-Tahan 2017a	14	14	15	15	2.4%	1.00 [0.88 , 1.14]
El-Tahan 2017b	33	35	32	32	2.7%	0.94 [0.86 , 1.04]
Enomoto 2008	99	99	93	104	2.9%	1.12 [1.04 , 1.20]
Erdivanli 2018	375	388	366	388	3.1%	1.02 [0.99 , 1.06]
Erturk 2015	37	40	33	40	2.1%	1.12 [0.95 , 1.33]
Ferrando 2011	29	30	24	30	1.9%	1.21 [1.00 , 1.46]
Gupta 2020	39	40	38	40	2.8%	1.03 [0.94 , 1.12]
Hirabayashi 2009 (2)	253	264	179	256	2.8%	1.37 [1.26 , 1.49]
Hosalli 2017	27	30	23	30	1.6%	1.17 [0.93 , 1.48]
Kim 2013	22	22	19	23	1.8%	1.20 [0.98 , 1.47]
Kim 2018	104	110	89	110	2.6%	1.17 [1.06 , 1.29]
Koh 2010	24	25	10	25	0.6%	2.40 [1.48 , 3.90]
Komatsu 2010	37	50	45	50	1.9%	0.82 [0.68 , 0.99]
Maharaj 2006	30	30	29	30	2.7%	1.03 [0.94 , 1.13]
Maharaj 2007	20	20	19	20	2.4%	1.05 [0.92 , 1.20]
Maharaj 2008	19	20	13	20	1.1%	1.46 [1.04 , 2.05]
Malik 2008	27	30	26	30	2.0%	1.04 [0.86 , 1.25]
Malik 2009a	28	30	29	30	2.5%	0.97 [0.86 , 1.08]
Malik 2009b	18	25	17	25	0.9%	1.06 [0.74 , 1.52]
Marco 2011	47	54	43	54	2.1%	1.09 [0.92 , 1.30]
Mathew 2018	30	33	32	33	2.5%	0.94 [0.83 , 1.06]
McElwain 2011	28	29	25	31	2.0%	1.20 [0.99 , 1.44]
Nakayama 2010	80	80	70	80	2.8%	1.14 [1.05 , 1.24]
Park 2010	32	37	19	37	1.0%	1.68 [1.20 , 2.36]
Ranieri 2012	68	68	54	64	2.6%	1.18 [1.06 , 1.32]
Reena 2019	46	50	37	50	2.0%	1.24 [1.03 , 1.49]
Shukla 2017	39	40	32	40	2.1%	1.22 [1.04 , 1.43]
Takenaka 2011	35	35	29	34	2.3%	1.17 [1.01 , 1.36]
Teoh 2010	95	100	98	100	3.0%	0.97 [0.92 , 1.02]
Varsha 2019	35	35	33	35	2.7%	1.06 [0.96 , 1.17]
Vijayakumar 2016	45	45	45	45	3.0%	1.00 [0.96 , 1.04]
Wasem 2013	28	30	26	30	2.1%	1.08 [0.91 , 1.28]
Woo 2012	50	50	50	109	1.8%	2.16 [1.76 , 2.65]
Zhao 2014	65	74	50	75	2.0%	1.32 [1.10 , 1.58]
Total (95% CI)		**2591**		**2619**	**100.0%**	**1.10 [1.05 , 1.15]**
Total events:	2407		2164			

Heterogeneity: Tau² = 0.02; Chi² = 283.18, df = 46 (P < 0.00001); I² = 84%
Test for overall effect: Z = 4.30 (P < 0.0001)
Test for subgroup differences: Not applicable



Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) Novice intubators.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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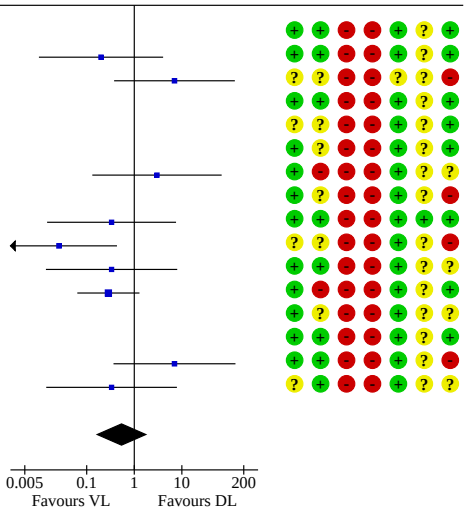
Analysis 3.4. Comparison 3: Channelled VL versus DL, Outcome 4: Oesophageal intubation

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdallah 2019	0	35	0	35		Not estimable	+	+	-	-	+	?	+
Abdelgalel 2018	0	40	2	40	10.1%	0.20 [0.01 , 4.04]	+	+	-	-	+	?	+
Acarel 2018	3	30	0	30	10.5%	7.00 [0.38 , 129.93]	?	?	-	-	?	?	-
Ali 2017	0	30	0	30		Not estimable	+	+	-	-	+	?	+
Aoi 2010	0	17	0	17		Not estimable	?	?	-	-	+	?	+
Castillo-Monzon 2017	0	23	0	23		Not estimable	+	?	-	-	+	?	+
Erden 2010	1	16	0	16	9.6%	3.00 [0.13 , 68.57]	+	-	-	-	+	?	?
Ferrando 2011	0	60	0	60		Not estimable	+	?	-	-	+	?	-
Hindman 2014	0	14	1	14	9.6%	0.33 [0.01 , 7.55]	+	+	-	-	+	+	+
Hirabayashi 2009	0	264	18	256	11.0%	0.03 [0.00 , 0.43]	?	?	-	-	+	?	-
Komatsu 2010	0	50	1	50	9.4%	0.33 [0.01 , 7.99]	+	+	-	-	+	?	?
Park 2010	2	37	7	37	20.0%	0.29 [0.06 , 1.29]	+	-	-	-	+	?	+
Saracoglu 2014	0	30	0	30		Not estimable	+	?	-	-	+	?	?
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Trimmel 2011	3	106	0	106	10.3%	7.00 [0.37 , 133.88]	+	+	-	-	+	?	-
Wasem 2013	0	30	1	30	9.4%	0.33 [0.01 , 7.87]	?	+	-	-	+	?	?
Total (95% CI)		**882**		**874**	**100.0%**	**0.54 [0.17 , 1.75]**							
Total events:	9		30										

Heterogeneity: Tau² = 1.21; Chi² = 13.07, df = 8 (P = 0.11); I² = 39%
Test for overall effect: Z = 1.03 (P = 0.30)
Test for subgroup differences: Not applicable



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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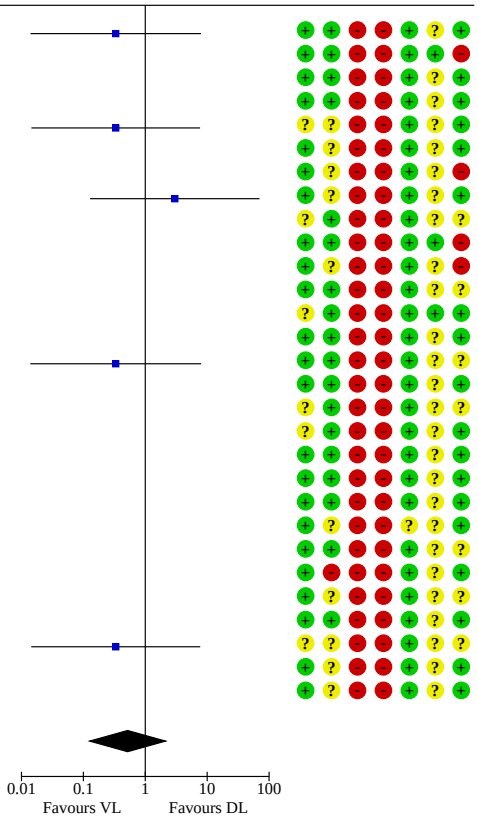
Analysis 3.5. Comparison 3: Channelled VL versus DL, Outcome 5: Dental trauma

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdelgalel 2018	0	40	1	40	19.8%	0.33 [0.01 , 7.95]
Al-Ghamdi 2016 (1)	0	43	0	22		Not estimable
Ali 2017	0	30	0	30		Not estimable
Amor 2013	0	60	0	60		Not estimable
Aoi 2010	0	18	1	18	20.2%	0.33 [0.01 , 7.68]
Bensghir 2013	0	35	0	35		Not estimable
Bhandari 2013	0	40	0	40		Not estimable
Castillo-Monzon 2017	1	23	0	23	20.1%	3.00 [0.13 , 70.02]
Colak 2015 (2)	0	46	0	49		Not estimable
El-Tahan 2017b	0	35	0	32		Not estimable
Ferrando 2011	0	60	0	60		Not estimable
Hosalli 2017	0	30	0	30		Not estimable
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Komatsu 2010	0	50	1	50	19.7%	0.33 [0.01 , 7.99]
Kumar 2019	0	30	0	30		Not estimable
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2008	0	20	0	20		Not estimable
Malik 2008	0	30	0	30		Not estimable
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	0	25	0	25		Not estimable
Marco 2011	0	54	0	54		Not estimable
McElwain 2011	0	29	0	31		Not estimable
Park 2010	0	37	0	37		Not estimable
Saracoglu 2014	0	30	0	30		Not estimable
Teoh 2010	0	100	0	100		Not estimable
Tolon 2012	0	20	1	20	20.2%	0.33 [0.01 , 7.72]
Vijayakumar 2016	0	45	0	45		Not estimable
Zhao 2014	0	74	0	75		Not estimable
Total (95% CI)		**1196**		**1179**	**100.0%**	**0.52 [0.13 , 2.12]**
Total events:	1		4			

Heterogeneity: Tau² = 0.00; Chi² = 1.50, df = 4 (P = 0.83); I² = 0%
Test for overall effect: Z = 0.91 (P = 0.36)
Test for subgroup differences: Not applicable



Footnotes

(1) Only mucosal injury data used, as unclear whether multiple events occurred in single patients. Multi-arm study. Data combined for each VL group.
(2) Multi-arm study. Data combined for each VL group.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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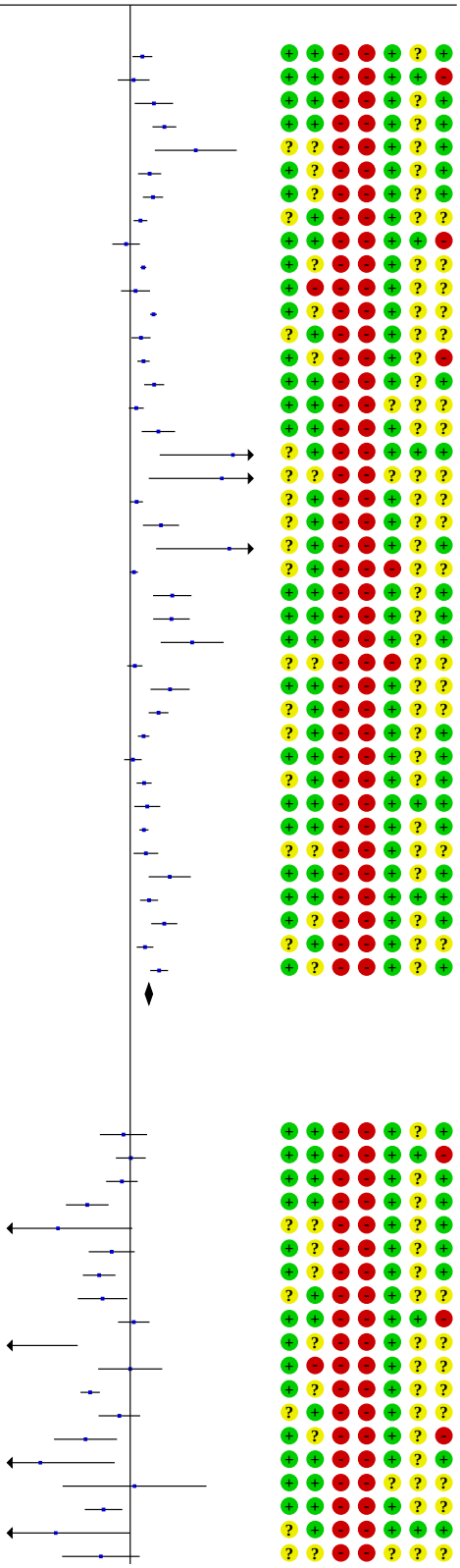
Analysis 3.6. Comparison 3: Channelled VL versus DL, Outcome 6: Cormack-Lehane (CL) grade

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
3.6.1 Cormack-Lehane 1						
Abdelgalel 2018	30	40	19	40	1.4%	1.58 [1.09 , 2.29]
Al-Ghamdi 2016 (1)	20	43	9	22	1.3%	1.14 [0.63 , 2.06]
Ali 2017	17	30	7	30	1.2%	2.43 [1.18 , 4.99]
Amor 2013	54	60	15	60	1.4%	3.60 [2.30 , 5.63]
Aoi 2010	17	17	1	17	0.7%	11.67 [2.52 , 54.10]
Bensghir 2013	29	35	14	35	1.4%	2.07 [1.34 , 3.19]
Blajic 2019	47	59	20	59	1.4%	2.35 [1.61 , 3.43]
Colak 2015	40	46	29	49	1.5%	1.47 [1.14 , 1.90]
El-Tahan 2017b	15	35	16	32	1.4%	0.86 [0.51 , 1.44]
Enomoto 2008	203	203	124	203	1.5%	1.63 [1.46 , 1.82]
Erden 2010	11	16	9	16	1.3%	1.22 [0.71 , 2.11]
Erdivanli 2018	357	388	149	388	1.5%	2.40 [2.11 , 2.73]
Erturk 2015	30	40	20	40	1.4%	1.50 [1.05 , 2.15]
Ferrando 2011	56	60	34	60	1.5%	1.65 [1.31 , 2.08]
Gupta 2020	40	40	16	40	1.4%	2.45 [1.69 , 3.57]
Hamp 2015	16	17	15	20	1.5%	1.25 [0.95 , 1.66]
Hosalli 2017	23	30	8	30	1.3%	2.88 [1.54 , 5.37]
Kim 2013	22	22	0	23	0.3%	46.96 [3.02 , 729.73]
Lopez 2017	15	17	0	17	0.3%	31.00 [2.00 , 479.77]
Maharaj 2006	28	30	22	30	1.5%	1.27 [1.01 , 1.61]
Maharaj 2007	19	20	6	20	1.3%	3.17 [1.61 , 6.23]
Maharaj 2008	20	20	0	20	0.3%	41.00 [2.65 , 634.60]
Mahmood 2015	30	30	26	30	1.5%	1.15 [0.99 , 1.34]
Malik 2008	29	30	6	30	1.2%	4.83 [2.36 , 9.92]
Malik 2009a	30	30	6	30	1.3%	4.69 [2.37 , 9.31]
Malik 2009b	25	25	2	25	0.9%	10.20 [3.14 , 33.19]
Maruyama 2008b	12	12	10	12	1.5%	1.19 [0.89 , 1.59]
McElwain 2011	25	29	6	31	1.2%	4.45 [2.14 , 9.27]
Ndoko 2008	53	53	18	53	1.4%	2.89 [2.00 , 4.19]
Ranieri 2012	65	68	37	64	1.5%	1.65 [1.33 , 2.05]
Reena 2019	31	50	28	50	1.5%	1.11 [0.80 , 1.54]
Takenaka 2011	35	35	20	34	1.5%	1.68 [1.27 , 2.23]
Tempe 2016 (1)	35	39	9	19	1.4%	1.89 [1.17 , 3.08]
Teoh 2010	97	100	58	100	1.5%	1.67 [1.41 , 1.98]
Tolon 2012	18	20	10	20	1.4%	1.80 [1.13 , 2.86]
Turkstra 2009	22	24	5	24	1.2%	4.40 [2.00 , 9.69]
Varsha 2019	35	35	17	35	1.5%	2.03 [1.45 , 2.84]
Vijayakumar 2016	43	45	12	45	1.4%	3.58 [2.20 , 5.84]
Wasem 2013	30	30	17	30	1.5%	1.74 [1.28 , 2.38]
Zhao 2014	70	74	24	75	1.5%	2.96 [2.12 , 4.13]
Subtotal (95% CI)		**1997**		**1958**	**51.9%**	**2.01 [1.75 , 2.31]**
Total events:	1794		844			
Heterogeneity: Tau² = 0.13; Chi² = 254.82, df = 39 (P < 0.00001); I² = 85%						
Test for overall effect: Z = 9.91 (P < 0.00001)						
3.6.2 Cormack-Lehane 2						
Abdelgalel 2018	7	40	9	40	1.1%	0.78 [0.32 , 1.88]
Al-Ghamdi 2016 (1)	20	43	10	22	1.3%	1.02 [0.59 , 1.79]
Ali 2017	11	30	15	30	1.3%	0.73 [0.41 , 1.32]
Amor 2013	6	60	30	60	1.2%	0.20 [0.09 , 0.45]
Aoi 2010	0	17	7	17	0.3%	0.07 [0.00 , 1.08]
Bensghir 2013	6	35	12	35	1.1%	0.50 [0.21 , 1.18]
Blajic 2019	10	59	32	59	1.3%	0.31 [0.17 , 0.58]
Colak 2015	5	46	15	49	1.1%	0.36 [0.14 , 0.90]
El-Tahan 2017b	15	35	12	32	1.3%	1.14 [0.63 , 2.06]
Enomoto 2008	0	203	57	203	0.3%	0.01 [0.00 , 0.14]
Erden 2010	4	16	4	16	0.9%	1.00 [0.30 , 3.32]
Erdivanli 2018	31	388	139	388	1.4%	0.22 [0.16 , 0.32]
Erturk 2015	8	40	12	40	1.2%	0.67 [0.31 , 1.45]
Ferrando 2011	3	60	16	60	0.9%	0.19 [0.06 , 0.61]
Gupta 2020	0	40	14	40	0.3%	0.03 [0.00 , 0.56]
Hamp 2015	1	17	1	20	0.4%	1.18 [0.08 , 17.42]
Hosalli 2017	7	30	19	30	1.2%	0.37 [0.18 , 0.74]
Kim 2013	0	22	8	23	0.3%	0.06 [0.00 , 1.00]
Lopez 2017	2	17	6	17	0.8%	0.33 [0.08 , 1.42]



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Analysis 3.6. (Continued)

Kim 2013	0	22	8	23	0.3%	0.06 [0.00 , 1.00]
Lopez 2017	2	17	6	17	0.8%	0.33 [0.08 , 1.42]
Maharaj 2006	2	30	7	30	0.8%	0.29 [0.06 , 1.26]
Maharaj 2007	1	20	7	20	0.5%	0.14 [0.02 , 1.06]
Maharaj 2008	0	20	3	20	0.3%	0.14 [0.01 , 2.60]
Mahmood 2015	0	30	2	30	0.3%	0.20 [0.01 , 4.00]
Malik 2008	1	30	19	30	0.6%	0.05 [0.01 , 0.37]
Malik 2009a	0	30	19	30	0.3%	0.03 [0.00 , 0.41]
Malik 2009b	0	25	15	25	0.3%	0.03 [0.00 , 0.51]
Maruyama 2008b	0	12	2	12	0.3%	0.20 [0.01 , 3.77]
McElwain 2011	4	29	15	31	1.1%	0.29 [0.11 , 0.76]
Ndoko 2008	0	53	24	53	0.3%	0.02 [0.00 , 0.33]
Ranieri 2012	3	68	20	64	0.9%	0.14 [0.04 , 0.45]
Reena 2019	17	50	13	50	1.3%	1.31 [0.71 , 2.40]
Takenaka 2011	0	35	12	34	0.3%	0.04 [0.00 , 0.63]
Tempe 2016 (1)	3	39	6	19	0.9%	0.24 [0.07 , 0.87]
Teoh 2010	3	100	37	100	1.0%	0.08 [0.03 , 0.25]
Tolon 2012	2	20	8	20	0.8%	0.25 [0.06 , 1.03]
Turkstra 2009	2	24	17	24	0.8%	0.12 [0.03 , 0.45]
Varsha 2019	0	35	7	35	0.3%	0.07 [0.00 , 1.12]
Vijayakumar 2016	2	45	21	45	0.8%	0.10 [0.02 , 0.38]
Wasem 2013	0	30	13	30	0.3%	0.04 [0.00 , 0.60]
Zhao 2014	4	74	46	75	1.1%	0.09 [0.03 , 0.23]
Subtotal (95% CI)		**1997**		**1958**	**31.7%**	**0.24 [0.17 , 0.35]**
Total events:	180		731			

Heterogeneity: Tau² = 0.80; Chi² = 157.63, df = 39 (P < 0.00001); I² = 75%
Test for overall effect: Z = 7.57 (P < 0.00001)

3.6.3 Cormack-Lehane 3-4

Abdelgalel 2018	3	40	12	40	0.9%	0.25 [0.08 , 0.82]
Al-Ghamdi 2016 (1)	2	43	3	22	0.7%	0.34 [0.06 , 1.89]
Ali 2017	2	30	8	30	0.8%	0.25 [0.06 , 1.08]
Amor 2013	0	60	15	60	0.3%	0.03 [0.00 , 0.53]
Aoi 2010	0	17	9	17	0.3%	0.05 [0.00 , 0.84]
Bensghir 2013	0	35	9	35	0.3%	0.05 [0.00 , 0.87]
Blajic 2019	2	59	7	59	0.7%	0.29 [0.06 , 1.32]
Colak 2015	1	46	5	49	0.5%	0.21 [0.03 , 1.76]
El-Tahan 2017b	5	35	4	32	0.9%	1.14 [0.34 , 3.89]
Enomoto 2008	0	203	22	203	0.3%	0.02 [0.00 , 0.36]
Erden 2010	1	16	3	16	0.5%	0.33 [0.04 , 2.87]
Erdivanli 2018	0	388	100	388	0.3%	0.00 [0.00 , 0.08]
Erturk 2015	2	40	8	40	0.8%	0.25 [0.06 , 1.11]
Ferrando 2011	1	60	10	60	0.5%	0.10 [0.01 , 0.76]
Gupta 2020	0	40	10	40	0.3%	0.05 [0.00 , 0.79]
Hamp 2015	0	17	4	20	0.3%	0.13 [0.01 , 2.25]
Hosalli 2017	0	30	3	30	0.3%	0.14 [0.01 , 2.65]
Kim 2013	0	22	15	23	0.3%	0.03 [0.00 , 0.53]
Lopez 2017	0	17	11	17	0.3%	0.04 [0.00 , 0.68]
Maharaj 2006	0	30	1	30	0.3%	0.33 [0.01 , 7.87]
Maharaj 2007	0	20	7	20	0.3%	0.07 [0.00 , 1.09]
Maharaj 2008	0	20	17	20	0.3%	0.03 [0.00 , 0.44]
Mahmood 2015	0	30	2	30	0.3%	0.20 [0.01 , 4.00]
Malik 2008	0	30	5	30	0.3%	0.09 [0.01 , 1.57]
Malik 2009a (2)	0	30	2	30	0.3%	0.20 [0.01 , 4.00]
Malik 2009b	0	25	8	25	0.3%	0.06 [0.00 , 0.97]
Maruyama 2008b	0	12	0	12		Not estimable
McElwain 2011	0	29	10	31	0.3%	0.05 [0.00 , 0.83]
Ndoko 2008	0	53	11	53	0.3%	0.04 [0.00 , 0.72]
Ranieri 2012	0	68	7	64	0.3%	0.06 [0.00 , 1.08]
Reena 2019	2	50	9	50	0.8%	0.22 [0.05 , 0.98]
Takenaka 2011	0	35	2	34	0.3%	0.19 [0.01 , 3.91]
Tempe 2016 (1)	1	39	4	19	0.5%	0.12 [0.01 , 1.02]
Teoh 2010	0	100	5	100	0.3%	0.09 [0.01 , 1.62]
Tolon 2012	0	20	2	20	0.3%	0.20 [0.01 , 3.92]
Turkstra 2009	0	24	2	24	0.3%	0.20 [0.01 , 3.96]
Varsha 2019	0	35	11	35	0.3%	0.04 [0.00 , 0.71]
Vijayakumar 2016	0	45	12	45	0.3%	0.04 [0.00 , 0.66]
Wasem 2013	0	30	0	30		Not estimable
Zhao 2014	0	74	5	75	0.3%	0.09 [0.01 , 1.64]

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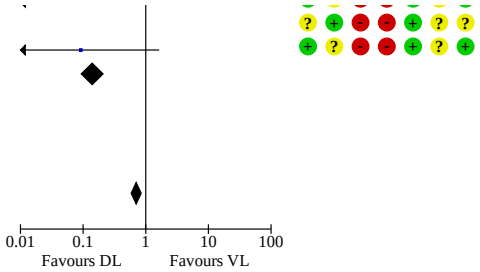
Analysis 3.6. (Continued)

Wasem 2013	0	30	0	30		Not estimable
Zhao 2014	0	74	5	75	0.3%	0.09 [0.01 , 1.64]
Subtotal (95% CI)		**1997**		**1958**	**16.4%**	**0.14 [0.09 , 0.21]**
Total events:	22		380			
Heterogeneity: Tau² = 0.22; Chi² = 43.25, df = 37 (P = 0.22); I² = 14%						
Test for overall effect: Z = 9.62 (P < 0.00001)						
Total (95% CI)		**5991**		**5874**	**100.0%**	**0.70 [0.58 , 0.85]**
Total events:	1996		1955			
Heterogeneity: Tau² = 0.58; Chi² = 1161.39, df = 117 (P < 0.00001); I² = 90%						
Test for overall effect: Z = 3.75 (P = 0.0002)						
Test for subgroup differences: Chi² = 237.13, df = 2 (P < 0.00001), I² = 99.2%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.
(2) Data for 3 participants intubated with a Macintosh missing.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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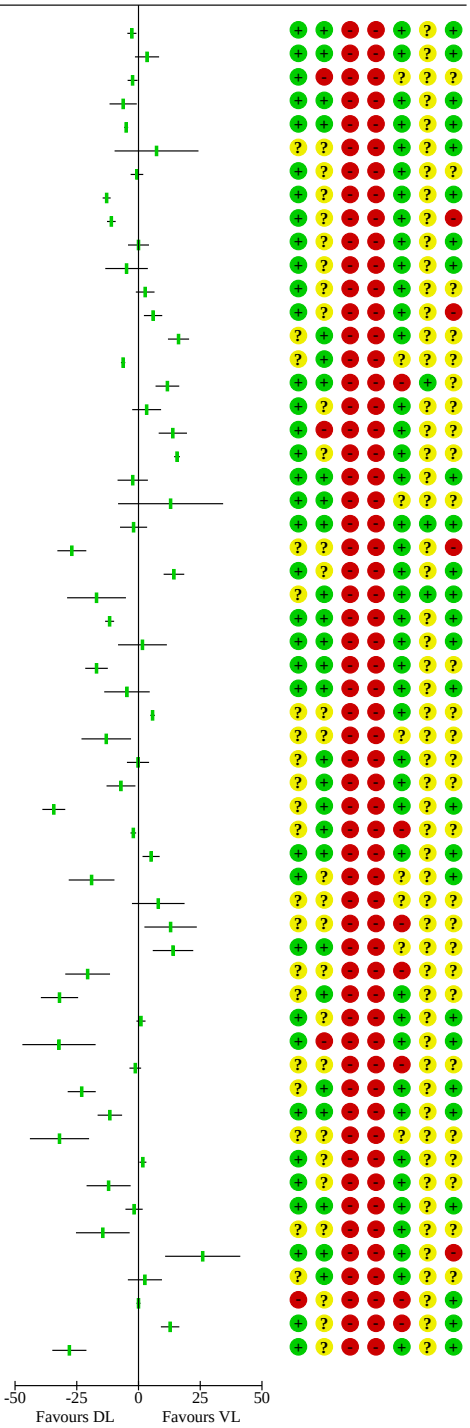
Analysis 3.7. Comparison 3: Channelled VL versus DL, Outcome 7: Time for tracheal intubation

Study or Subgroup	Videolaryngoscope Mean	SD	Total	Direct laryngoscope Mean	SD	Total	Mean Difference IV, Random, 95% CI
Abdallah 2019	11.5	4.36	35	14.18	3.42	35	-2.68 [-4.52 , -0.84]
Abdelgalel 2018	32.25	11.96	40	28.8	10.27	40	3.45 [-1.44 , 8.34]
Aleksandrowicz 2018	9.8	2.68	20	12.2	3.71	20	-2.40 [-4.41 , -0.39]
Ali 2017	26.29	11.2	30	32.5	10.6	30	-6.21 [-11.73 , -0.69]
Amor 2013	14	1	60	19	3	60	-5.00 [-5.80 , -4.20]
Aoi 2010	62.9	26	18	55.6	26	18	7.30 [-9.69 , 24.29]
Barman 2017	22.94	5.56	35	23.57	5.34	35	-0.63 [-3.18 , 1.92]
Bensghir 2013	28.2	2.1	35	41.1	4.4	35	-12.90 [-14.52 , -11.28]
Bhandari 2013	18	2.6	40	29	5.04	40	-11.00 [-12.76 , -9.24]
Blajic 2019	29	9	59	29	14	59	0.00 [-4.25 , 4.25]
Castillo-Monzon 2017	17.27	16.1	23	22.11	13.62	23	-4.84 [-13.46 , 3.78]
Cha 2009	19.7	8.22	60	17	12.51	60	2.70 [-1.09 , 6.49]
Chalkeidis 2010	29.6	8.5	33	23.7	5.9	25	5.90 [2.19 , 9.61]
Colak 2015	29.8	13.82	46	13.59	5.49	49	16.21 [11.93 , 20.49]
Dharanindra 2020	13.6	2.55	70	19.84	2.73	70	-6.24 [-7.12 , -5.36]
El-Tahan 2017a	23.4	7.52	14	11.7	5.41	15	11.70 [6.90 , 16.50]
Enomoto 2008	53.8	13.7	99	50.5	27	104	3.30 [-2.55 , 9.15]
Erden 2010	45.4	8.7	16	31.5	7.8	16	13.90 [8.17 , 19.63]
Erdivanli 2018	23.5	10.8	388	7.9	4.7	388	15.60 [14.43 , 16.77]
Gupta 2020	22.78	10.05	40	25.12	17.07	40	-2.34 [-8.48 , 3.80]
Hamp 2015	88	31	17	75	35	20	13.00 [-8.27 , 34.27]
Hindman 2014	19.6	7	14	21.6	7.8	14	-2.00 [-7.49 , 3.49]
Hirabayashi 2009	44	19	264	71	44	256	-27.00 [-32.86 , -21.14]
Kanchi 2011	36.43	2	15	22.08	8	15	14.35 [10.18 , 18.52]
Kim 2013	12.9	6	22	29.9	28.5	23	-17.00 [-28.91 , -5.09]
Kim 2018	33	8	110	44.7	5.6	110	-11.70 [-13.52 , -9.88]
Koh 2010	46	15.1	25	44.4	20.2	25	1.60 [-8.29 , 11.49]
Komatsu 2010	18	4	50	35	16	50	-17.00 [-21.57 , -12.43]
Kumar 2019	34.5	17.89	30	39.17	18.51	30	-4.67 [-13.88 , 4.54]
Lee 2013	18.5	1.55	20	12.8	1.39	20	5.70 [4.79 , 6.61]
Lopez 2017	30.34	12.5	17	43.4	17	17	-13.06 [-23.09 , -3.03]
Maharaj 2006	12.2	8.5	30	12.4	9.2	30	-0.20 [-4.68 , 4.28]
Maharaj 2007	13.2	5.4	20	20.3	12.2	20	-7.10 [-12.95 , -1.25]
Maharaj 2008	13.4	6.3	20	47.7	8.5	20	-34.30 [-38.94 , -29.66]
Mahmood 2015	10.97	1.129	30	13.07	2.97	30	-2.10 [-3.24 , -0.96]
Malik 2008	16.7	7.6	30	11.6	6	30	5.10 [1.64 , 8.56]
Marco 2011	40	23	54	59	26	54	-19.00 [-28.26 , -9.74]
Maruyama 2008a	24	17	11	16	6	11	8.00 [-2.65 , 18.65]
Maruyama 2008b	29.8	15.4	12	16.8	10.7	12	13.00 [2.39 , 23.61]
Mathew 2018	42.47	20.54	30	28.5	10.15	30	13.97 [5.77 , 22.17]
Nakayama 2010	53.6	11.6	80	74.2	39.7	80	-20.60 [-29.66 , -11.54]
Ndoko 2008	24	16	53	56	23	53	-32.00 [-39.54 , -24.46]
Nishikawa 2009	22.2	3.5	20	21.2	2.3	20	1.00 [-0.84 , 2.84]
Park 2010	58.1	23.1	37	90.3	39.8	37	-32.20 [-47.03 , -17.37]
Rabbani 2020	9.8	4.8	40	11.1	5.9	40	-1.30 [-3.66 , 1.06]
Ranieri 2012	14	3	68	37	23	64	-23.00 [-28.68 , -17.32]
Reena 2019	28.7	10.6	50	40.3	14.4	50	-11.60 [-16.56 , -6.64]
Sansone 2012	26	16	21	58	23	21	-32.00 [-43.98 , -20.02]
Saracoglu 2014	11.23	2.9	30	9.46	2.7	30	1.77 [0.35 , 3.19]
Shukla 2017	33.18	11.06	40	45.29	26.58	40	-12.11 [-21.03 , -3.19]
Teoh 2010	20.6	11.5	100	22.4	13.6	100	-1.80 [-5.29 , 1.69]
Tolon 2012	34.3	12.27	20	48.75	21.57	20	-14.45 [-25.33 , -3.57]
Trimmel 2011	49	58	106	23	55	106	26.00 [10.78 , 41.22]
Wasem 2013	20.1	16.5	30	17.5	10	30	2.60 [-4.30 , 9.50]
Woo 2012	15	2	50	15	2	50	0.00 [-0.78 , 0.78]
Yallapragada 2016	40.98	10.71	40	28.18	5.53	40	12.80 [9.06 , 16.54]
Zhao 2014	68	21	74	96	22	75	-28.00 [-34.91 , -21.09]



Test for subgroup differences: Not applicable

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)

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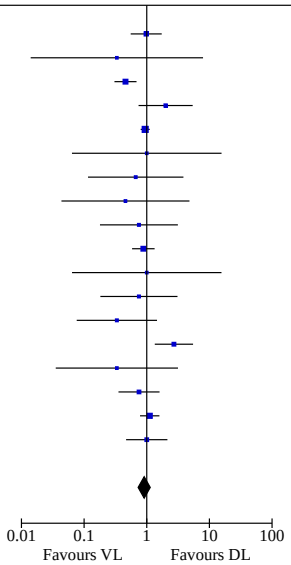
Analysis 3.7. (Continued)

(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 3.8. Comparison 3: Channelled VL versus DL, Outcome 8: Patient-reported sore throat

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdallah 2011	16	50	16	49	8.8%	0.98 [0.55 , 1.73]	+	+	-	-	?	?	-
Abdallah 2019	0	35	1	35	0.5%	0.33 [0.01 , 7.91]	+	+	-	-	+	?	+
Al-Ghamdi 2016 (1)	17	43	19	22	12.3%	0.46 [0.31 , 0.69]	+	+	-	-	+	+	-
Aoi 2010	8	17	4	17	4.0%	2.00 [0.74 , 5.41]	?	?	-	-	+	?	+
Bhandari 2013	34	40	36	40	18.7%	0.94 [0.80 , 1.12]	+	?	-	-	+	?	-
Blajic 2019	1	59	1	59	0.6%	1.00 [0.06 , 15.61]	+	?	-	-	+	?	+
Cha 2009	2	60	3	60	1.5%	0.67 [0.12 , 3.85]	+	?	-	-	+	?	?
El-Tahan 2017b	1	35	2	32	0.9%	0.46 [0.04 , 4.80]	+	+	-	-	+	+	-
Gandhi 2019	3	40	4	40	2.2%	0.75 [0.18 , 3.14]	?	?	-	-	+	?	?
Kim 2018	30	110	34	110	12.1%	0.88 [0.58 , 1.33]	+	+	-	-	+	?	+
Marco 2011	1	54	1	54	0.6%	1.00 [0.06 , 15.58]	+	?	-	-	?	?	+
Mathew 2018	3	33	4	33	2.2%	0.75 [0.18 , 3.09]	+	+	-	-	?	?	?
Nishikawa 2009	2	20	6	20	2.1%	0.33 [0.08 , 1.46]	+	?	-	-	+	?	+
Saracoglu 2014	19	30	7	30	6.8%	2.71 [1.34 , 5.48]	+	?	-	-	+	?	?
Teoh 2010	1	100	3	100	0.9%	0.33 [0.04 , 3.15]	+	+	-	-	+	?	+
Wasem 2013	8	29	11	30	6.1%	0.75 [0.35 , 1.60]	?	+	-	-	+	?	?
Woo 2012	29	50	26	50	13.6%	1.12 [0.78 , 1.59]	-	?	-	-	-	?	+
Yallapragada 2016	10	40	10	40	6.1%	1.00 [0.47 , 2.14]	+	?	-	-	-	?	+
Total (95% CI)		**845**		**821**	**100.0%**	**0.91 [0.73 , 1.14]**							
Total events:	185		188										



Heterogeneity: Tau² = 0.06; Chi² = 28.10, df = 17 (P = 0.04); I² = 40%
Test for overall effect: Z = 0.83 (P = 0.41)
Test for subgroup differences: Not applicable

Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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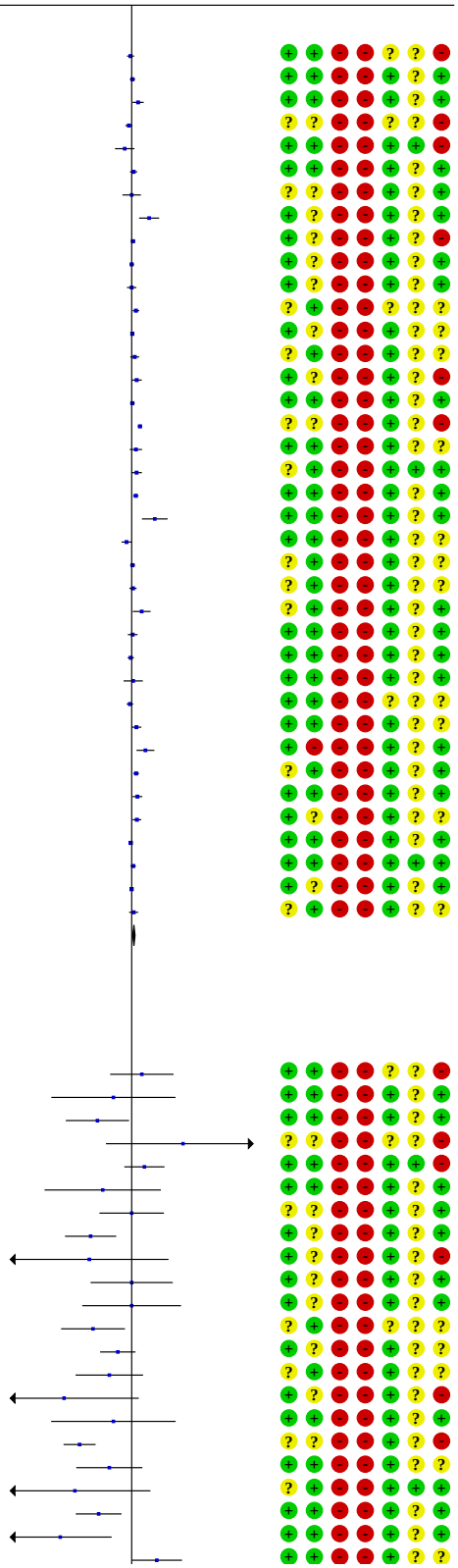
Analysis 3.9. Comparison 3: Channelled VL versus DL, Outcome 9: Number of attempts

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
3.9.1 1 attempt														
Abdallah 2011	44	50	45	49	2.8%	0.96 [0.84 , 1.09]		+	+	-	-	?	?	-
Abdallah 2019	34	35	33	35	3.1%	1.03 [0.93 , 1.14]		+	+	-	-	+	?	+
Abdelgalel 2018	37	40	29	40	2.1%	1.28 [1.03 , 1.57]		+	+	-	-	+	?	+
Acarel 2018	27	30	30	30	2.8%	0.90 [0.79 , 1.03]		?	?	-	-	?	?	-
Al-Ghamdi 2016 (1)	24	43	16	22	1.2%	0.77 [0.53 , 1.11]		+	+	-	-	+	+	-
Ali 2017	29	30	27	30	2.8%	1.07 [0.94 , 1.23]		+	+	-	-	+	?	+
Aoi 2010	14	18	14	18	1.2%	1.00 [0.71 , 1.42]		?	?	-	-	+	?	+
Bensghir 2013	31	35	16	35	1.1%	1.94 [1.32 , 2.83]		+	?	-	-	+	?	+
Bhandari 2013	40	40	38	40	3.2%	1.05 [0.97 , 1.15]		+	?	-	-	+	?	-
Blajic 2019	56	59	56	59	3.3%	1.00 [0.92 , 1.09]		+	?	-	-	+	?	+
Castillo-Monzon 2017	21	23	21	23	2.4%	1.00 [0.84 , 1.20]		+	?	-	-	+	?	+
Dharanindra 2020	67	70	57	70	2.9%	1.18 [1.04 , 1.33]		?	+	-	-	?	?	?
Erdivanli 2018	375	388	366	388	3.6%	1.02 [0.99 , 1.06]		+	?	-	-	+	?	?
Erturk 2015	37	40	33	40	2.5%	1.12 [0.95 , 1.33]		?	+	-	-	+	?	?
Ferrando 2011	29	30	24	30	2.3%	1.21 [1.00 , 1.46]		+	?	-	-	+	?	-
Gupta 2020	39	40	38	40	3.2%	1.03 [0.94 , 1.12]		+	+	-	-	+	?	+
Hirabayashi 2009 (2)	253	264	179	256	3.3%	1.37 [1.26 , 1.49]		?	?	-	-	+	?	-
Hosalli 2017	27	30	23	30	2.0%	1.17 [0.93 , 1.48]		+	+	-	-	+	?	?
Kim 2013	22	22	19	23	2.2%	1.20 [0.98 , 1.47]		?	+	-	-	+	+	+
Kim 2018	104	110	89	110	3.1%	1.17 [1.06 , 1.29]		+	+	-	-	+	?	+
Koh 2010	24	25	10	25	0.8%	2.40 [1.48 , 3.90]		+	+	-	-	+	?	+
Komatsu 2010	37	50	45	50	2.3%	0.82 [0.68 , 0.99]		+	+	-	-	+	?	?
Maharaj 2006	30	30	29	30	3.2%	1.03 [0.94 , 1.13]		?	+	-	-	+	?	?
Maharaj 2007	20	20	19	20	2.8%	1.05 [0.92 , 1.20]		?	+	-	-	+	?	?
Maharaj 2008	19	20	13	20	1.3%	1.46 [1.04 , 2.05]		?	+	-	-	+	?	+
Malik 2008	27	30	26	30	2.4%	1.04 [0.86 , 1.25]		+	+	-	-	+	?	+
Malik 2009a	28	30	29	30	3.0%	0.97 [0.86 , 1.08]		+	+	-	-	+	?	+
Malik 2009b	18	25	17	25	1.2%	1.06 [0.74 , 1.52]		+	+	-	-	+	?	+
Mathew 2018	30	33	32	33	2.9%	0.94 [0.83 , 1.06]		+	+	-	-	?	?	?
McElwain 2011	28	29	25	31	2.3%	1.20 [0.99 , 1.44]		+	+	-	-	+	?	?
Park 2010	32	37	19	37	1.3%	1.68 [1.20 , 2.36]		+	-	-	-	+	?	+
Ranieri 2012	68	68	54	64	3.1%	1.18 [1.06 , 1.32]		?	+	-	-	+	?	+
Reena 2019	46	50	37	50	2.4%	1.24 [1.03 , 1.49]		+	+	-	-	+	?	+
Shukla 2017	39	40	32	40	2.6%	1.22 [1.04 , 1.43]		+	?	-	-	+	?	?
Teoh 2010	95	100	98	100	3.5%	0.97 [0.92 , 1.02]		+	+	-	-	+	?	+
Varsha 2019	35	35	33	35	3.1%	1.06 [0.96 , 1.17]		+	+	-	-	+	+	+
Vijayakumar 2016	45	45	45	45	3.5%	1.00 [0.96 , 1.04]		+	?	-	-	+	?	+
Wasem 2013	28	30	26	30	2.5%	1.08 [0.91 , 1.28]		?	+	-	-	+	?	?
Subtotal (95% CI)		**2094**		**2063**	**95.3%**	**1.09 [1.04 , 1.14]**								
Total events:	1959		1742											
Heterogeneity: Tau² = 0.01; Chi² = 196.29, df = 37 (P < 0.00001); I² = 81%														
Test for overall effect: Z = 3.74 (P = 0.0002)														
3.9.2 2-4 attempts														
Abdallah 2011	6	50	4	49	0.2%	1.47 [0.44 , 4.89]		+	+	-	-	?	?	-
Abdallah 2019	1	35	2	35	0.0%	0.50 [0.05 , 5.27]		+	+	-	-	+	?	+
Abdelgalel 2018	3	40	11	40	0.2%	0.27 [0.08 , 0.90]		+	+	-	-	+	?	+
Acarel 2018	3	30	0	30	0.0%	7.00 [0.38 , 129.93]		?	?	-	-	?	?	-
Al-Ghamdi 2016 (1)	19	43	6	22	0.4%	1.62 [0.76 , 3.47]		+	+	-	-	+	+	-
Ali 2017	1	30	3	30	0.0%	0.33 [0.04 , 3.03]		+	+	-	-	+	?	+
Aoi 2010	4	18	4	18	0.1%	1.00 [0.29 , 3.39]		?	?	-	-	+	?	+
Bensghir 2013	4	35	19	35	0.2%	0.21 [0.08 , 0.56]		+	?	-	-	+	?	+
Bhandari 2013	0	40	2	40	0.0%	0.20 [0.01 , 4.04]		+	?	-	-	+	?	-
Blajic 2019	3	59	3	59	0.1%	1.00 [0.21 , 4.75]		+	?	-	-	+	?	+
Castillo-Monzon 2017	2	23	2	23	0.1%	1.00 [0.15 , 6.51]		+	?	-	-	+	?	+
Dharanindra 2020	3	70	13	70	0.2%	0.23 [0.07 , 0.77]		?	+	-	-	?	?	?
Erdivanli 2018	13	388	22	388	0.4%	0.59 [0.30 , 1.16]		+	?	-	-	+	?	?
Erturk 2015	3	40	7	40	0.1%	0.43 [0.12 , 1.54]		?	+	-	-	+	?	?
Ferrando 2011	0	30	6	30	0.0%	0.08 [0.00 , 1.31]		+	?	-	-	+	?	-
Gupta 2020	1	40	2	40	0.0%	0.50 [0.05 , 5.30]		+	+	-	-	+	?	+
Hirabayashi 2009 (2)	11	264	77	256	0.5%	0.14 [0.08 , 0.25]		?	?	-	-	+	?	-
Hosalli 2017	3	30	7	30	0.1%	0.43 [0.12 , 1.50]		+	+	-	-	+	?	?
Kim 2013	0	22	4	23	0.0%	0.12 [0.01 , 2.04]		?	+	-	-	+	+	+
Kim 2018	6	110	21	110	0.3%	0.29 [0.12 , 0.68]		+	+	-	-	+	?	+
Koh 2010	1	25	15	25	0.1%	0.07 [0.01 , 0.47]		+	+	-	-	+	?	+
Komatsu 2010	13	50	5	50	0.2%	2.60 [1.00 , 6.75]		+	+	-	-	+	?	?



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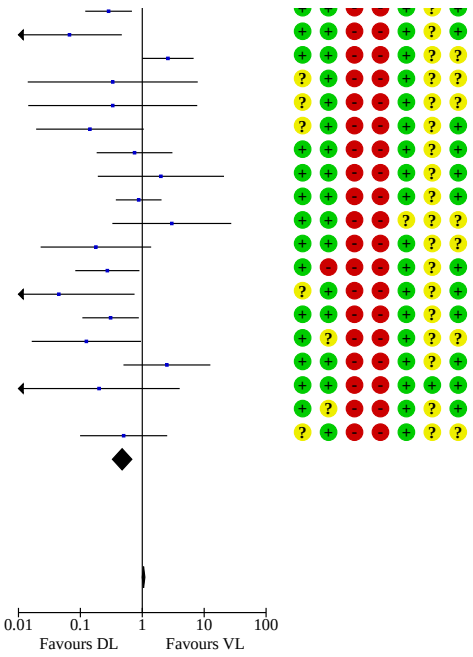
Analysis 3.9. (Continued)

Koh 2010	1	25	15	25	0.1%	0.07 [0.01 , 0.47]
Komatsu 2010	13	50	5	50	0.2%	2.60 [1.00 , 6.75]
Maharaj 2006	0	30	1	30	0.0%	0.33 [0.01 , 7.87]
Maharaj 2007	0	20	1	20	0.0%	0.33 [0.01 , 7.72]
Maharaj 2008	1	20	7	20	0.1%	0.14 [0.02 , 1.06]
Malik 2008	3	30	4	30	0.1%	0.75 [0.18 , 3.07]
Malik 2009a	2	30	1	30	0.0%	2.00 [0.19 , 20.90]
Malik 2009b	7	25	8	25	0.3%	0.88 [0.37 , 2.05]
Mathew 2018	3	33	1	33	0.0%	3.00 [0.33 , 27.38]
McElwain 2011	1	29	6	31	0.1%	0.18 [0.02 , 1.39]
Park 2010	3	37	11	37	0.2%	0.27 [0.08 , 0.90]
Ranieri 2012	0	68	10	64	0.0%	0.04 [0.00 , 0.75]
Reena 2019	4	50	13	50	0.2%	0.31 [0.11 , 0.88]
Shukla 2017	1	40	8	40	0.1%	0.13 [0.02 , 0.95]
Teoh 2010	5	100	2	100	0.1%	2.50 [0.50 , 12.59]
Varsha 2019	0	35	2	35	0.0%	0.20 [0.01 , 4.02]
Vijayakumar 2016	0	45	0	45		Not estimable
Wasem 2013	2	30	4	30	0.1%	0.50 [0.10 , 2.53]
Subtotal (95% CI)		**2094**		**2063**	**4.7%**	**0.47 [0.33 , 0.68]**
Total events:	132		314			
Heterogeneity: Tau² = 0.58; Chi² = 82.24, df = 36 (P < 0.0001); I² = 56%						
Test for overall effect: Z = 4.07 (P < 0.0001)						
Total (95% CI)		**4188**		**4126**	**100.0%**	**1.05 [1.00 , 1.10]**
Total events:	2091		2056			
Heterogeneity: Tau² = 0.02; Chi² = 293.13, df = 74 (P < 0.00001); I² = 75%						
Test for overall effect: Z = 1.97 (P = 0.05)						
Test for subgroup differences: Chi² = 20.15, df = 1 (P < 0.00001), I² = 95.0%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.

(2) Novice intubators.

Risk of bias legend

(A) Random sequence generation (selection bias)

(B) Allocation concealment (selection bias)

(C) Blinding of participants and personnel (performance bias)

(D) Blinding of outcome assessment (detection bias)

(E) Incomplete outcome data (attrition bias)

(F) Selective reporting (reporting bias)

(G) Experience of intubator

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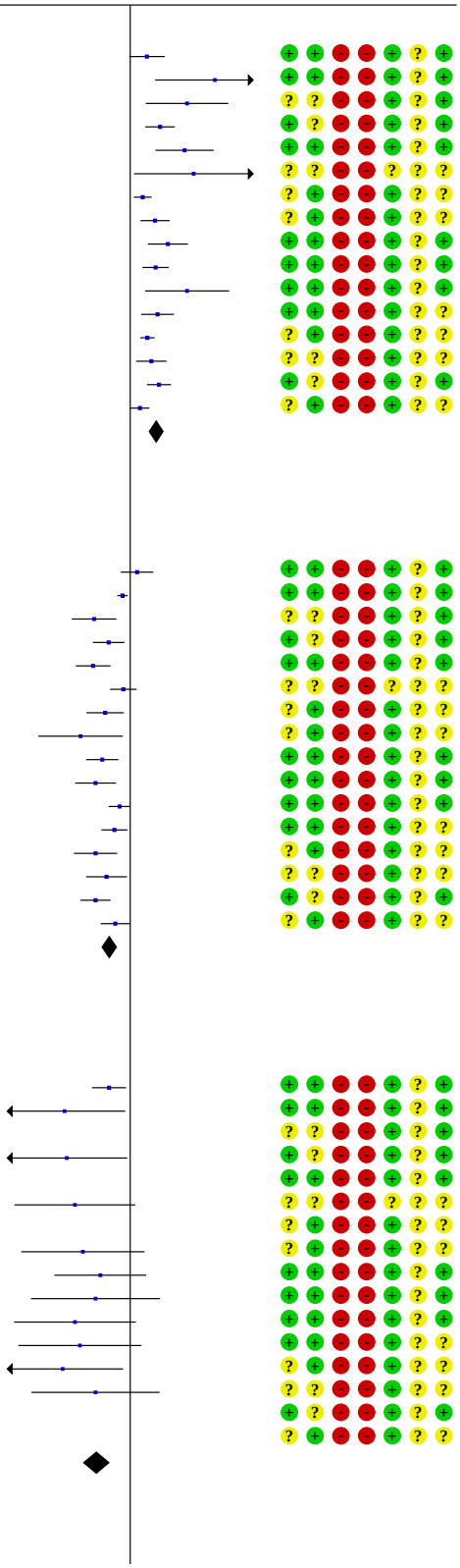
Analysis 3.10. Comparison 3: Channelled VL versus DL, Outcome 10: Intubation Difficulty Scale (IDS)

Study or Subgroup	Videolaryngoscope Events	Videolaryngoscope Total	Direct laryngoscope Events	Direct laryngoscope Total	Weight	Risk Ratio M-H, Random, 95% CI
3.10.1 IDS 0						
Ali 2017	13	30	6	30	2.8%	2.17 [0.95 , 4.94]
Amor 2013	25	60	0	60	1.1%	51.00 [3.18 , 819.00]
Aoi 2010	14	17	1	17	1.7%	14.00 [2.06 , 94.93]
Bensghir 2013	28	35	7	35	3.0%	4.00 [2.02 , 7.92]
Kumar 2019	25	30	2	30	2.3%	12.50 [3.25 , 48.14]
Lopez 2017	9	17	0	17	1.1%	19.00 [1.19 , 302.53]
Maharaj 2006	25	30	14	30	3.2%	1.79 [1.18 , 2.70]
Maharaj 2007	19	20	6	20	3.0%	3.17 [1.61 , 6.23]
Malik 2008	23	30	4	30	2.7%	5.75 [2.26 , 14.62]
Malik 2009a	26	30	8	30	3.0%	3.25 [1.77 , 5.98]
Malik 2009b	14	25	1	25	1.7%	14.00 [1.99 , 98.55]
McElwain 2011	20	29	6	31	2.9%	3.56 [1.67 , 7.61]
Ndoko 2008	49	53	22	53	3.3%	2.23 [1.60 , 3.09]
Tolon 2012	16	20	6	20	3.0%	2.67 [1.32 , 5.39]
Vijayakumar 2016	38	45	10	45	3.1%	3.80 [2.17 , 6.66]
Wasem 2013	22	30	14	30	3.2%	1.57 [1.01 , 2.44]
Subtotal (95% CI)		**501**		**503**	**41.0%**	**3.34 [2.43 , 4.60]**
Total events:	366		107			
Heterogeneity: Tau² = 0.23; Chi² = 43.83, df = 15 (P = 0.0001); I² = 66%						
Test for overall effect: Z = 7.40 (P < 0.00001)						
3.10.2 IDS 1-5						
Ali 2017	11	30	8	30	2.9%	1.38 [0.64 , 2.93]
Amor 2013 (1)	35	60	50	60	3.3%	0.70 [0.55 , 0.89]
Aoi 2010	3	17	16	17	2.6%	0.19 [0.07 , 0.53]
Bensghir 2013	7	35	19	35	2.9%	0.37 [0.18 , 0.76]
Kumar 2019	5	30	28	30	2.9%	0.18 [0.08 , 0.40]
Lopez 2017	8	17	11	17	3.0%	0.73 [0.39 , 1.34]
Maharaj 2006	5	30	16	30	2.8%	0.31 [0.13 , 0.74]
Maharaj 2007	1	20	10	20	1.7%	0.10 [0.01 , 0.71]
Malik 2008	6	30	22	30	2.9%	0.27 [0.13 , 0.58]
Malik 2009a	4	30	20	30	2.7%	0.20 [0.08 , 0.52]
Malik 2009b	11	25	18	25	3.1%	0.61 [0.37 , 1.01]
McElwain 2011	9	29	20	31	3.1%	0.48 [0.26 , 0.88]
Ndoko 2008	4	53	20	53	2.6%	0.20 [0.07 , 0.55]
Tolon 2012	4	20	12	20	2.7%	0.33 [0.13 , 0.86]
Vijayakumar 2016	7	45	35	45	3.0%	0.20 [0.10 , 0.40]
Wasem 2013	8	30	16	30	3.0%	0.50 [0.25 , 0.99]
Subtotal (95% CI)		**501**		**503**	**45.2%**	**0.38 [0.27 , 0.53]**
Total events:	128		321			
Heterogeneity: Tau² = 0.29; Chi² = 54.80, df = 15 (P < 0.00001); I² = 73%						
Test for overall effect: Z = 5.76 (P < 0.00001)						
3.10.3 IDS > 5						
Ali 2017	6	30	16	30	2.9%	0.38 [0.17 , 0.83]
Amor 2013 (2)	0	60	10	60	1.1%	0.05 [0.00 , 0.79]
Aoi 2010	0	17	0	17		Not estimable
Bensghir 2013	0	35	9	35	1.1%	0.05 [0.00 , 0.87]
Kumar 2019	0	30	0	30		Not estimable
Lopez 2017	0	17	6	17	1.1%	0.08 [0.00 , 1.27]
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	4	20	1.1%	0.11 [0.01 , 1.94]
Malik 2008	1	30	4	30	1.5%	0.25 [0.03 , 2.11]
Malik 2009a	0	30	2	30	1.0%	0.20 [0.01 , 4.00]
Malik 2009b	0	25	6	25	1.1%	0.08 [0.00 , 1.30]
McElwain 2011	0	29	5	31	1.1%	0.10 [0.01 , 1.68]
Ndoko 2008	0	53	11	53	1.1%	0.04 [0.00 , 0.72]
Tolon 2012	0	20	2	20	1.0%	0.20 [0.01 , 3.92]
Vijayakumar 2016	0	45	0	45		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Subtotal (95% CI)		**501**		**503**	**13.9%**	**0.21 [0.12 , 0.37]**
Total events:	7		75			
Heterogeneity: Tau² = 0.00; Chi² = 8.20, df = 10 (P = 0.61); I² = 0%						
Test for overall effect: Z = 5.27 (P < 0.00001)						



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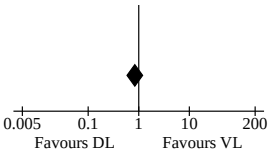
Analysis 3.10. (Continued)

Test for overall effect: Z = 5.27 (P < 0.00001)

Total (95% CI)	**1503**	**1509**	**100.0%**	**0.84 [0.59 , 1.19]**	
Total events:	501	503			

Heterogeneity: Tau² = 0.98; Chi² = 335.49, df = 42 (P < 0.00001); I² = 87%
Test for overall effect: Z = 0.99 (P = 0.32)
Test for subgroup differences: Chi² = 115.13, df = 2 (P < 0.00001), I² = 98.3%



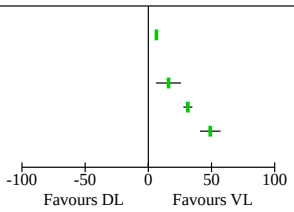
Footnotes
(1) Reported for 1-6
(2) Reported for > 6

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Analysis 3.11. Comparison 3: Channelled VL versus DL, Outcome 11: POGO Score

Study or Subgroup	Videolaryngoscope Mean	SD	Total	Direct laryngoscope Mean	SD	Total	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdallah 2019	97.02	2.41	35	90.6	2.48	35	6.42 [5.27 , 7.57]	+	+	-	-	+	?	+
Cha 2009	100	0	60	79.7	33.04	60	Not estimable	+	?	-	-	+	?	?
Hindman 2014	90	10	14	74	16	14	16.00 [6.12 , 25.88]	+	+	-	-	+	+	+
Kim 2018	80.9	9.7	110	49.6	16.5	110	31.30 [27.72 , 34.88]	+	+	-	-	+	?	+
Woo 2012	97	4	50	48	29	50	49.00 [40.89 , 57.11]	-	?	-	-	-	?	+

Mean Difference IV, Random, 95% CI



Test for subgroup differences: Not applicable

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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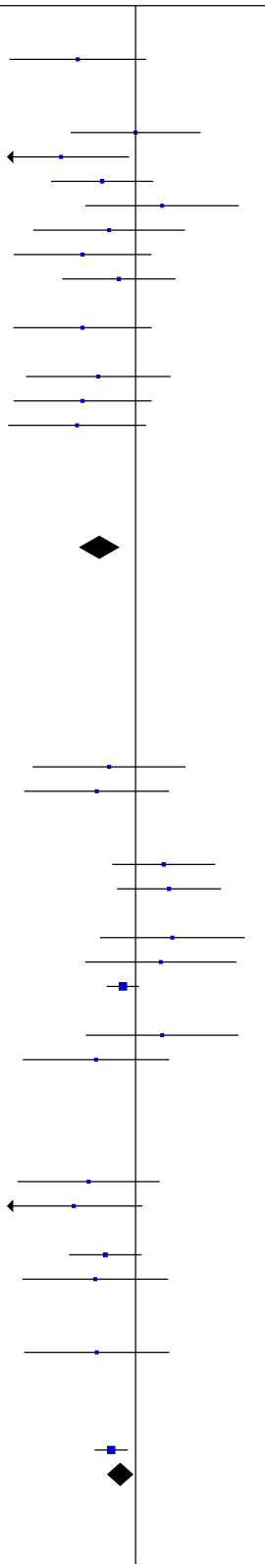
Analysis 3.12. Comparison 3: Channelled VL versus DL, Outcome 12: Subgroup analysis of failed intubation: airway difficulty

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
3.12.1 Predicted, known or simulated difficulty													
Aleksandrowicz 2018	0	20	5	20	1.8%	0.09 [0.01 , 1.54]	+	-	-	-	?	?	?
Ali 2017	0	30	0	30		Not estimable	+	+	-	-	+	?	+
Amor 2013	0	60	0	60		Not estimable	+	+	-	-	+	?	+
Aoi 2010	1	18	1	18	2.0%	1.00 [0.07 , 14.79]	?	?	-	-	+	?	+
Enomoto 2008	0	99	11	104	1.9%	0.05 [0.00 , 0.76]	+	?	-	-	+	?	?
Koh 2010	1	25	4	25	3.2%	0.25 [0.03 , 2.08]	+	+	-	-	+	?	+
Komatsu 2010	1	50	0	50	1.5%	3.00 [0.13 , 71.92]	+	+	-	-	+	?	?
Maharaj 2007	0	20	1	20	1.5%	0.33 [0.01 , 7.72]	?	+	-	-	+	?	?
Maharaj 2008	0	20	4	20	1.8%	0.11 [0.01 , 1.94]	?	+	-	-	+	?	+
Malik 2008	1	30	2	30	2.7%	0.50 [0.05 , 5.22]	+	+	-	-	+	?	+
Malik 2009a	0	30	0	30		Not estimable	+	+	-	-	+	?	+
Malik 2009b	0	25	4	25	1.8%	0.11 [0.01 , 1.96]	+	+	-	-	+	?	+
Mathew 2018	0	33	0	33		Not estimable	+	+	-	-	?	?	?
McElwain 2011	0	29	2	31	1.6%	0.21 [0.01 , 4.26]	+	+	-	-	+	?	?
Sansone 2012	0	21	4	21	1.8%	0.11 [0.01 , 1.94]	?	?	-	-	?	?	?
Takenaka 2011	0	35	5	34	1.8%	0.09 [0.01 , 1.54]	?	+	-	-	+	?	+
Tolon 2012	0	20	0	20		Not estimable	?	?	-	-	+	?	?
Turkstra 2009	0	24	0	24		Not estimable	+	+	-	-	+	?	+
Vijayakumar 2016	0	45	0	45		Not estimable	+	?	-	-	+	?	+
Woo 2012	0	50	0	109		Not estimable	-	?	-	-	-	?	+
Subtotal (95% CI)		**684**		**749**	**23.4%**	**0.22 [0.10 , 0.49]**							
Total events:	4		43										
Heterogeneity: Tau² = 0.00; Chi² = 7.24, df = 11 (P = 0.78); I² = 0%													
Test for overall effect: Z = 3.72 (P = 0.0002)													
3.12.2 No difficulty													
Abdallah 2019	0	35	0	35		Not estimable	+	+	-	-	+	?	+
Acarel 2018	0	30	0	30		Not estimable	?	?	-	-	?	?	-
Al-Ghamdi 2016 (1)	0	44	0	22		Not estimable	+	+	-	-	+	+	-
Bensghir 2013	0	35	1	35	1.5%	0.33 [0.01 , 7.91]	+	?	-	-	+	?	+
Bhandari 2013	0	40	2	40	1.6%	0.20 [0.01 , 4.04]	+	?	-	-	+	?	-
Blajic 2019	0	59	0	59		Not estimable	+	?	-	-	+	?	+
Castillo-Monzon 2017	0	23	0	23		Not estimable	+	?	-	-	+	?	+
Chalkeidis 2010	4	35	1	28	3.2%	3.20 [0.38 , 27.04]	+	?	-	-	+	?	-
Colak 2015 (1)	4	50	1	50	3.1%	4.00 [0.46 , 34.54]	?	+	-	-	+	?	?
El-Tahan 2017a	0	14	0	15		Not estimable	+	+	-	-	-	+	?
El-Tahan 2017b	2	35	0	32	1.6%	4.58 [0.23 , 92.00]	+	+	-	-	+	+	-
Erden 2010	1	17	0	16	1.5%	2.83 [0.12 , 64.89]	+	-	-	-	+	?	?
Erdivanli 2018	13	388	22	388	24.5%	0.59 [0.30 , 1.16]	+	?	-	-	+	?	?
Erturk 2015	0	40	0	40		Not estimable	?	+	-	-	+	?	?
Ferrando 2011	1	30	0	30	1.5%	3.00 [0.13 , 70.83]	+	?	-	-	+	?	-
Hirabayashi 2009	0	264	2	256	1.6%	0.19 [0.01 , 4.02]	?	?	-	-	+	?	-
Hosalli 2017	0	30	0	30		Not estimable	+	+	-	-	+	?	?
Kim 2013	0	22	0	23		Not estimable	?	+	-	-	+	+	+
Kim 2018	0	110	0	110		Not estimable	+	+	-	-	+	?	+
Maharaj 2006	0	30	0	30		Not estimable	?	+	-	-	+	?	?
Nakayama 2010	0	80	3	80	1.7%	0.14 [0.01 , 2.72]	?	?	-	-	-	?	?
Ndoko 2008	0	53	6	53	1.8%	0.08 [0.00 , 1.33]	?	+	-	-	+	?	?
Nishikawa 2009	0	20	0	20		Not estimable	+	?	-	-	+	?	+
Park 2010	2	37	7	37	6.2%	0.29 [0.06 , 1.29]	+	-	-	-	+	?	+
Ranieri 2012	0	68	2	64	1.6%	0.19 [0.01 , 3.85]	?	+	-	-	+	?	+
Reena 2019	0	50	0	50		Not estimable	+	+	-	-	+	?	+
Saracoglu 2014	0	30	0	30		Not estimable	+	?	-	-	+	?	?
Shukla 2017	0	40	2	40	1.6%	0.20 [0.01 , 4.04]	+	?	-	-	+	?	?
Teoh 2010	0	100	0	100		Not estimable	+	+	-	-	+	?	+
Varsha 2019	0	35	0	35		Not estimable	+	+	-	-	+	+	+
Wasem 2013	0	30	0	30		Not estimable	?	+	-	-	+	?	?
Zhao 2014	9	74	25	75	23.4%	0.36 [0.18 , 0.73]	+	?	-	-	+	?	+
Subtotal (95% CI)		**1948**		**1906**	**76.6%**	**0.53 [0.32 , 0.88]**							
Total events:	36		74										
Heterogeneity: Tau² = 0.14; Chi² = 16.46, df = 14 (P = 0.29); I² = 15%													
Test for overall effect: Z = 2.44 (P = 0.01)													



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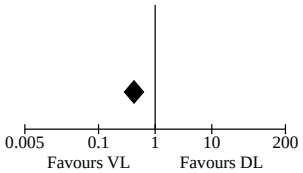
Analysis 3.12. (Continued)

Heterogeneity: Tau² = 0.14; Chi² = 16.46, df = 14 (P = 0.29); I² = 15%
Test for overall effect: Z = 2.44 (P = 0.01)

Total (95% CI)		**2632**	**2655**	**100.0%**	**0.42 [0.29 , 0.62]**
Total events:	40	117			

Heterogeneity: Tau² = 0.04; Chi² = 27.09, df = 26 (P = 0.40); I² = 4%
Test for overall effect: Z = 4.35 (P < 0.0001)
Test for subgroup differences: Chi² = 3.25, df = 1 (P = 0.07), I² = 69.3%



Footnotes
(1) Multi-arm study. Data combined for each VL group.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

Comparison 4. VL versus DL (all devices combined)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 Failed intubation	139	16228	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.35, 0.56]
4.2 Hypoxia	41	5434	Risk Ratio (M-H, Random, 95% CI)	0.61 [0.44, 0.85]
4.3 Successful first attempt	138	19797	Risk Ratio (M-H, Random, 95% CI)	1.05 [1.03, 1.07]
4.4 Oesophageal intubation	40	5768	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.29, 0.77]
4.5 Subgroup analysis of failed intubation: theatre versus non-theatre	141	16450	Risk Ratio (M-H, Random, 95% CI)	0.46 [0.36, 0.59]
4.5.1 Theatre	130	14604	Risk Ratio (M-H, Random, 95% CI)	0.41 [0.32, 0.54]
4.5.2 Non-theatre	11	1846	Risk Ratio (M-H, Random, 95% CI)	0.68 [0.42, 1.09]
4.6 Subgroup analysis of failed intubation: obesity	133	14881	Risk Ratio (M-H, Random, 95% CI)	0.43 [0.32, 0.56]
4.6.1 Obese	13	1085	Risk Ratio (M-H, Random, 95% CI)	0.25 [0.13, 0.46]
4.6.2 Non-obese	120	13796	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.35, 0.62]
4.7 Subgroup analysis of failed intubation: airway difficulty	132	14999	Risk Ratio (M-H, Random, 95% CI)	0.42 [0.32, 0.54]
4.7.1 Predicted, known or simulated difficulty	42	4100	Risk Ratio (M-H, Random, 95% CI)	0.32 [0.23, 0.44]
4.7.2 No difficulty	90	10899	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.38, 0.78]

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.8 Subgroup analysis of failed intubation: intubator experience	115	13095	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.34, 0.58]
4.8.1 Expert	98	10939	Risk Ratio (M-H, Random, 95% CI)	0.41 [0.33, 0.50]
4.8.2 Non-expert	17	2156	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.32, 1.18]

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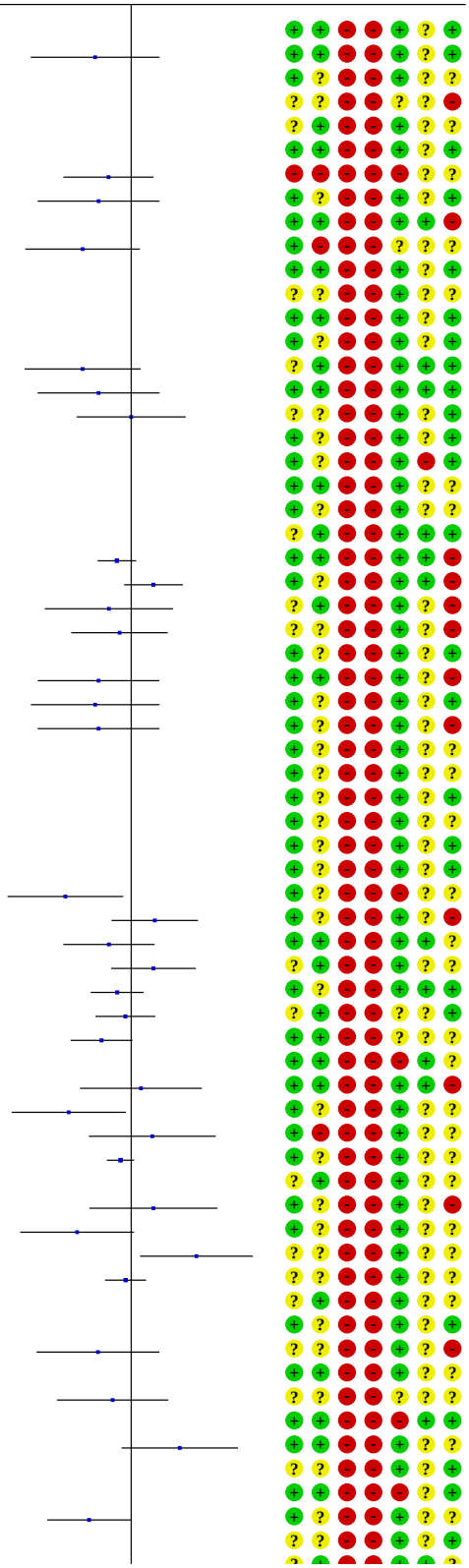
Analysis 4.1. Comparison 4: VL versus DL (all devices combined), Outcome 1: Failed intubation

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdallah 2019	0	35	0	35		Not estimable	+	+	-	-	+	?	+
Abdelgalel 2018	0	80	1	40	0.5%	0.17 [0.01 , 4.05]	+	+	-	-	+	?	+
Abdelgawad 2015	0	40	0	40		Not estimable	+	?	-	-	+	?	?
Acarel 2018	0	30	0	30		Not estimable	?	?	-	-	?	?	-
Aggarwal 2019	0	50	0	50		Not estimable	?	+	-	-	+	?	?
Agrawal 2020	0	40	0	40		Not estimable	+	+	-	-	+	?	+
Ahmadi 2015	1	49	3	48	1.0%	0.33 [0.04 , 3.03]	-	-	-	-	-	?	?
Akbar 2015	0	45	2	45	0.6%	0.20 [0.01 , 4.05]	+	?	-	-	+	?	+
Al-Ghamdi 2016 (1)	0	65	0	22		Not estimable	+	+	-	-	+	+	-
Aleksandrowicz 2018	0	20	5	20	0.7%	0.09 [0.01 , 1.54]	+	-	-	-	?	?	?
Ali 2017	0	30	0	30		Not estimable	+	+	-	-	+	?	+
Altaiee 2020	0	50	0	50		Not estimable	?	?	-	-	+	?	?
Amor 2013	0	60	0	60		Not estimable	+	+	-	-	+	?	+
Anandraja 2021	0	30	0	30		Not estimable	+	?	-	-	+	?	+
Ander 2017	0	39	5	39	0.7%	0.09 [0.01 , 1.59]	?	+	-	-	+	+	+
Andersen 2011	0	50	2	50	0.6%	0.20 [0.01 , 4.06]	+	+	-	-	+	+	+
Aoi 2010	1	18	1	18	0.7%	1.00 [0.07 , 14.79]	?	?	-	-	+	?	+
Aqil 2016	0	40	0	40		Not estimable	+	?	-	-	+	?	+
Aqil 2017	0	70	0	70		Not estimable	+	?	-	-	+	-	+
Arici 2014	0	40	0	40		Not estimable	+	+	-	-	+	?	?
Arora 2013 (2)	0	54	0	54		Not estimable	+	?	-	-	+	?	?
Arslan 2017 (1)	0	80	0	40		Not estimable	?	+	-	-	+	+	+
Aziz 2012	6	149	12	147	3.6%	0.49 [0.19 , 1.28]	+	+	-	-	+	+	-
Bakshi 2015 (3)	12	84	2	42	2.1%	3.00 [0.70 , 12.79]	+	?	-	-	+	+	-
Bakshi 2019	0	37	1	37	0.5%	0.33 [0.01 , 7.93]	?	+	-	-	+	?	-
Barak 2007	1	80	2	90	0.9%	0.56 [0.05 , 6.09]	?	?	-	-	+	?	-
Bashir 2020	0	40	0	40		Not estimable	+	?	-	-	+	?	+
Bensghir 2010	0	34	2	34	0.6%	0.20 [0.01 , 4.02]	+	+	-	-	+	?	-
Bensghir 2013	0	70	1	35	0.5%	0.17 [0.01 , 4.05]	+	?	-	-	+	?	+
Bhandari 2013	0	40	2	40	0.6%	0.20 [0.01 , 4.04]	+	?	-	-	+	?	-
Bhat 2015	0	50	0	50		Not estimable	+	?	-	-	+	?	?
Bilehjani 2009	0	40	0	38		Not estimable	+	?	-	-	+	?	?
Blajic 2019	0	119	0	59		Not estimable	+	?	-	-	+	?	+
Cakir 2020	0	31	0	31		Not estimable	+	?	-	-	+	?	?
Carassiti 2013	0	15	0	15		Not estimable	+	?	-	-	+	?	+
Castillo-Monzon 2017	0	23	0	23		Not estimable	+	?	-	-	+	?	+
Cavus 2011 (1)	0	100	6	50	0.7%	0.04 [0.00 , 0.68]	+	?	-	-	-	?	?
Chalkeidis 2010	4	35	1	28	1.1%	3.20 [0.38 , 27.04]	+	?	-	-	+	?	-
Chen 2019	1	220	3	220	1.0%	0.33 [0.03 , 3.18]	+	+	-	-	+	+	?
Colak 2015 (1)	6	100	1	50	1.2%	3.00 [0.37 , 24.25]	?	+	-	-	+	?	?
Cordovani 2019	3	24	5	20	2.4%	0.50 [0.14 , 1.84]	+	?	-	-	+	+	+
Dey 2020	3	124	4	124	2.0%	0.75 [0.17 , 3.28]	?	+	-	-	?	?	+
Driver 2016	2	103	8	95	1.9%	0.23 [0.05 , 1.06]	+	+	-	-	?	?	?
El-Tahan 2017a	0	14	0	15		Not estimable	+	+	-	-	-	+	?
El-Tahan 2017b	2	101	0	32	0.6%	1.62 [0.08 , 32.85]	+	+	-	-	+	+	-
Enomoto 2008	0	99	11	104	0.7%	0.05 [0.00 , 0.76]	+	?	-	-	+	?	?
Erden 2010	1	17	0	16	0.6%	2.83 [0.12 , 64.89]	+	-	-	-	+	?	?
Erdivanli 2018	13	388	22	388	5.0%	0.59 [0.30 , 1.16]	+	?	-	-	+	?	?
Erturk 2015	0	40	0	40		Not estimable	?	+	-	-	+	?	?
Ferrando 2011	1	30	0	30	0.5%	3.00 [0.13 , 70.83]	+	?	-	-	+	?	-
Foulds 2016b	0	24	7	25	0.7%	0.07 [0.00 , 1.15]	+	?	-	-	+	?	?
Frohlich 2011	12	30	0	30	0.7%	25.00 [1.55 , 403.99]	?	?	-	-	+	?	?
Gao 2018	6	81	8	82	3.4%	0.76 [0.28 , 2.09]	?	?	-	-	+	?	?
Gunes 2020	0	90	0	90		Not estimable	?	+	-	-	+	?	?
Gupta 2013	0	60	0	60		Not estimable	+	?	-	-	+	?	+
Hirabayashi 2009	0	264	2	256	0.6%	0.19 [0.01 , 4.02]	?	?	-	-	+	?	-
Hosalli 2017	0	30	0	30		Not estimable	+	+	-	-	+	?	?
Hostic 2016	1	100	1	40	0.7%	0.40 [0.03 , 6.24]	?	?	-	-	?	?	?
Hu 2017 (4)	0	100	0	96		Not estimable	+	+	-	-	-	+	+
Ilyas 2014	5	64	0	64	0.7%	11.00 [0.62 , 194.90]	+	+	-	-	+	?	?
Inal 2016	0	50	0	50		Not estimable	?	?	-	-	+	?	+
Jafra 2018	0	100	0	100		Not estimable	+	+	-	-	-	?	+
Jungbauer 2009	1	100	8	100	1.2%	0.13 [0.02 , 0.98]	+	?	-	-	+	?	?
Kaur 2020	0	80	0	40		Not estimable	?	?	-	-	+	?	+
Kido 2015	0	25	0	25		Not estimable	?	+	-	-	+	+	?



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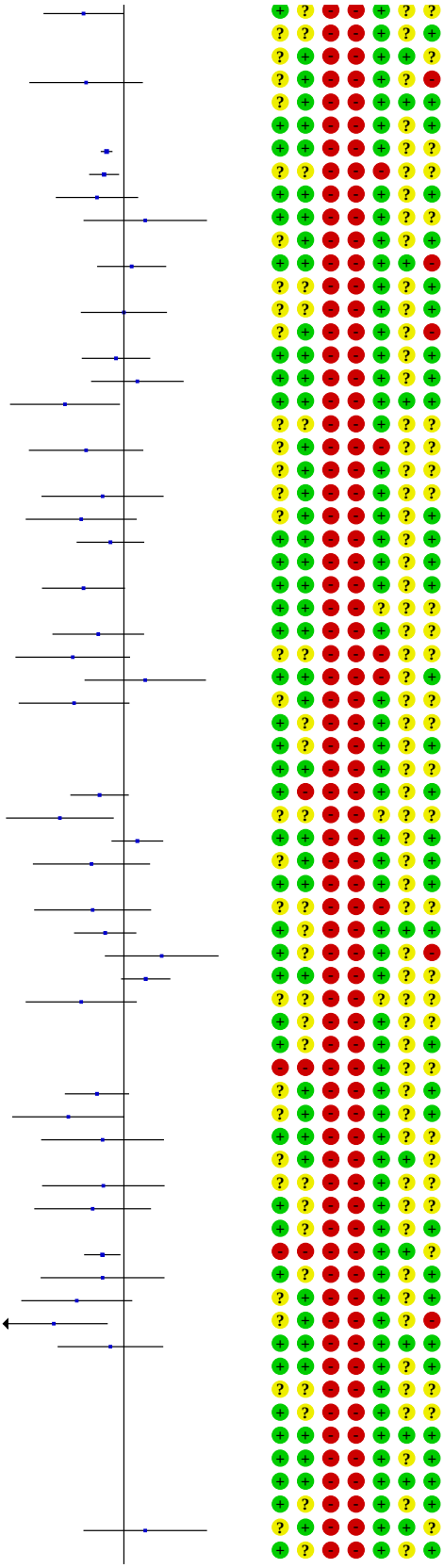
Analysis 4.1. (Continued)

Jungbauer 2009	1	100	8	100	1.2%	0.13 [0.02 , 0.98]
Kaur 2020	0	80	0	40		Not estimable
Kido 2015	0	25	0	25		Not estimable
Kill 2013	0	30	3	30	0.6%	0.14 [0.01 , 2.65]
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Kleine-Brueggeney 2017	64	360	52	120	7.3%	0.41 [0.30 , 0.55]
Koennecke 2014 (1)	10	83	10	30	4.5%	0.36 [0.17 , 0.78]
Koh 2010	1	25	4	25	1.1%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	0.5%	3.00 [0.13 , 71.92]
Kucukosman 2020	0	30	0	30		Not estimable
Lascarrou 2017	3	186	2	185	1.5%	1.49 [0.25 , 8.83]
Lee 2009	0	41	0	44		Not estimable
Lee 2012 (1)	3	75	1	25	1.0%	1.00 [0.11 , 9.18]
Lim 2005	0	30	0	30		Not estimable
Lin 2012	2	85	3	85	1.5%	0.67 [0.11 , 3.89]
Liu 2016	2	90	1	90	0.9%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	0.7%	0.05 [0.00 , 0.82]
Maassen 2012	0	40	0	40		Not estimable
Macke 2020	0	76	3	76	0.6%	0.14 [0.01 , 2.72]
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	0.6%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	0.7%	0.11 [0.01 , 1.94]
Malik 2008 (1)	3	90	2	30	1.6%	0.50 [0.09 , 2.85]
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	1	50	4	25	1.1%	0.13 [0.01 , 1.06]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	0.9%	0.27 [0.03 , 2.83]
Nakayama 2010	0	160	3	80	0.6%	0.07 [0.00 , 1.37]
Nandakumar 2018	1	15	0	15	0.6%	3.00 [0.13 , 68.26]
Ndoko 2008	0	53	6	53	0.7%	0.08 [0.00 , 1.33]
Ninan 2016	0	30	0	30		Not estimable
Nishikawa 2009	0	20	0	20		Not estimable
Paik 2020	0	20	0	20		Not estimable
Park 2010	2	37	7	37	2.0%	0.29 [0.06 , 1.29]
Peck 2009	0	27	13	27	0.7%	0.04 [0.00 , 0.59]
Pournajafian 2014	6	52	3	52	2.4%	2.00 [0.53 , 7.57]
Ranieri 2012	0	68	2	64	0.6%	0.19 [0.01 , 3.85]
Reena 2019	0	50	0	50		Not estimable
Rovsing 2010	0	50	2	50	0.6%	0.20 [0.01 , 4.06]
Ruetzler 2020	2	66	5	63	1.8%	0.38 [0.08 , 1.90]
Russell 2013	3	35	0	35	0.6%	7.00 [0.37 , 130.69]
Sanguanwit 2021	9	78	3	80	2.5%	3.08 [0.87 , 10.94]
Sansone 2012	0	21	4	21	0.7%	0.11 [0.01 , 1.94]
Saracoglu 2014	0	30	0	30		Not estimable
Sargin 2016	0	50	0	50		Not estimable
Sarkilar 2015	0	55	0	55		Not estimable
Serocki 2010	2	80	4	40	1.7%	0.25 [0.05 , 1.31]
Serocki 2013 (1)	0	63	4	32	0.6%	0.06 [0.00 , 1.03]
Shah 2016 (5)	0	30	1	30	0.5%	0.33 [0.01 , 7.87]
Shimazaki 2018	0	20	0	20		Not estimable
Shippey 2013	0	24	1	25	0.6%	0.35 [0.01 , 8.12]
Shukla 2017	0	40	2	40	0.6%	0.20 [0.01 , 4.04]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	3.7%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	0.5%	0.33 [0.01 , 8.09]
Takenaka 2011	0	35	5	34	0.7%	0.09 [0.01 , 1.54]
Taylor 2013	0	44	18	44	0.7%	0.03 [0.00 , 0.43]
Tempe 2016	1	40	1	20	0.7%	0.50 [0.03 , 7.59]
Teoh 2010	0	300	0	100		Not estimable
Tolon 2012	0	20	0	20		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Walker 2009	1	60	0	60	0.5%	3.00 [0.12 , 72.20]
Wallace 2015	0	52	0	53		Not estimable



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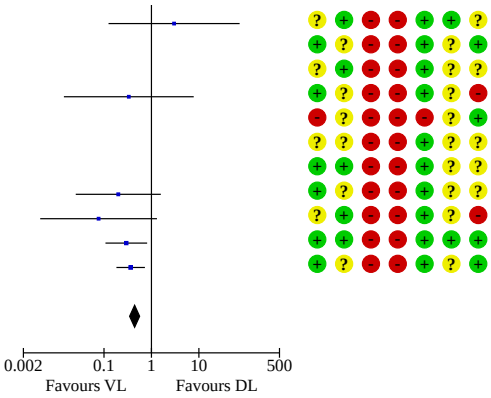
Analysis 4.1. (Continued)

Walker 2009	1	60	0	60	0.5%	3.00 [0.12 , 72.20]
Wallace 2015	0	52	0	53		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Wasinwong 2017	0	23	1	23	0.6%	0.33 [0.01 , 7.78]
Woo 2012	0	50	0	109		Not estimable
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yoo 2018	1	22	5	22	1.2%	0.20 [0.03 , 1.58]
Yousef 2012	0	30	6	30	0.7%	0.08 [0.00 , 1.31]
Yumul 2016	6	90	7	31	3.4%	0.30 [0.11 , 0.81]
Zhao 2014	9	74	25	75	4.9%	0.36 [0.18 , 0.73]
Total (95% CI)		**8800**		**7428**	**100.0%**	**0.44 [0.35 , 0.56]**
Total events:	221		375			



Heterogeneity: Tau² = 0.19; Chi² = 97.56, df = 76 (P = 0.05); I² = 22%
Test for overall effect: Z = 6.60 (P < 0.00001)
Test for subgroup differences: Not applicable

Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(3) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(4) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(5) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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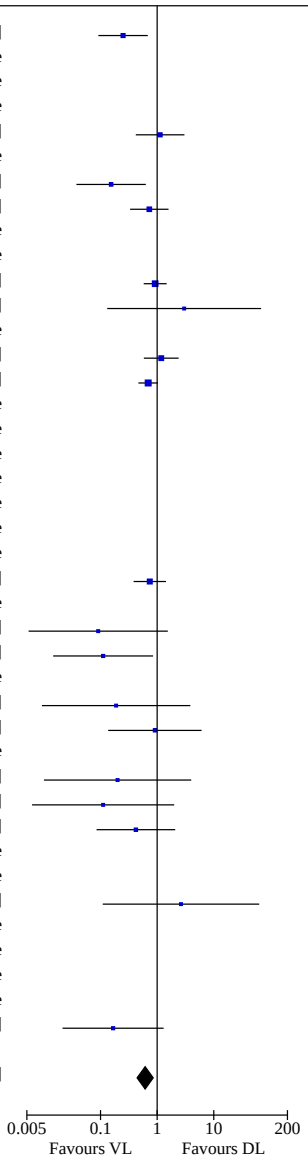
Analysis 4.2. Comparison 4: VL versus DL (all devices combined), Outcome 2: Hypoxia

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Abdelgalel 2018 (1)	5	80	10	40	7.1%	0.25 [0.09 , 0.68]		+	+	-	-	+	?	+
Akbar 2015	0	45	0	45		Not estimable		+	?	-	-	+	?	+
Ali 2017	0	30	0	30		Not estimable		+	+	-	-	+	?	+
Andersen 2011	0	50	0	50		Not estimable		+	+	-	-	+	+	+
Aziz 2012	8	149	7	147	7.3%	1.13 [0.42 , 3.03]		+	+	-	-	+	+	-
Barak 2007	0	80	0	90		Not estimable		?	?	-	-	+	?	-
Bensghir 2010	2	34	13	34	4.3%	0.15 [0.04 , 0.63]		+	+	-	-	+	?	-
Bensghir 2013	8	35	11	35	9.7%	0.73 [0.33 , 1.59]		+	?	-	-	+	?	+
Bhat 2015	0	50	0	50		Not estimable		+	?	-	-	+	?	?
Castillo-Monzon 2017	0	23	0	23		Not estimable		+	?	-	-	+	?	+
Driver 2016 (2)	26	103	26	95	15.1%	0.92 [0.58 , 1.47]		+	+	-	-	?	?	?
Erden 2010	1	16	0	16	1.0%	3.00 [0.13 , 68.57]		+	-	-	-	+	?	?
Erdivanli 2018	0	388	0	388		Not estimable		+	?	-	-	+	?	?
Gao 2018 (1)	14	81	12	82	10.8%	1.18 [0.58 , 2.40]		?	?	-	-	+	?	?
Goksu 2016 (3)	25	75	36	75	16.5%	0.69 [0.47 , 1.03]		?	+	-	-	+	?	-
Gunes 2020	0	90	0	90		Not estimable		?	+	-	-	+	?	?
Gupta 2013	0	60	0	60		Not estimable		+	?	-	-	+	?	+
Gupta 2020	0	40	0	40		Not estimable		+	+	-	-	+	?	+
Inal 2016	0	50	0	50		Not estimable		?	?	-	-	+	?	+
Ing 2017	0	11	0	16		Not estimable		+	+	-	-	?	+	?
Kido 2015	0	25	0	25		Not estimable		?	+	-	-	+	+	?
Komatsu 2010	0	50	0	50		Not estimable		+	+	-	-	+	?	?
Lascarrou 2017	14	173	19	174	11.6%	0.74 [0.38 , 1.43]		+	+	-	-	+	+	-
Lin 2012	0	83	0	82		Not estimable		+	+	-	-	+	?	+
Maharaj 2008 (4)	0	20	5	20	1.3%	0.09 [0.01 , 1.54]		?	+	-	-	+	?	+
Ndoko 2008 (5)	1	53	9	53	2.3%	0.11 [0.01 , 0.85]		?	+	-	-	+	?	?
Park 2010	0	37	0	37		Not estimable		+	-	-	-	+	?	+
Ranieri 2012	0	68	2	64	1.1%	0.19 [0.01 , 3.85]		?	+	-	-	+	?	+
Risse 2020	2	34	2	31	2.6%	0.91 [0.14 , 6.09]		?	+	-	-	+	?	?
Serocki 2010	0	80	0	40		Not estimable		?	+	-	-	+	?	+
Shah 2016	0	30	2	30	1.1%	0.20 [0.01 , 4.00]		+	+	-	-	+	?	?
Shukla 2017	0	40	4	40	1.2%	0.11 [0.01 , 2.00]		+	?	-	-	+	?	?
Silverberg 2015 (1)	2	57	5	60	3.5%	0.42 [0.09 , 2.08]		-	-	-	-	+	+	?
Tempe 2016 (6)	0	39	0	19		Not estimable		+	+	-	-	+	+	+
Teoh 2010	0	300	0	100		Not estimable		+	+	-	-	+	?	+
Thion 2018	1	65	0	57	1.0%	2.64 [0.11 , 63.47]		+	?	-	-	-	-	?
Tsan 2020	0	69	0	69		Not estimable		+	+	-	-	+	+	+
Vijayakumar 2016	0	45	0	45		Not estimable		+	?	-	-	+	?	+
Walker 2009	0	60	0	60		Not estimable		?	+	-	-	+	+	?
Yoo 2018	0	22	0	22		Not estimable		+	?	-	-	+	?	?
Yousef 2012 (7)	1	30	6	30	2.3%	0.17 [0.02 , 1.30]		?	+	-	-	+	?	-
Total (95% CI)		**2870**		**2564**	**100.0%**	**0.61 [0.44 , 0.85]**								
Total events:	110		169											

Heterogeneity: Tau² = 0.13; Chi² = 25.64, df = 17 (P = 0.08); I² = 34%
Test for overall effect: Z = 2.92 (P = 0.003)
Test for subgroup differences: Not applicable



Footnotes
(1) ICU population
(2) ED intubation
(3) ED intubations.
(4) Difficult airways.
(5) Morbidly obese population.
(6) Multi-arm study. Data combined for each VL group.
(7) Morbidly obese population

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)

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Analysis 4.2. (Continued)

(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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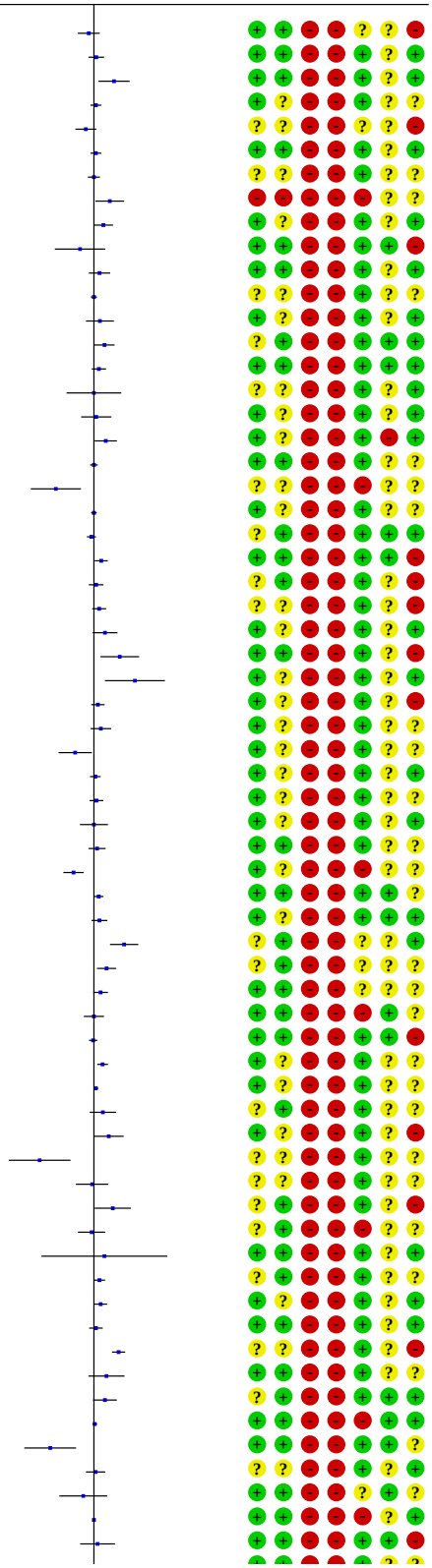
Analysis 4.3. Comparison 4: VL versus DL (all devices combined), Outcome 3: Successful first attempt

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI	A	B	C	D	E	F	G
Abdallah 2011	43	50	45	49	0.7%	0.94 [0.81 , 1.08]	+	+	-	-	?	?	-
Abdallah 2019	34	35	33	35	0.9%	1.03 [0.93 , 1.14]	+	+	-	-	+	?	+
Abdelgalel 2018	75	80	29	40	0.5%	1.29 [1.06 , 1.58]	+	+	-	-	+	?	+
Abdelgawad 2015	40	40	39	40	1.0%	1.03 [0.96 , 1.10]	+	?	-	-	+	?	?
Acarel 2018	27	30	30	30	0.8%	0.90 [0.79 , 1.03]	?	?	-	-	?	?	-
Agrawal 2020	40	40	39	40	1.0%	1.03 [0.96 , 1.10]	+	+	-	-	+	?	+
Ahmad 2015	25	25	25	25	1.0%	1.00 [0.93 , 1.08]	?	?	-	-	+	?	?
Ahmadi 2015	45	49	36	48	0.6%	1.22 [1.02 , 1.47]	-	-	-	-	-	?	?
Akbar 2015	44	45	39	45	0.8%	1.13 [1.00 , 1.28]	+	?	-	-	+	?	+
Al-Ghamdi 2016	39	64	16	22	0.3%	0.84 [0.61 , 1.16]	+	+	-	-	+	+	-
Ali 2017	29	30	27	30	0.7%	1.07 [0.94 , 1.23]	+	+	-	-	+	?	+
Altaiee 2020	50	50	50	50	1.1%	1.00 [0.96 , 1.04]	?	?	-	-	+	?	?
Altun 2018 (1)	70	82	34	43	0.6%	1.08 [0.90 , 1.29]	+	?	-	-	+	?	+
Ander 2017	39	39	34	39	0.8%	1.14 [1.01 , 1.30]	?	+	-	-	+	+	+
Andersen 2011	49	50	46	50	0.9%	1.07 [0.97 , 1.17]	+	+	-	-	+	+	+
Aoi 2010	14	18	14	18	0.2%	1.00 [0.71 , 1.42]	?	?	-	-	+	?	+
Aqil 2016	34	40	33	40	0.5%	1.03 [0.85 , 1.25]	+	?	-	-	+	?	+
Aqil 2017	64	70	55	70	0.7%	1.16 [1.01 , 1.34]	+	?	-	-	+	-	+
Arici 2014	40	40	40	40	1.1%	1.00 [0.95 , 1.05]	+	+	-	-	+	?	?
Arima 2014	26	56	40	53	0.3%	0.62 [0.45 , 0.85]	?	?	-	-	-	?	?
Arora 2013	54	54	54	54	1.1%	1.00 [0.96 , 1.04]	+	?	-	-	+	?	?
Arslan 2017 (1)	77	80	40	40	1.1%	0.97 [0.91 , 1.03]	?	+	-	-	+	+	+
Aziz 2012	138	149	124	147	1.0%	1.10 [1.01 , 1.19]	+	+	-	-	+	+	-
Bakshi 2019	36	37	35	37	0.9%	1.03 [0.94 , 1.13]	?	+	-	-	+	?	-
Barak 2007	76	80	80	90	1.0%	1.07 [0.98 , 1.17]	?	?	-	-	+	?	-
Bashir 2020	38	40	33	40	0.7%	1.15 [0.98 , 1.35]	+	?	-	-	+	?	+
Bensghir 2010	32	34	23	34	0.4%	1.39 [1.09 , 1.78]	+	+	-	-	+	?	-
Bensghir 2013	54	70	16	35	0.2%	1.69 [1.15 , 2.47]	+	?	-	-	+	?	+
Bhandari 2013	40	40	38	40	1.0%	1.05 [0.97 , 1.15]	+	?	-	-	+	?	-
Bhat 2015	47	50	43	50	0.8%	1.09 [0.96 , 1.25]	+	?	-	-	+	?	?
Bilehjani 2009	29	40	35	38	0.5%	0.79 [0.64 , 0.97]	+	?	-	-	+	?	?
Blajic 2019	115	119	56	59	1.0%	1.02 [0.95 , 1.09]	+	?	-	-	+	?	+
Cakir 2020	31	31	30	31	1.0%	1.03 [0.95 , 1.13]	+	?	-	-	+	?	?
Castillo-Monzon 2017	21	23	21	23	0.6%	1.00 [0.84 , 1.20]	+	?	-	-	+	?	+
Cattano 2013	25	25	24	25	0.9%	1.04 [0.93 , 1.16]	+	+	-	-	+	?	?
Cavus 2011 (1)	74	100	48	50	0.8%	0.77 [0.68 , 0.88]	+	?	-	-	-	?	?
Chen 2019	205	219	191	217	1.1%	1.06 [1.00 , 1.13]	+	+	-	-	+	+	?
Colak 2019	44	45	41	45	0.9%	1.07 [0.97 , 1.19]	+	?	-	-	+	+	+
Dey 2020	91	108	63	110	0.6%	1.47 [1.23 , 1.76]	?	+	-	-	?	?	+
Dharanindra 2020	67	70	57	70	0.8%	1.18 [1.04 , 1.33]	?	+	-	-	?	?	?
Driver 2016	86	92	91	106	0.9%	1.09 [0.99 , 1.20]	+	+	-	-	?	?	?
El-Tahan 2017a	14	14	15	15	0.8%	1.00 [0.88 , 1.14]	+	+	-	-	-	+	?
El-Tahan 2017b	99	101	32	32	1.1%	0.99 [0.94 , 1.04]	+	+	-	-	+	+	-
Enomoto 2008	99	99	93	104	1.0%	1.12 [1.04 , 1.20]	+	?	-	-	+	?	?
Erdivanli 2018	375	388	366	388	1.2%	1.02 [0.99 , 1.06]	+	?	-	-	+	?	?
Erturk 2015	37	40	33	40	0.6%	1.12 [0.95 , 1.33]	?	+	-	-	+	?	?
Ferrando 2011	29	30	24	30	0.6%	1.21 [1.00 , 1.46]	+	?	-	-	+	?	-
Frohlich 2011	14	30	28	30	0.2%	0.50 [0.34 , 0.74]	?	?	-	-	+	?	?
Gao 2018	55	81	57	82	0.5%	0.98 [0.79 , 1.20]	?	?	-	-	+	?	?
Goksu 2016	56	75	44	75	0.4%	1.27 [1.01 , 1.60]	?	+	-	-	+	?	-
Golboyu 2016	34	40	35	40	0.6%	0.97 [0.82 , 1.16]	?	+	-	-	-	?	?
Griesdale 2012a	8	20	7	20	0.1%	1.14 [0.51 , 2.55]	+	+	-	-	+	?	+
Gunes 2020	88	90	82	90	1.0%	1.07 [1.00 , 1.15]	?	+	-	-	+	?	?
Gupta 2013 (1)	60	60	55	60	1.0%	1.09 [1.00 , 1.18]	+	?	-	-	+	?	+
Gupta 2020	39	40	38	40	1.0%	1.03 [0.94 , 1.12]	+	+	-	-	+	?	+
Hirabayashi 2009 (2)	253	264	179	256	1.0%	1.37 [1.26 , 1.49]	?	?	-	-	+	?	-
Hosalli 2017	27	30	23	30	0.4%	1.17 [0.93 , 1.48]	+	+	-	-	+	?	?
Hsu 2012	30	30	26	30	0.7%	1.15 [0.99 , 1.34]	?	+	-	-	+	+	+
Hu 2017	100	100	95	96	1.2%	1.01 [0.98 , 1.04]	+	+	-	-	-	+	+
Huang 2020 (1)	27	59	24	30	0.3%	0.57 [0.41 , 0.80]	+	+	-	-	+	+	?
Inal 2016	46	50	45	50	0.8%	1.02 [0.90 , 1.16]	?	?	-	-	+	?	+
Ing 2017	9	11	15	16	0.3%	0.87 [0.64 , 1.19]	+	+	-	-	?	+	?
Jafra 2018	100	100	100	100	1.2%	1.00 [0.98 , 1.02]	+	+	-	-	-	?	+
Janz 2016	51	74	50	76	0.5%	1.05 [0.84 , 1.31]	+	+	-	-	+	+	-
Kapadia 2021	51	55	50	55	0.9%	1.02 [0.91 , 1.14]	+	+	-	-	+	?	?



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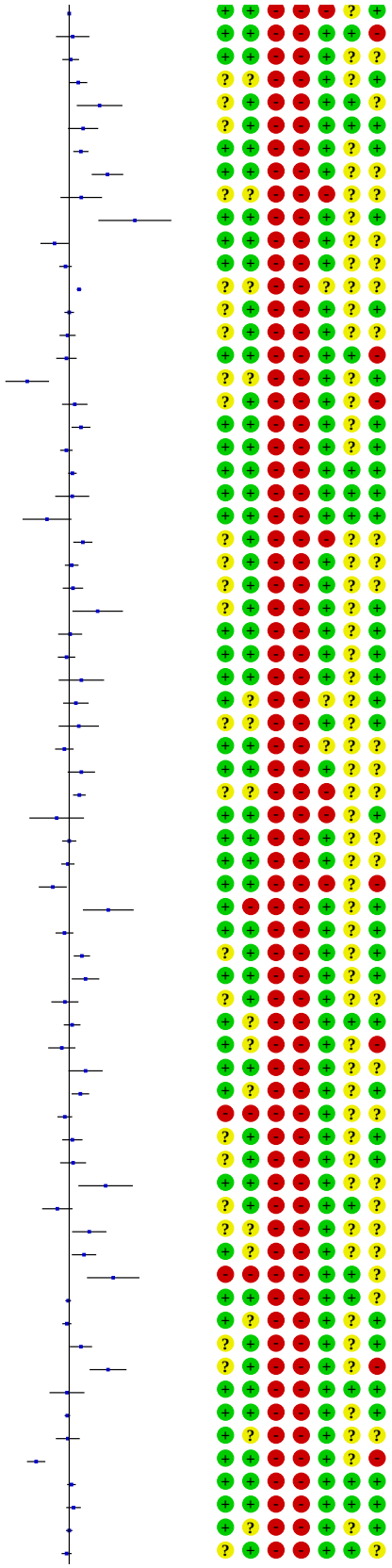
Analysis 4.3. (Continued)

Jafra 2018	100	100	100	100	1.2%	1.00 [0.98 , 1.02]
Janz 2016	51	74	50	76	0.5%	1.05 [0.84 , 1.31]
Kapadia 2021	51	55	50	55	0.9%	1.02 [0.91 , 1.14]
Kaur 2020	79	80	35	40	0.8%	1.13 [1.00 , 1.27]
Kido 2015	24	25	16	25	0.3%	1.50 [1.11 , 2.03]
Kim 2013	22	22	19	23	0.5%	1.20 [0.98 , 1.47]
Kim 2018	104	110	89	110	0.9%	1.17 [1.06 , 1.29]
Kleine-Brueggeney 2017	265	360	53	120	0.5%	1.67 [1.35 , 2.06]
Koennecke 2014 (1)	65	83	20	30	0.3%	1.17 [0.89 , 1.55]
Koh 2010	24	25	10	25	0.1%	2.40 [1.48 , 3.90]
Komatsu 2010	37	50	45	50	0.6%	0.82 [0.68 , 0.99]
Kreutziger 2019	211	267	205	247	1.0%	0.95 [0.88 , 1.04]
Kriege 2020	1019	1084	896	1087	1.2%	1.14 [1.11 , 1.18]
Kucukosman 2020	30	30	30	30	1.1%	1.00 [0.94 , 1.07]
Kurnaz 2016	46	50	47	50	0.9%	0.98 [0.88 , 1.09]
Lascarrou 2017	126	186	130	185	0.7%	0.96 [0.84 , 1.10]
Lee 2012	36	75	21	25	0.3%	0.57 [0.43 , 0.76]
Lim 2005	28	30	26	30	0.6%	1.08 [0.91 , 1.28]
Lin 2012	77	83	65	82	0.8%	1.17 [1.03 , 1.33]
Liu 2016	80	88	84	89	1.0%	0.96 [0.89 , 1.05]
Liu 2019	172	181	163	179	1.1%	1.04 [0.99 , 1.10]
Loughnan 2019	17	20	40	49	0.5%	1.04 [0.83 , 1.31]
Loughnan 2019	17	28	40	49	0.3%	0.74 [0.54 , 1.03]
Macke 2020	72	76	60	76	0.8%	1.20 [1.06 , 1.36]
Maharaj 2006	30	30	29	30	0.9%	1.03 [0.94 , 1.13]
Maharaj 2007	20	20	19	20	0.8%	1.05 [0.92 , 1.20]
Maharaj 2008	19	20	13	20	0.3%	1.46 [1.04 , 2.05]
Malik 2008 (1)	79	90	26	30	0.7%	1.01 [0.86 , 1.19]
Malik 2009a	28	30	29	30	0.8%	0.97 [0.86 , 1.08]
Malik 2009b	40	50	17	25	0.3%	1.18 [0.87 , 1.59]
Marco 2011	47	54	43	54	0.6%	1.09 [0.92 , 1.30]
Masoumifar 2020	25	30	22	30	0.4%	1.14 [0.87 , 1.49]
Mathew 2018	30	33	32	33	0.8%	0.94 [0.83 , 1.06]
McElwain 2011	55	58	25	31	0.6%	1.18 [0.98 , 1.41]
Nakayama 2010	160	160	70	80	1.0%	1.15 [1.05 , 1.25]
Nandakumar 2018	11	15	13	15	0.2%	0.85 [0.59 , 1.22]
Paik 2020	20	20	20	20	0.9%	1.00 [0.91 , 1.10]
Pappu 2020	57	60	29	30	1.0%	0.98 [0.90 , 1.07]
Parasa 2016	24	30	30	30	0.6%	0.80 [0.67 , 0.97]
Park 2010	32	37	19	37	0.3%	1.68 [1.20 , 2.36]
Pournajafian 2014	46	52	49	52	0.8%	0.94 [0.83 , 1.06]
Ranieri 2012	68	68	54	64	0.9%	1.18 [1.06 , 1.32]
Reena 2019	46	50	37	50	0.6%	1.24 [1.03 , 1.49]
Risse 2020	29	34	28	31	0.6%	0.94 [0.79 , 1.13]
Ruetzler 2020	61	66	56	63	0.9%	1.04 [0.93 , 1.16]
Russell 2013	29	35	32	35	0.6%	0.91 [0.76 , 1.09]
Sanguanwit 2021	57	78	47	80	0.4%	1.24 [0.99 , 1.56]
Sargin 2016	50	50	43	50	0.8%	1.16 [1.03 , 1.31]
Sarkilar 2015	50	55	53	55	0.9%	0.94 [0.86 , 1.04]
Serocki 2010	73	80	35	40	0.8%	1.04 [0.91 , 1.19]
Serocki 2013 (1)	56	63	27	32	0.6%	1.05 [0.89 , 1.25]
Shah 2016	26	30	16	30	0.2%	1.63 [1.13 , 2.34]
Shimazaki 2018	17	20	20	20	0.5%	0.85 [0.70 , 1.05]
Shippey 2013	24	24	19	25	0.4%	1.31 [1.04 , 1.64]
Shukla 2017	39	40	32	40	0.6%	1.22 [1.04 , 1.43]
Silverberg 2015	41	57	24	60	0.2%	1.80 [1.27 , 2.55]
Sulser 2016	73	74	73	73	1.1%	0.99 [0.95 , 1.02]
Sun 2005	94	100	97	100	1.1%	0.97 [0.91 , 1.03]
Takenaka 2011	35	35	29	34	0.7%	1.17 [1.01 , 1.36]
Taylor 2013	44	44	26	44	0.4%	1.68 [1.31 , 2.15]
Tempe 2016	33	40	17	20	0.4%	0.97 [0.77 , 1.23]
Teoh 2010	287	300	98	100	1.1%	0.98 [0.94 , 1.01]
Tosh 2018	53	65	54	65	0.7%	0.98 [0.84 , 1.15]
Trimmel 2016 (3)	104	168	152	158	0.8%	0.64 [0.57 , 0.73]
Tsan 2020	68	69	66	69	1.1%	1.03 [0.97 , 1.09]
Varsha 2019	35	35	33	35	0.9%	1.06 [0.96 , 1.17]
Vijayakumar 2016	45	45	45	45	1.1%	1.00 [0.96 , 1.04]
Walker 2009	57	60	59	60	1.0%	0.97 [0.90 , 1.03]



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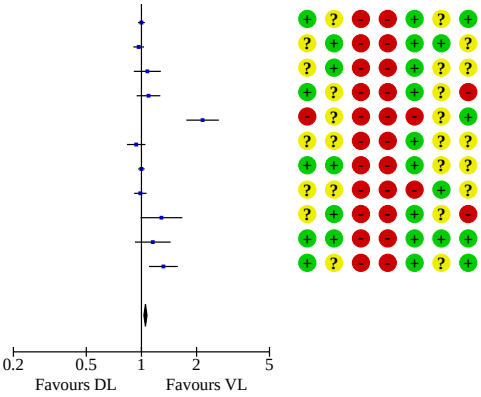
Analysis 4.3. (Continued)

Vijayakumar 2016	45	45	45	45	1.1%	1.00 [0.96 , 1.04]
Walker 2009	57	60	59	60	1.0%	0.97 [0.90 , 1.03]
Wasem 2013	28	30	26	30	0.6%	1.08 [0.91 , 1.28]
Wasinwong 2017	23	23	21	23	0.7%	1.09 [0.94 , 1.27]
Woo 2012	50	50	50	109	0.5%	2.16 [1.76 , 2.65]
Xue 2007	28	30	27	27	0.8%	0.94 [0.83 , 1.05]
Yao 2015	48	48	48	48	1.1%	1.00 [0.96 , 1.04]
Yeatts 2013	242	303	259	320	1.0%	0.99 [0.91 , 1.07]
Yousef 2012	27	30	21	30	0.4%	1.29 [0.99 , 1.67]
Yumul 2016	77	90	23	31	0.5%	1.15 [0.92 , 1.44]
Zhao 2014	65	74	50	75	0.6%	1.32 [1.10 , 1.58]
Total (95% CI)		**10525**		**9272**	**100.0%**	**1.05 [1.03 , 1.07]**
Total events:	9364		7739			



Heterogeneity: Tau² = 0.01; Chi² = 736.62, df = 138 (P < 0.00001); I² = 81%
Test for overall effect: Z = 5.13 (P < 0.00001)
Test for subgroup differences: Not applicable

Footnotes
(1) Multi-arm study. Data combined for each VL group.
(2) Novice intubators.
(3) Prehospital study.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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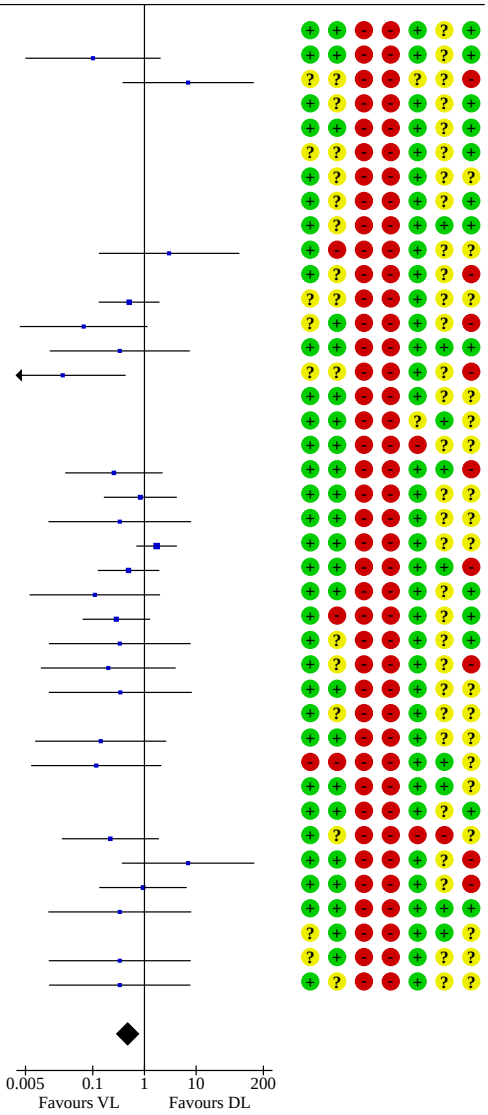
Analysis 4.4. Comparison 4: VL versus DL (all devices combined), Outcome 4: Oesophageal intubation

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
Abdallah 2019	0	35	0	35		Not estimable
Abdelgalel 2018	0	80	2	40	2.4%	0.10 [0.00 , 2.06]
Acarel 2018	3	30	0	30	2.5%	7.00 [0.38 , 129.93]
Akbar 2015	0	45	0	45		Not estimable
Ali 2017	0	30	0	30		Not estimable
Aoi 2010	0	17	0	17		Not estimable
Bhat 2015	0	50	0	50		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Colak 2019	0	45	0	45		Not estimable
Erden 2010	1	16	0	16	2.2%	3.00 [0.13 , 68.57]
Ferrando 2011	0	60	0	60		Not estimable
Gao 2018	3	81	6	82	8.8%	0.51 [0.13 , 1.96]
Goksu 2016	0	75	7	75	2.6%	0.07 [0.00 , 1.15]
Hindman 2014	0	14	1	14	2.2%	0.33 [0.01 , 7.55]
Hirabayashi 2009	0	264	18	256	2.7%	0.03 [0.00 , 0.43]
Inangil 2018	0	35	0	35		Not estimable
Ing 2017	0	11	0	16		Not estimable
Ithnin 2009	0	30	0	30		Not estimable
Janz 2016	1	74	4	76	4.3%	0.26 [0.03 , 2.24]
Kleine-Brueggeney 2017	5	360	2	120	6.8%	0.83 [0.16 , 4.24]
Komatsu 2010	0	50	1	50	2.2%	0.33 [0.01 , 7.99]
Kreutziger 2019	13	267	7	247	14.2%	1.72 [0.70 , 4.24]
Lascarrou 2017	3	184	6	181	8.7%	0.49 [0.12 , 1.94]
Lin 2012	0	83	4	82	2.5%	0.11 [0.01 , 2.01]
Park 2010	2	37	7	37	7.6%	0.29 [0.06 , 1.29]
Russell 2012	0	23	1	23	2.2%	0.33 [0.01 , 7.78]
Russell 2013	0	35	2	35	2.4%	0.20 [0.01 , 4.02]
Sanguanwit 2021	0	78	1	80	2.2%	0.34 [0.01 , 8.26]
Saracoglu 2014	0	30	0	30		Not estimable
Shah 2016	0	30	3	30	2.5%	0.14 [0.01 , 2.65]
Silverberg 2015	0	57	4	60	2.6%	0.12 [0.01 , 2.12]
Sulser 2016	0	74	0	73		Not estimable
Teoh 2010	0	300	0	100		Not estimable
Thion 2018	1	65	4	57	4.3%	0.22 [0.03 , 1.91]
Trimmel 2011	3	106	0	106	2.5%	7.00 [0.37 , 133.88]
Trimmel 2016	2	168	2	158	5.1%	0.94 [0.13 , 6.60]
Tsan 2020	0	69	1	69	2.2%	0.33 [0.01 , 8.04]
Walker 2009	0	60	0	60		Not estimable
Wasem 2013	0	30	1	30	2.2%	0.33 [0.01 , 7.87]
Yoo 2018	0	22	1	22	2.2%	0.33 [0.01 , 7.76]
Total (95% CI)		**3143**		**2625**	**100.0%**	**0.47 [0.29 , 0.77]**
Total events:	37		85			

Heterogeneity: Tau² = 0.22; Chi² = 28.44, df = 24 (P = 0.24); I² = 16%
Test for overall effect: Z = 3.01 (P = 0.003)
Test for subgroup differences: Not applicable



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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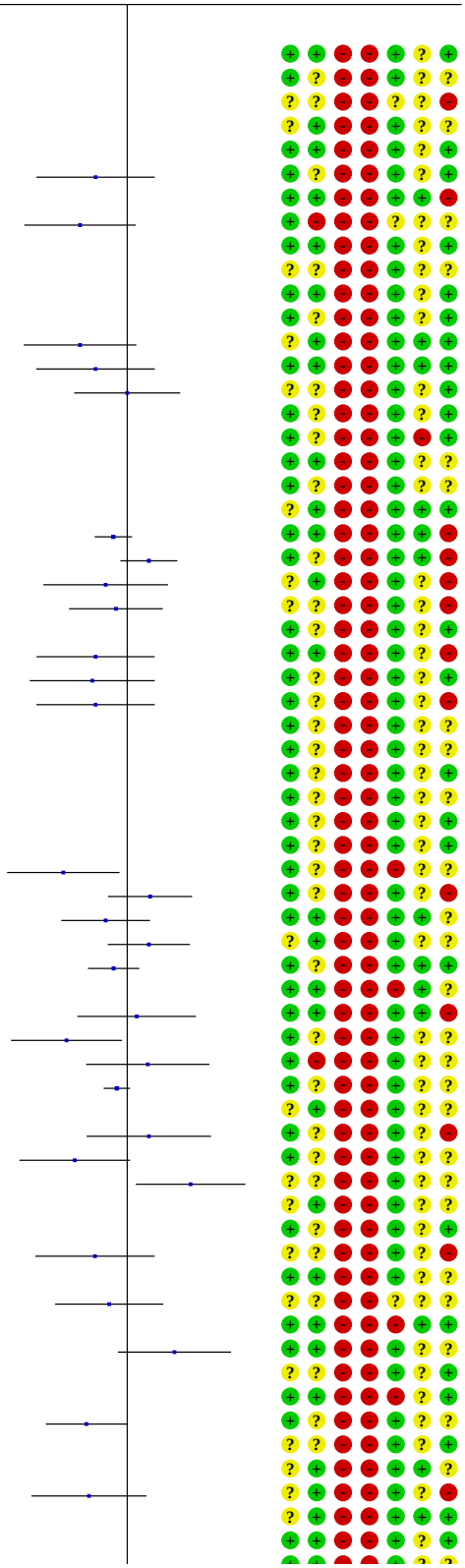
Analysis 4.5. Comparison 4: VL versus DL (all devices combined), Outcome 5: Subgroup analysis of failed intubation: theatre versus non-theatre

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
4.5.1 Theatre						
Abdallah 2019	0	35	0	35		Not estimable
Abdelgawad 2015	0	40	0	40		Not estimable
Acarel 2018	0	30	0	30		Not estimable
Aggarwal 2019	0	50	0	50		Not estimable
Agrawal 2020	0	40	0	40		Not estimable
Akbar 2015	0	45	2	45	0.6%	0.20 [0.01 , 4.05]
Al-Ghamdi 2016	0	65	0	22		Not estimable
Aleksandrowicz 2018	0	20	5	20	0.7%	0.09 [0.01 , 1.54]
Ali 2017	0	30	0	30		Not estimable
Altaiee 2020	0	50	0	50		Not estimable
Amor 2013	0	60	0	60		Not estimable
Anandraja 2021	0	30	0	30		Not estimable
Ander 2017	0	39	5	39	0.7%	0.09 [0.01 , 1.59]
Andersen 2011	0	50	2	50	0.6%	0.20 [0.01 , 4.06]
Aoi 2010	1	18	1	18	0.8%	1.00 [0.07 , 14.79]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (1)	0	54	0	54		Not estimable
Arslan 2017 (2)	0	80	0	40		Not estimable
Aziz 2012	6	149	12	147	3.1%	0.49 [0.19 , 1.28]
Bakshi 2015 (3)	12	84	2	42	2.0%	3.00 [0.70 , 12.79]
Bakshi 2019	0	37	1	37	0.6%	0.33 [0.01 , 7.93]
Barak 2007	1	80	2	90	0.9%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bensghir 2010	0	34	2	34	0.6%	0.20 [0.01 , 4.02]
Bensghir 2013	0	70	1	35	0.6%	0.17 [0.01 , 4.05]
Bhandari 2013	0	40	2	40	0.6%	0.20 [0.01 , 4.04]
Bhat 2015	0	50	0	50		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Blajic 2019	0	119	0	59		Not estimable
Cakir 2020	0	31	0	31		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Cavus 2011 (2)	0	100	6	50	0.7%	0.04 [0.00 , 0.68]
Chalkeidis 2010	4	35	1	28	1.1%	3.20 [0.38 , 27.04]
Chen 2019	1	220	3	220	1.0%	0.33 [0.03 , 3.18]
Colak 2015	6	100	1	50	1.2%	3.00 [0.37 , 24.25]
Cordovani 2019	3	24	5	20	2.2%	0.50 [0.14 , 1.84]
El-Tahan 2017a	0	14	0	15		Not estimable
El-Tahan 2017b	2	101	0	32	0.6%	1.62 [0.08 , 32.85]
Enomoto 2008	0	99	11	104	0.7%	0.05 [0.00 , 0.76]
Erden 2010	1	17	0	16	0.6%	2.83 [0.12 , 64.89]
Erdivanli 2018	13	388	22	388	4.0%	0.59 [0.30 , 1.16]
Erturk 2015	0	40	0	40		Not estimable
Ferrando 2011	1	30	0	30	0.6%	3.00 [0.13 , 70.83]
Foulds 2016b	0	24	7	25	0.7%	0.07 [0.00 , 1.15]
Frohlich 2011	12	30	0	30	0.7%	25.00 [1.55 , 403.99]
Gunes 2020	0	90	0	90		Not estimable
Gupta 2013	0	60	0	60		Not estimable
Hirabayashi 2009	0	264	2	256	0.6%	0.19 [0.01 , 4.02]
Hosalli 2017	0	30	0	30		Not estimable
Hostic 2016	1	100	1	40	0.7%	0.40 [0.03 , 6.24]
Hu 2017 (4)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	0.7%	11.00 [0.62 , 194.90]
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Jungbauer 2009	1	100	8	100	1.2%	0.13 [0.02 , 0.98]
Kaur 2020	0	80	0	40		Not estimable
Kido 2015	0	25	0	25		Not estimable
Kill 2013	0	30	3	30	0.7%	0.14 [0.01 , 2.65]
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Kleine-Brueggeney 2017 (2)	64	360	52	120	5.2%	0.41 [0.30 , 0.55]



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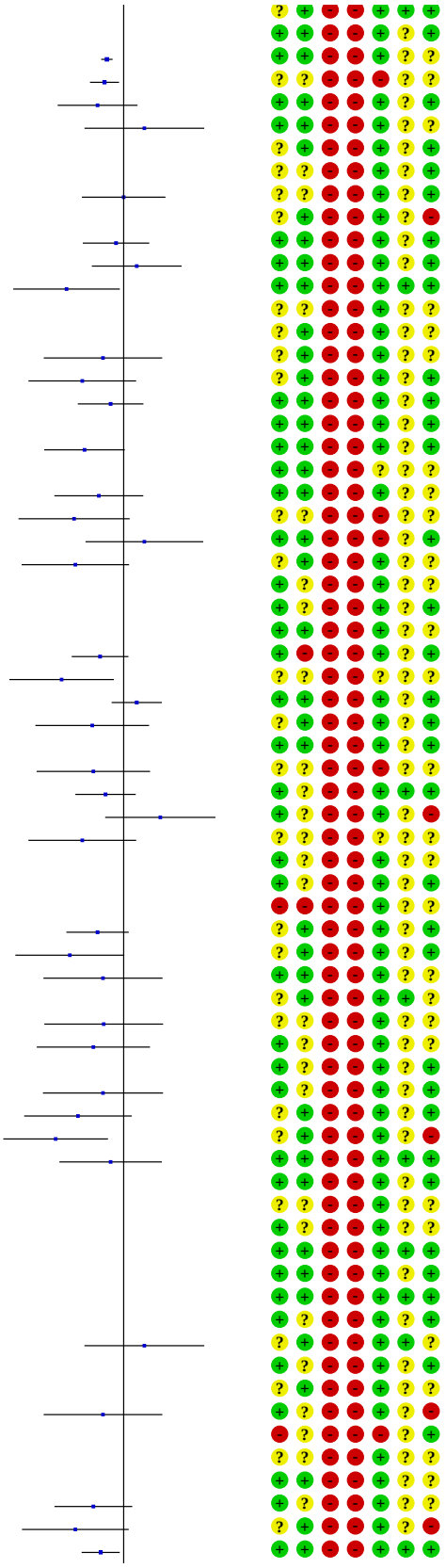
Analysis 4.5. (Continued)

Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Kleine-Brueggeney 2017 (2)	64	360	52	120	5.2%	0.41 [0.30 , 0.55]
Koennecke 2014 (2)	10	83	10	30	3.7%	0.36 [0.17 , 0.78]
Koh 2010	1	25	4	25	1.1%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	0.6%	3.00 [0.13 , 71.92]
Kucukosman 2020	0	30	0	30		Not estimable
Lee 2009	0	41	0	44		Not estimable
Lee 2012 (2)	3	75	1	25	1.0%	1.00 [0.11 , 9.18]
Lim 2005	0	30	0	30		Not estimable
Lin 2012	2	85	3	85	1.5%	0.67 [0.11 , 3.89]
Liu 2016	2	90	1	90	0.9%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	0.7%	0.05 [0.00 , 0.82]
Maassen 2012	0	40	0	40		Not estimable
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	0.6%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	0.7%	0.11 [0.01 , 1.94]
Malik 2008 (2)	3	90	2	30	1.5%	0.50 [0.09 , 2.85]
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	1	50	4	25	1.1%	0.13 [0.01 , 1.06]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	0.9%	0.27 [0.03 , 2.83]
Nakayama 2010	0	160	3	80	0.6%	0.07 [0.00 , 1.37]
Nandakumar 2018	1	15	0	15	0.6%	3.00 [0.13 , 68.26]
Ndoko 2008	0	53	6	53	0.7%	0.08 [0.00 , 1.33]
Ninan 2016	0	30	0	30		Not estimable
Nishikawa 2009	0	20	0	20		Not estimable
Paik 2020	0	20	0	20		Not estimable
Park 2010	2	37	7	37	1.9%	0.29 [0.06 , 1.29]
Peck 2009	0	27	13	27	0.7%	0.04 [0.00 , 0.59]
Pournajafian 2014	6	52	3	52	2.2%	2.00 [0.53 , 7.57]
Ranieri 2012	0	68	2	64	0.6%	0.19 [0.01 , 3.85]
Reena 2019	0	50	0	50		Not estimable
Rovsing 2010	0	50	2	50	0.6%	0.20 [0.01 , 4.06]
Ruetzler 2020	2	66	5	63	1.7%	0.38 [0.08 , 1.90]
Russell 2013	3	35	0	35	0.7%	7.00 [0.37 , 130.69]
Sansone 2012	0	21	4	21	0.7%	0.11 [0.01 , 1.94]
Saracoglu 2014	0	30	0	30		Not estimable
Sargin 2016	0	50	0	50		Not estimable
Sarkilar 2015	0	55	0	55		Not estimable
Serocki 2010	2	80	4	40	1.6%	0.25 [0.05 , 1.31]
Serocki 2013 (2)	0	63	4	32	0.7%	0.06 [0.00 , 1.03]
Shah 2016 (5)	0	30	1	30	0.6%	0.33 [0.01 , 7.87]
Shimazaki 2018	0	20	0	20		Not estimable
Shippey 2013	0	24	1	25	0.6%	0.35 [0.01 , 8.12]
Shukla 2017	0	40	2	40	0.6%	0.20 [0.01 , 4.04]
Siddiqui 2009	0	20	0	20		Not estimable
Sun 2005	0	100	1	100	0.6%	0.33 [0.01 , 8.09]
Takenaka 2011	0	35	5	34	0.7%	0.09 [0.01 , 1.54]
Taylor 2013	0	44	18	44	0.7%	0.03 [0.00 , 0.43]
Tempe 2016	1	40	1	20	0.7%	0.50 [0.03 , 7.59]
Teoh 2010	0	300	0	100		Not estimable
Tolon 2012	0	20	0	20		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Walker 2009	1	60	0	60	0.6%	3.00 [0.12 , 72.20]
Wallace 2015	0	52	0	53		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Wasinwong 2017	0	23	1	23	0.6%	0.33 [0.01 , 7.78]
Woo 2012	0	50	0	109		Not estimable
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yoo 2018	1	22	5	22	1.2%	0.20 [0.03 , 1.58]
Yousef 2012	0	30	6	30	0.7%	0.08 [0.00 , 1.31]
Yumul 2016	6	90	7	31	2.9%	0.30 [0.11 , 0.81]



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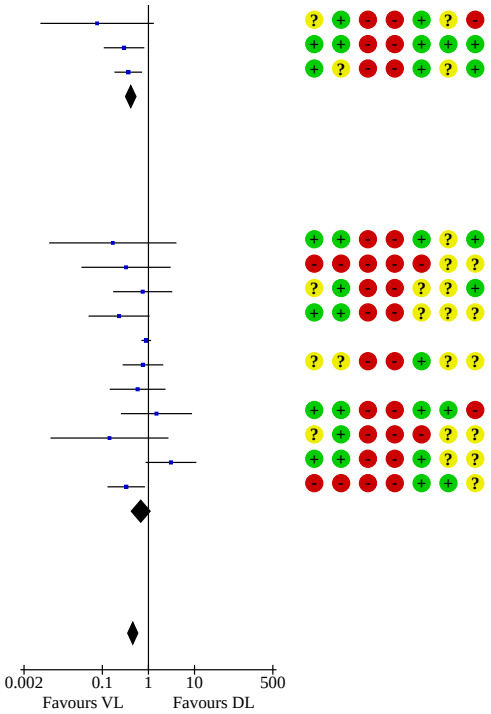
Analysis 4.5. (Continued)

Yousef 2012	0	30	6	30	0.7%	0.08 [0.00 , 1.31]
Yumul 2016	6	90	7	31	2.9%	0.30 [0.11 , 0.81]
Zhao 2014	9	74	25	75	3.9%	0.36 [0.18 , 0.73]
Subtotal (95% CI)		**7966**		**6638**	**76.8%**	**0.41 [0.32 , 0.54]**
Total events:	192		327			
Heterogeneity: Tau² = 0.16; Chi² = 82.83, df = 67 (P = 0.09); I² = 19%						
Test for overall effect: Z = 6.62 (P < 0.00001)						
4.5.2 Non-theatre						
Abdelgalel 2018	0	80	1	40	0.6%	0.17 [0.01 , 4.05]
Ahmadi 2015	1	49	3	48	1.0%	0.33 [0.04 , 3.03]
Dey 2020	3	124	4	124	1.9%	0.75 [0.17 , 3.28]
Driver 2016	2	103	8	95	1.8%	0.23 [0.05 , 1.06]
Ducharme 2017	29	40	34	42	5.3%	0.90 [0.70 , 1.14]
Gao 2018	6	81	8	82	2.9%	0.76 [0.28 , 2.09]
Kim 2016	3	71	5	69	2.1%	0.58 [0.14 , 2.35]
Lascarrou 2017	3	186	2	185	1.5%	1.49 [0.25 , 8.83]
Macke 2020	0	76	3	76	0.6%	0.14 [0.01 , 2.72]
Sanguanwit 2021	9	78	3	80	2.3%	3.08 [0.87 , 10.94]
Silverberg 2015	5	57	16	60	3.2%	0.33 [0.13 , 0.84]
Subtotal (95% CI)		**945**		**901**	**23.2%**	**0.68 [0.42 , 1.09]**
Total events:	61		87			
Heterogeneity: Tau² = 0.19; Chi² = 16.36, df = 10 (P = 0.09); I² = 39%						
Test for overall effect: Z = 1.61 (P = 0.11)						
Total (95% CI)		**8911**		**7539**	**100.0%**	**0.46 [0.36 , 0.59]**
Total events:	253		414			
Heterogeneity: Tau² = 0.29; Chi² = 127.15, df = 78 (P = 0.0004); I² = 39%						
Test for overall effect: Z = 6.10 (P < 0.00001)						
Test for subgroup differences: Chi² = 3.29, df = 1 (P = 0.07), I² = 69.6%						



Footnotes

(1) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(2) Multi-arm study. Data combined for each VL group.
(3) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(4) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(5) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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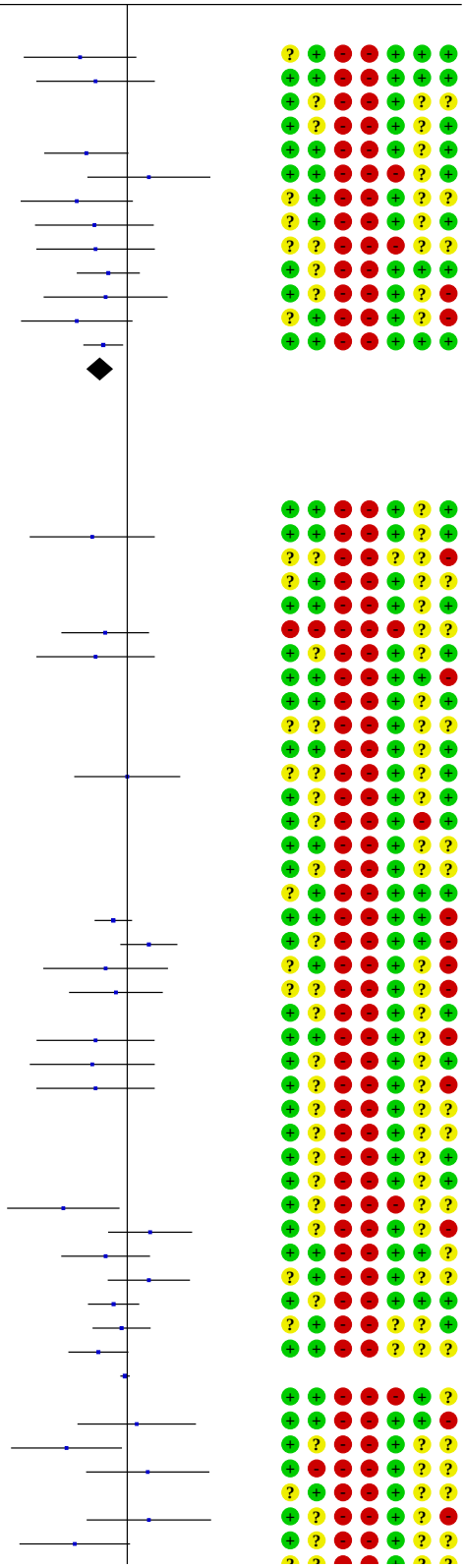
Analysis 4.6. Comparison 4: VL versus DL (all devices combined), Outcome 6: Subgroup analysis of failed intubation: obesity

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
4.6.1 Obese						
Ander 2017	0	39	5	39	0.8%	0.09 [0.01 , 1.59]
Andersen 2011	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Cakir 2020	0	31	0	31		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Malik 2009b	1	50	4	25	1.3%	0.13 [0.01 , 1.06]
Nandakumar 2018	1	15	0	15	0.7%	3.00 [0.13 , 68.26]
Ndoko 2008	0	53	6	53	0.8%	0.08 [0.00 , 1.33]
Ranieri 2012	0	68	2	64	0.7%	0.19 [0.01 , 3.85]
Rovsing 2010	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Ruetzler 2020	2	66	5	63	2.0%	0.38 [0.08 , 1.90]
Wasinwong 2017	0	23	1	23	0.7%	0.33 [0.01 , 7.78]
Yousef 2012	0	30	6	30	0.8%	0.08 [0.00 , 1.31]
Yumul 2016	6	90	7	31	3.3%	0.30 [0.11 , 0.81]
Subtotal (95% CI)		**588**		**497**	**12.5%**	**0.25 [0.13 , 0.46]**
Total events:	10		40			
Heterogeneity: Tau² = 0.00; Chi² = 5.25, df = 10 (P = 0.87); I² = 0%						
Test for overall effect: Z = 4.33 (P < 0.0001)						
4.6.2 Non-obese						
Abdallah 2019	0	35	0	35		Not estimable
Abdelgalel 2018	0	80	1	40	0.7%	0.17 [0.01 , 4.05]
Acarel 2018	0	30	0	30		Not estimable
Aggarwal 2019	0	50	0	50		Not estimable
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015	1	49	3	48	1.2%	0.33 [0.04 , 3.03]
Akbar 2015	0	45	2	45	0.7%	0.20 [0.01 , 4.05]
Al-Ghamdi 2016 (1)	0	65	0	22		Not estimable
Ali 2017	0	30	0	30		Not estimable
Altaiee 2020	0	50	0	50		Not estimable
Amor 2013	0	60	0	60		Not estimable
Aoi 2010	1	18	1	18	0.9%	1.00 [0.07 , 14.79]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (2)	0	54	0	54		Not estimable
Arslan 2017 (1)	0	80	0	40		Not estimable
Aziz 2012	6	149	12	147	3.5%	0.49 [0.19 , 1.28]
Bakshi 2015 (3)	12	84	2	42	2.2%	3.00 [0.70 , 12.79]
Bakshi 2019	0	37	1	37	0.7%	0.33 [0.01 , 7.93]
Barak 2007	1	80	2	90	1.1%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bensghir 2010	0	34	2	34	0.7%	0.20 [0.01 , 4.02]
Bensghir 2013	0	70	1	35	0.7%	0.17 [0.01 , 4.05]
Bhandari 2013	0	40	2	40	0.7%	0.20 [0.01 , 4.04]
Bhat 2015	0	50	0	50		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Blajic 2019	0	119	0	59		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Cavus 2011 (1)	0	100	6	50	0.8%	0.04 [0.00 , 0.68]
Chalkeidis 2010	4	35	1	28	1.3%	3.20 [0.38 , 27.04]
Chen 2019	1	220	3	220	1.2%	0.33 [0.03 , 3.18]
Colak 2015 (1)	6	100	1	50	1.3%	3.00 [0.37 , 24.25]
Cordovani 2019	3	24	5	20	2.6%	0.50 [0.14 , 1.84]
Dey 2020	3	124	4	124	2.2%	0.75 [0.17 , 3.28]
Driver 2016	2	103	8	95	2.1%	0.23 [0.05 , 1.06]
Ducharme 2017	29	40	34	42	5.8%	0.90 [0.70 , 1.14]
El-Tahan 2017a	0	14	0	15		Not estimable
El-Tahan 2017b	2	101	0	32	0.7%	1.62 [0.08 , 32.85]
Enomoto 2008	0	99	11	104	0.8%	0.05 [0.00 , 0.76]
Erden 2010	1	17	0	16	0.7%	2.83 [0.12 , 64.89]
Erturk 2015	0	40	0	40		Not estimable
Ferrando 2011	1	30	0	30	0.7%	3.00 [0.13 , 70.83]
Foulds 2016b	0	24	7	25	0.8%	0.07 [0.00 , 1.15]
Frohlich 2011	12	30	0	30	0.8%	25.00 [1.55 , 403.99]



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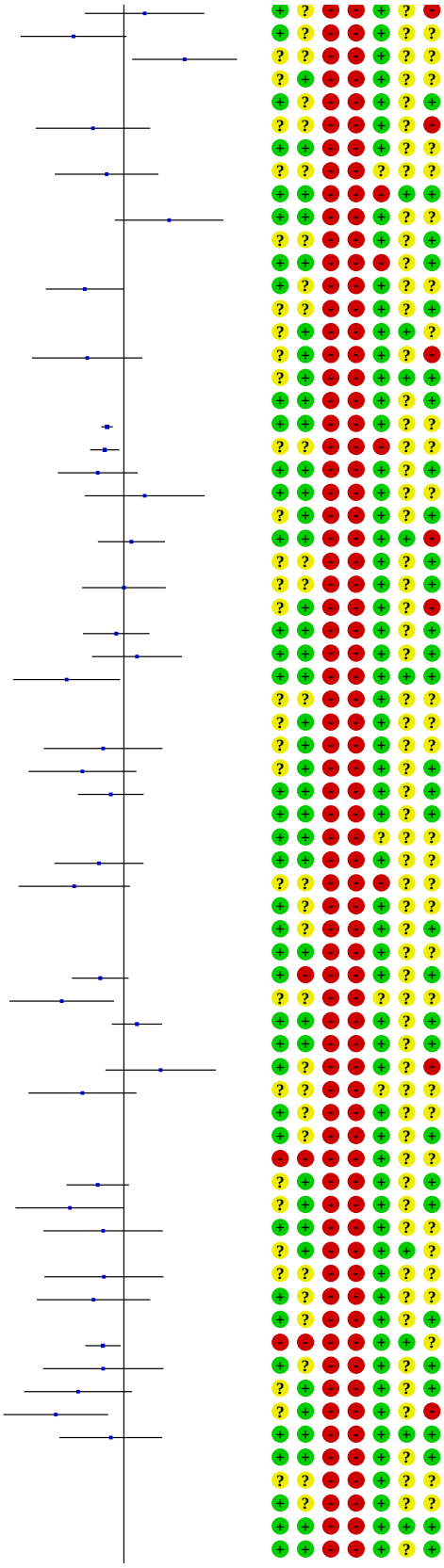
Analysis 4.6. (Continued)

Ferrando 2011	1	30	0	30	0.7%	3.00 [0.13 , 70.83]
Foulds 2016b	0	24	7	25	0.8%	0.07 [0.00 , 1.15]
Frohlich 2011	12	30	0	30	0.8%	25.00 [1.55 , 403.99]
Gunes 2020	0	90	0	90		Not estimable
Gupta 2013	0	60	0	60		Not estimable
Hirabayashi 2009	0	264	2	256	0.7%	0.19 [0.01 , 4.02]
Hosalli 2017	0	30	0	30		Not estimable
Hostic 2016	1	100	1	40	0.9%	0.40 [0.03 , 6.24]
Hu 2017 (4)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	0.8%	11.00 [0.62 , 194.90]
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Jungbauer 2009	1	100	8	100	1.4%	0.13 [0.02 , 0.98]
Kaur 2020	0	80	0	40		Not estimable
Kido 2015	0	25	0	25		Not estimable
Kill 2013	0	30	3	30	0.8%	0.14 [0.01 , 2.65]
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Kleine-Brueggeney 2017 (1)	64	360	52	120	5.7%	0.41 [0.30 , 0.55]
Koennecke 2014 (1)	10	83	10	30	4.1%	0.36 [0.17 , 0.78]
Koh 2010	1	25	4	25	1.3%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	0.7%	3.00 [0.13 , 71.92]
Kucukosman 2020	0	30	0	30		Not estimable
Lascarrou 2017	3	186	2	185	1.7%	1.49 [0.25 , 8.83]
Lee 2009	0	41	0	44		Not estimable
Lee 2012 (1)	3	75	1	25	1.2%	1.00 [0.11 , 9.18]
Lim 2005	0	30	0	30		Not estimable
Lin 2012	2	85	3	85	1.7%	0.67 [0.11 , 3.89]
Liu 2016	2	90	1	90	1.1%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	0.8%	0.05 [0.00 , 0.82]
Maassen 2012	0	40	0	40		Not estimable
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	0.7%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	0.8%	0.11 [0.01 , 1.94]
Malik 2008	3	90	2	30	1.8%	0.50 [0.09 , 2.85]
Malik 2009a	0	30	0	30		Not estimable
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	1.1%	0.27 [0.03 , 2.83]
Nakayama 2010	0	160	3	80	0.8%	0.07 [0.00 , 1.37]
Ninan 2016	0	30	0	30		Not estimable
Nishikawa 2009	0	20	0	20		Not estimable
Paik 2020	0	20	0	20		Not estimable
Park 2010	2	37	7	37	2.1%	0.29 [0.06 , 1.29]
Peck 2009	0	27	13	27	0.8%	0.04 [0.00 , 0.59]
Pournajafian 2014	6	52	3	52	2.5%	2.00 [0.53 , 7.57]
Reena 2019	0	50	0	50		Not estimable
Russell 2013	3	35	0	35	0.8%	7.00 [0.37 , 130.69]
Sansone 2012	0	21	4	21	0.8%	0.11 [0.01 , 1.94]
Saracoglu 2014	0	30	0	30		Not estimable
Sargin 2016	0	50	0	50		Not estimable
Sarkilar 2015	0	55	0	55		Not estimable
Serocki 2010	2	80	4	40	1.9%	0.25 [0.05 , 1.31]
Serocki 2013 (1)	0	63	4	32	0.8%	0.06 [0.00 , 1.03]
Shah 2016 (5)	0	30	1	30	0.7%	0.33 [0.01 , 7.87]
Shimazaki 2018	0	20	0	20		Not estimable
Shippey 2013	0	24	1	25	0.7%	0.35 [0.01 , 8.12]
Shukla 2017	0	40	2	40	0.7%	0.20 [0.01 , 4.04]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	3.5%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	0.7%	0.33 [0.01 , 8.09]
Takenaka 2011	0	35	5	34	0.8%	0.09 [0.01 , 1.54]
Taylor 2013	0	44	18	44	0.8%	0.03 [0.00 , 0.43]
Tempe 2016	1	40	1	20	0.9%	0.50 [0.03 , 7.59]
Teoh 2010	0	300	0	100		Not estimable
Tolon 2012	0	20	0	20		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Turkstra 2009	0	24	0	24		Not estimable



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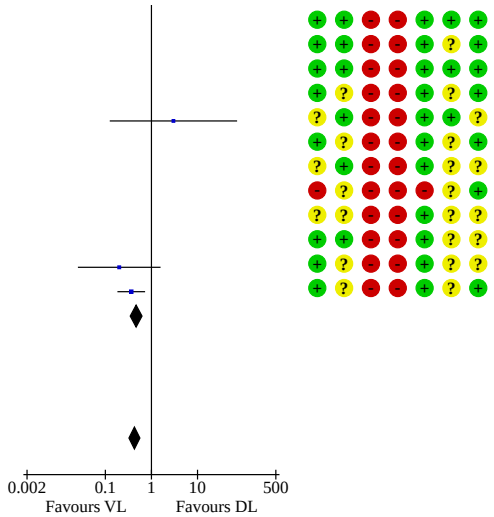
Analysis 4.6. (Continued)

Tsan 2020	0	69	0	69		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Walker 2009	1	60	0	60	0.7%	3.00 [0.12 , 72.20]
Wallace 2015	0	52	0	53		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Woo 2012	0	50	0	109		Not estimable
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yoo 2018	1	22	5	22	1.4%	0.20 [0.03 , 1.58]
Zhao 2014	9	74	25	75	4.4%	0.36 [0.18 , 0.73]
Subtotal (95% CI)		**7539**		**6257**	**87.5%**	**0.47 [0.35 , 0.62]**
Total events:	212		328			
Heterogeneity: Tau² = 0.33; Chi² = 105.68, df = 61 (P = 0.0003); I² = 42%						
Test for overall effect: Z = 5.10 (P < 0.00001)						
Total (95% CI)		**8127**		**6754**	**100.0%**	**0.43 [0.32 , 0.56]**
Total events:	222		368			
Heterogeneity: Tau² = 0.32; Chi² = 118.97, df = 72 (P = 0.0004); I² = 39%						
Test for overall effect: Z = 6.10 (P < 0.00001)						
Test for subgroup differences: Chi² = 3.18, df = 1 (P = 0.07), I² = 68.5%						



Footnotes

(1) Multi-arm study. Data combined for each VL group.
(2) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(3) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(4) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(5) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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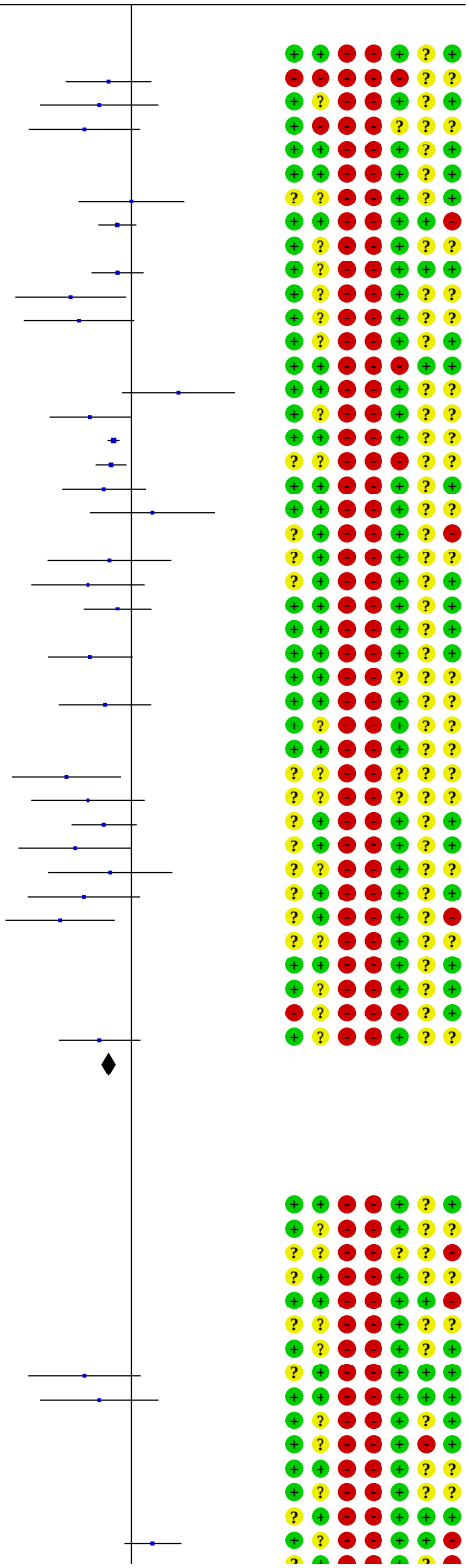
Analysis 4.7. Comparison 4: VL versus DL (all devices combined), Outcome 7: Subgroup analysis of failed intubation: airway difficulty

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
4.7.1 Predicted, known or simulated difficulty						
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015 (1)	1	24	3	23	1.2%	0.32 [0.04 , 2.85]
Akbar 2015	0	45	2	45	0.7%	0.20 [0.01 , 4.05]
Aleksandrowicz 2018	0	20	5	20	0.7%	0.09 [0.01 , 1.54]
Ali 2017	0	30	0	30		Not estimable
Amor 2013	0	60	0	60		Not estimable
Aoi 2010	1	18	1	18	0.8%	1.00 [0.07 , 14.79]
Aziz 2012	6	149	12	147	4.2%	0.49 [0.19 , 1.28]
Bhat 2015	0	50	0	50		Not estimable
Cordovani 2019	3	24	5	20	2.7%	0.50 [0.14 , 1.84]
Enomoto 2008	0	99	11	104	0.7%	0.05 [0.00 , 0.76]
Foulds 2016b	0	24	7	25	0.7%	0.07 [0.00 , 1.15]
Gupta 2013	0	60	0	60		Not estimable
Hu 2017 (2)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	0.7%	11.00 [0.62 , 194.90]
Jungbauer 2009	1	100	8	100	1.3%	0.13 [0.02 , 0.98]
Kleine-Brueggeney 2017	64	360	52	120	9.1%	0.41 [0.30 , 0.55]
Koennecke 2014 (3)	10	83	10	30	5.3%	0.36 [0.17 , 0.78]
Koh 2010	1	25	4	25	1.2%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	0.6%	3.00 [0.13 , 71.92]
Lim 2005	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	0.6%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	0.7%	0.11 [0.01 , 1.94]
Malik 2008	3	90	2	30	1.7%	0.50 [0.09 , 2.85]
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	1	50	4	25	1.2%	0.13 [0.01 , 1.06]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	1.0%	0.27 [0.03 , 2.83]
Ninan 2016	0	30	0	30		Not estimable
Paik 2020	0	20	0	20		Not estimable
Peck 2009	0	27	13	27	0.8%	0.04 [0.00 , 0.59]
Sansone 2012	0	21	4	21	0.7%	0.11 [0.01 , 1.94]
Serocki 2010	2	80	4	40	1.9%	0.25 [0.05 , 1.31]
Serocki 2013 (3)	0	63	4	32	0.7%	0.06 [0.00 , 1.03]
Shippey 2013	0	24	1	25	0.6%	0.35 [0.01 , 8.12]
Takenaka 2011	0	35	5	34	0.7%	0.09 [0.01 , 1.54]
Taylor 2013	0	44	18	44	0.8%	0.03 [0.00 , 0.43]
Tolon 2012	0	20	0	20		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Woo 2012	0	50	0	109		Not estimable
Yoo 2018	1	22	5	22	1.3%	0.20 [0.03 , 1.58]
Subtotal (95% CI)		**2261**		**1839**	**42.8%**	**0.32 [0.23 , 0.44]**
Total events:	101		187			
Heterogeneity: Tau² = 0.06; Chi² = 28.62, df = 26 (P = 0.33); I² = 9%						
Test for overall effect: Z = 6.84 (P < 0.00001)						
4.7.2 No difficulty						
Abdallah 2019	0	35	0	35		Not estimable
Abdelgawad 2015	0	40	0	40		Not estimable
Acarel 2018	0	30	0	30		Not estimable
Aggarwal 2019	0	50	0	50		Not estimable
Al-Ghamdi 2016	0	65	0	22		Not estimable
Altaiee 2020	0	50	0	50		Not estimable
Anandraja 2021	0	30	0	30		Not estimable
Ander 2017	0	39	5	39	0.7%	0.09 [0.01 , 1.59]
Andersen 2011	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (4)	0	54	0	54		Not estimable
Arslan 2017 (3)	0	80	0	40		Not estimable
Bakshi 2015 (5)	12	84	2	42	2.3%	3.00 [0.70 , 12.79]
Bakshi 2019	0	37	1	37	0.6%	0.33 [0.01 , 7.93]



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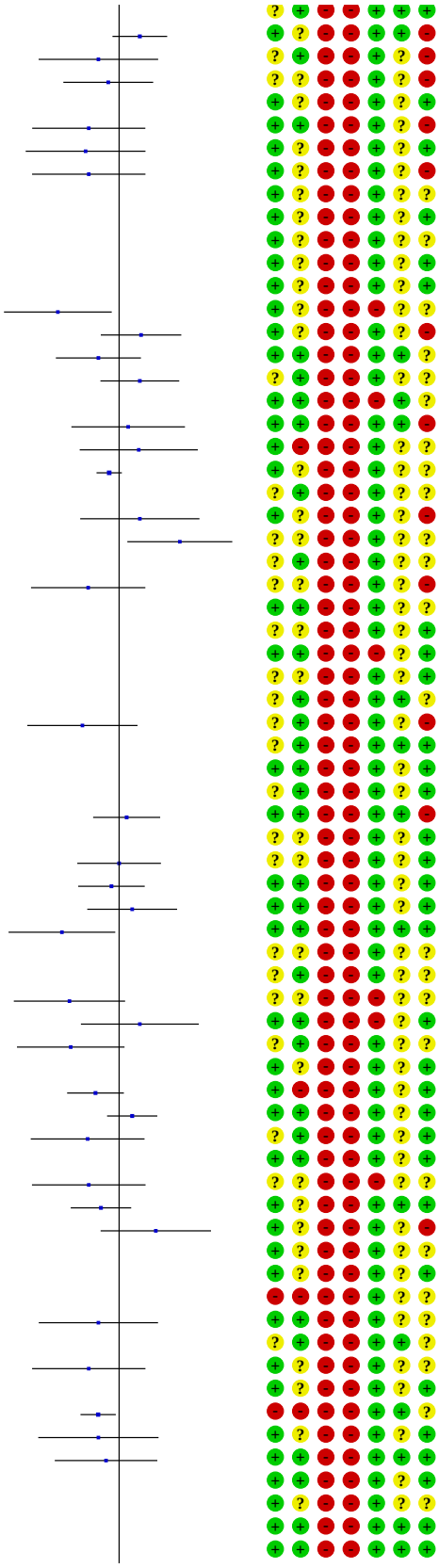
Analysis 4.7. (Continued)

Arslan 2017 (3)	0	80	0	40		Not estimable
Bakshi 2015 (5)	12	84	2	42	2.3%	3.00 [0.70 , 12.79]
Bakshi 2019	0	37	1	37	0.6%	0.33 [0.01 , 7.93]
Barak 2007	1	80	2	90	1.0%	0.56 [0.05 , 6.09]
Bashir 2020	0	40	0	40		Not estimable
Bensghir 2010	0	34	2	34	0.7%	0.20 [0.01 , 4.02]
Bensghir 2013	0	70	1	35	0.6%	0.17 [0.01 , 4.05]
Bhandari 2013	0	40	2	40	0.7%	0.20 [0.01 , 4.04]
Bilehjani 2009	0	40	0	38		Not estimable
Blajic 2019	0	119	0	59		Not estimable
Cakir 2020	0	31	0	31		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Cavus 2011 (3)	0	100	6	50	0.7%	0.04 [0.00 , 0.68]
Chalkeidis 2010	4	35	1	28	1.2%	3.20 [0.38 , 27.04]
Chen 2019	1	220	3	220	1.1%	0.33 [0.03 , 3.18]
Colak 2015	6	100	1	50	1.3%	3.00 [0.37 , 24.25]
El-Tahan 2017a	0	14	0	15		Not estimable
El-Tahan 2017b	2	101	0	32	0.7%	1.62 [0.08 , 32.85]
Erden 2010	1	17	0	16	0.6%	2.83 [0.12 , 64.89]
Erdivanli 2018	13	388	22	388	6.0%	0.59 [0.30 , 1.16]
Erturk 2015	0	40	0	40		Not estimable
Ferrando 2011	1	30	0	30	0.6%	3.00 [0.13 , 70.83]
Frohlich 2011	12	30	0	30	0.8%	25.00 [1.55 , 403.99]
Gunes 2020	0	90	0	90		Not estimable
Hirabayashi 2009	0	264	2	256	0.6%	0.19 [0.01 , 4.02]
Hosalli 2017	0	30	0	30		Not estimable
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Kaur 2020	0	80	0	40		Not estimable
Kido 2015	0	25	0	25		Not estimable
Kill 2013	0	30	3	30	0.7%	0.14 [0.01 , 2.65]
Kim 2013	0	22	0	23		Not estimable
Kim 2018	0	110	0	110		Not estimable
Kucukosman 2020	0	30	0	30		Not estimable
Lascarrou 2017	3	186	2	185	1.7%	1.49 [0.25 , 8.83]
Lee 2009	0	41	0	44		Not estimable
Lee 2012 (3)	3	75	1	25	1.1%	1.00 [0.11 , 9.18]
Lin 2012	2	85	3	85	1.7%	0.67 [0.11 , 3.89]
Liu 2016	2	90	1	90	1.0%	2.00 [0.18 , 21.67]
Liu 2019	0	179	10	181	0.7%	0.05 [0.00 , 0.82]
Maassen 2012	0	40	0	40		Not estimable
Maharaj 2006	0	30	0	30		Not estimable
Nakayama 2010	0	160	3	80	0.7%	0.07 [0.00 , 1.37]
Nandakumar 2018	1	15	0	15	0.6%	3.00 [0.13 , 68.26]
Ndoko 2008	0	53	6	53	0.7%	0.08 [0.00 , 1.33]
Nishikawa 2009	0	20	0	20		Not estimable
Park 2010	2	37	7	37	2.2%	0.29 [0.06 , 1.29]
Pournajafian 2014	6	52	3	52	2.7%	2.00 [0.53 , 7.57]
Ranieri 2012	0	68	2	64	0.7%	0.19 [0.01 , 3.85]
Reena 2019	0	50	0	50		Not estimable
Rovsing 2010	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Ruetzler 2020	2	66	5	63	2.0%	0.38 [0.08 , 1.90]
Russell 2013	3	35	0	35	0.7%	7.00 [0.37 , 130.69]
Saracoglu 2014	0	30	0	30		Not estimable
Sargin 2016	0	50	0	50		Not estimable
Sarkilar 2015	0	55	0	55		Not estimable
Shah 2016 (6)	0	30	1	30	0.6%	0.33 [0.01 , 7.87]
Shimazaki 2018	0	20	0	20		Not estimable
Shukla 2017	0	40	2	40	0.7%	0.20 [0.01 , 4.04]
Siddiqui 2009	0	20	0	20		Not estimable
Silverberg 2015	5	57	16	60	4.3%	0.33 [0.13 , 0.84]
Sun 2005	0	100	1	100	0.6%	0.33 [0.01 , 8.09]
Tempe 2016	1	40	1	20	0.8%	0.50 [0.03 , 7.59]
Teoh 2010	0	300	0	100		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Varsha 2019	0	35	0	35		Not estimable



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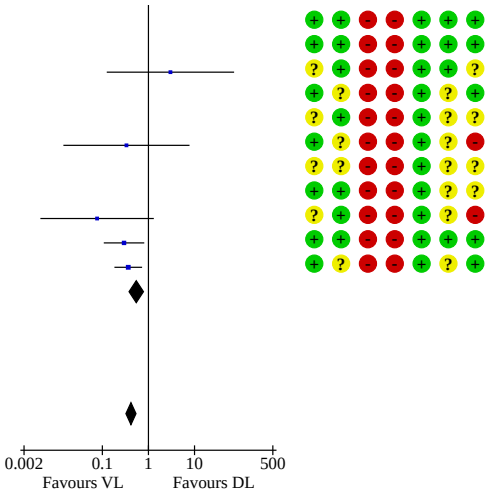
Analysis 4.7. (Continued)

Tsan 2020	0	69	0	69		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Walker 2009	1	60	0	60	0.6%	3.00 [0.12 , 72.20]
Wallace 2015	0	52	0	53		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Wasinwong 2017	0	23	1	23	0.6%	0.33 [0.01 , 7.78]
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yousef 2012	0	30	6	30	0.7%	0.08 [0.00 , 1.31]
Yumul 2016	6	90	7	31	3.9%	0.30 [0.11 , 0.81]
Zhao 2014	9	74	25	75	5.9%	0.36 [0.18 , 0.73]
Subtotal (95% CI)		**5872**		**5027**	**57.2%**	**0.54 [0.38 , 0.78]**
Total events:	99		160			
Heterogeneity: Tau² = 0.27; Chi² = 54.80, df = 42 (P = 0.09); I² = 23%						
Test for overall effect: Z = 3.32 (P = 0.0009)						
Total (95% CI)		**8133**		**6866**	**100.0%**	**0.42 [0.32 , 0.54]**
Total events:	200		347			
Heterogeneity: Tau² = 0.16; Chi² = 85.09, df = 69 (P = 0.09); I² = 19%						
Test for overall effect: Z = 6.82 (P < 0.00001)						
Test for subgroup differences: Chi² = 4.63, df = 1 (P = 0.03), I² = 78.4%						



Footnotes

(1) For the purposes of this subgroup analysis we extracted data only for the predicted difficult airways for this study.
(2) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(3) Multi-arm study. Data combined for each VL group.
(4) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(5) Mixed experience levels. All failures occurred in intubations performed by novice intubators.
(6) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

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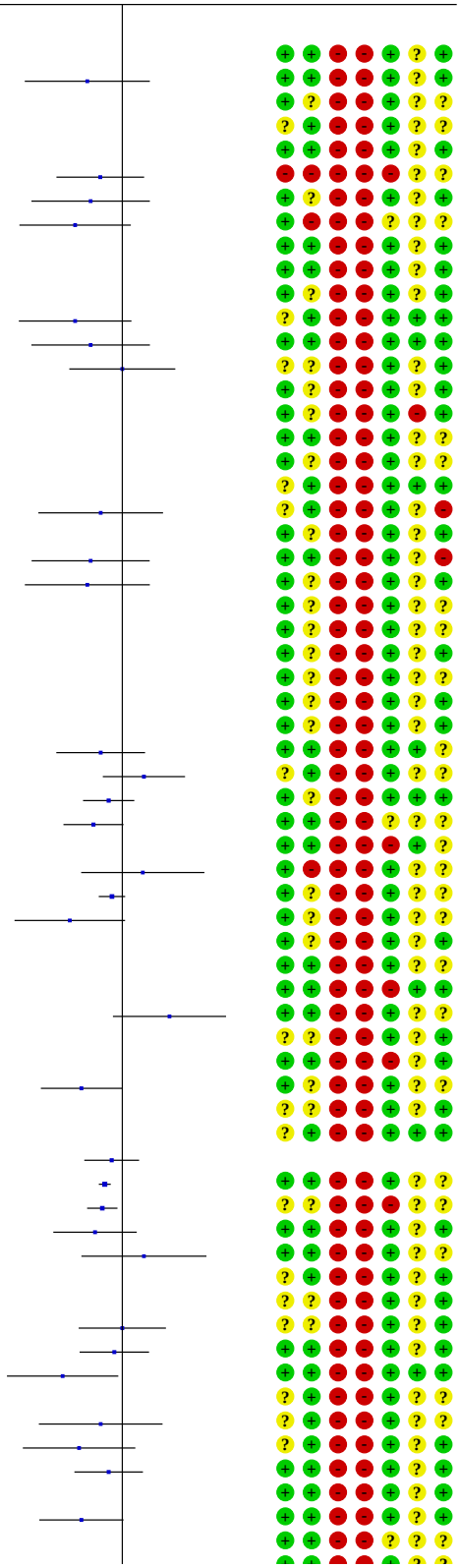
Analysis 4.8. Comparison 4: VL versus DL (all devices combined), Outcome 8: Subgroup analysis of failed intubation: intubator experience

Study or Subgroup	VL Events	VL Total	DL Events	DL Total	Weight	Risk Ratio M-H, Random, 95% CI
4.8.1 Expert						
Abdallah 2019	0	35	0	35		Not estimable
Abdelgalel 2018	0	80	1	40	0.7%	0.17 [0.01 , 4.05]
Abdelgawad 2015	0	40	0	40		Not estimable
Aggarwal 2019	0	50	0	50		Not estimable
Agrawal 2020	0	40	0	40		Not estimable
Ahmadi 2015	1	49	3	48	1.2%	0.33 [0.04 , 3.03]
Akbar 2015	0	45	2	45	0.7%	0.20 [0.01 , 4.05]
Aleksandrowicz 2018	0	20	5	20	0.8%	0.09 [0.01 , 1.54]
Ali 2017	0	30	0	30		Not estimable
Amor 2013	0	60	0	60		Not estimable
Anandraja 2021	0	30	0	30		Not estimable
Ander 2017	0	39	5	39	0.8%	0.09 [0.01 , 1.59]
Andersen 2011	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Aoi 2010	1	18	1	18	0.9%	1.00 [0.07 , 14.79]
Aqil 2016	0	40	0	40		Not estimable
Aqil 2017	0	70	0	70		Not estimable
Arici 2014	0	40	0	40		Not estimable
Arora 2013 (1)	0	54	0	54		Not estimable
Arslan 2017 (2)	0	80	0	40		Not estimable
Bakshi 2019 (3)	0	37	1	37	0.7%	0.33 [0.01 , 7.93]
Bashir 2020	0	40	0	40		Not estimable
Bensghir 2010	0	34	2	34	0.7%	0.20 [0.01 , 4.02]
Bensghir 2013	0	70	1	35	0.7%	0.17 [0.01 , 4.05]
Bhat 2015	0	50	0	50		Not estimable
Bilehjani 2009	0	40	0	38		Not estimable
Blajic 2019	0	119	0	59		Not estimable
Cakir 2020	0	31	0	31		Not estimable
Carassiti 2013	0	15	0	15		Not estimable
Castillo-Monzon 2017	0	23	0	23		Not estimable
Chen 2019	1	220	3	220	1.2%	0.33 [0.03 , 3.18]
Colak 2015 (2)	6	100	1	50	1.4%	3.00 [0.37 , 24.25]
Cordovani 2019	3	24	5	20	2.8%	0.50 [0.14 , 1.84]
Driver 2016	2	103	8	95	2.3%	0.23 [0.05 , 1.06]
El-Tahan 2017a	0	14	0	15		Not estimable
Erden 2010	1	17	0	16	0.7%	2.83 [0.12 , 64.89]
Erdivanli 2018	13	388	22	388	5.4%	0.59 [0.30 , 1.16]
Foulds 2016b	0	24	7	25	0.8%	0.07 [0.00 , 1.15]
Gupta 2013	0	60	0	60		Not estimable
Hosalli 2017	0	30	0	30		Not estimable
Hu 2017 (4)	0	100	0	96		Not estimable
Ilyas 2014	5	64	0	64	0.8%	11.00 [0.62 , 194.90]
Inal 2016	0	50	0	50		Not estimable
Jafra 2018	0	100	0	100		Not estimable
Jungbauer 2009	1	100	8	100	1.4%	0.13 [0.02 , 0.98]
Kaur 2020	0	80	0	40		Not estimable
Kim 2013	0	22	0	23		Not estimable
Kim 2016	3	71	5	69	2.6%	0.58 [0.14 , 2.35]
Kleine-Brueggeney 2017 (2)	64	360	52	120	7.4%	0.41 [0.30 , 0.55]
Koennecke 2014 (2)	10	83	10	30	4.9%	0.36 [0.17 , 0.78]
Koh 2010	1	25	4	25	1.4%	0.25 [0.03 , 2.08]
Komatsu 2010	1	50	0	50	0.7%	3.00 [0.13 , 71.92]
Kucukosman 2020	0	30	0	30		Not estimable
Lee 2009	0	41	0	44		Not estimable
Lee 2012 (2)	3	75	1	25	1.3%	1.00 [0.11 , 9.18]
Lin 2012	2	85	3	85	1.8%	0.67 [0.11 , 3.89]
Liu 2019	0	179	10	181	0.8%	0.05 [0.00 , 0.82]
Maharaj 2006	0	30	0	30		Not estimable
Maharaj 2007	0	20	1	20	0.7%	0.33 [0.01 , 7.72]
Maharaj 2008	0	20	4	20	0.8%	0.11 [0.01 , 1.94]
Malik 2008	3	90	2	30	1.9%	0.50 [0.09 , 2.85]
Malik 2009a	0	30	0	30		Not estimable
Malik 2009b	1	50	4	25	1.3%	0.13 [0.01 , 1.06]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	1.1%	0.27 [0.02 , 2.83]



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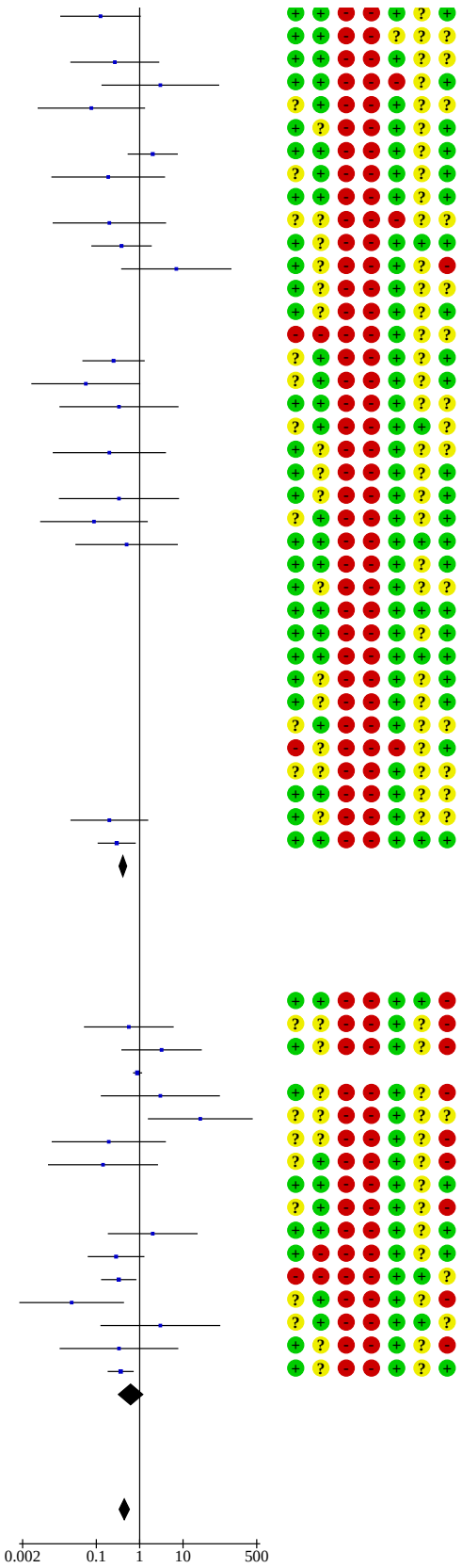
Analysis 4.8. (Continued)

Malik 2009b	1	50	4	25	1.3%	0.13 [0.01 , 1.06]
Mathew 2018	0	33	0	33		Not estimable
McElwain 2011	1	58	2	31	1.1%	0.27 [0.03 , 2.83]
Nandakumar 2018	1	15	0	15	0.7%	3.00 [0.13 , 68.26]
Ndoko 2008	0	53	6	53	0.8%	0.08 [0.00 , 1.33]
Nishikawa 2009	0	20	0	20		Not estimable
Pournajafian 2014	6	52	3	52	2.7%	2.00 [0.53 , 7.57]
Ranieri 2012	0	68	2	64	0.7%	0.19 [0.01 , 3.85]
Reena 2019	0	50	0	50		Not estimable
Rovsing 2010	0	50	2	50	0.7%	0.20 [0.01 , 4.06]
Ruetzler 2020	2	66	5	63	2.1%	0.38 [0.08 , 1.90]
Russell 2013	3	35	0	35	0.8%	7.00 [0.37 , 130.69]
Saracoglu 2014	0	30	0	30		Not estimable
Sargin 2016	0	50	0	50		Not estimable
Sarkilar 2015	0	55	0	55		Not estimable
Serocki 2010	2	80	4	40	2.0%	0.25 [0.05 , 1.31]
Serocki 2013 (2)	0	63	4	32	0.8%	0.06 [0.00 , 1.03]
Shah 2016 (5)	0	30	1	30	0.7%	0.33 [0.01 , 7.87]
Shimazaki 2018	0	20	0	20		Not estimable
Shukla 2017	0	40	2	40	0.7%	0.20 [0.01 , 4.04]
Siddiqui 2009	0	20	0	20		Not estimable
Sun 2005	0	100	1	100	0.7%	0.33 [0.01 , 8.09]
Takenaka 2011	0	35	5	34	0.8%	0.09 [0.01 , 1.54]
Tempe 2016	1	40	1	20	0.9%	0.50 [0.03 , 7.59]
Teoh 2010	0	300	0	100		Not estimable
Tosh 2018	0	65	0	65		Not estimable
Tsan 2020	0	69	0	69		Not estimable
Turkstra 2009	0	24	0	24		Not estimable
Varsha 2019	0	35	0	35		Not estimable
Vijayakumar 2016	0	45	0	45		Not estimable
Wallace 2015	0	52	0	53		Not estimable
Wasem 2013	0	30	0	30		Not estimable
Woo 2012	0	50	0	109		Not estimable
Xue 2007	0	30	0	27		Not estimable
Yao 2015	0	48	0	48		Not estimable
Yoo 2018	1	22	5	22	1.4%	0.20 [0.03 , 1.58]
Yumul 2016	6	90	7	31	3.8%	0.30 [0.11 , 0.81]
Subtotal (95% CI)		**5987**		**4952**	**71.8%**	**0.41 [0.33 , 0.50]**
Total events:	145		223			
Heterogeneity: Tau² = 0.00; Chi² = 42.74, df = 47 (P = 0.65); I² = 0%						
Test for overall effect: Z = 8.63 (P < 0.00001)						
4.8.2 Non-expert						
Al-Ghamdi 2016	0	65	0	22		Not estimable
Barak 2007	1	80	2	90	1.1%	0.56 [0.05 , 6.09]
Chalkeidis 2010	4	35	1	28	1.3%	3.20 [0.38 , 27.04]
Ducharme 2017	29	40	34	42	7.6%	0.90 [0.70 , 1.14]
Ferrando 2011	1	30	0	30	0.7%	3.00 [0.13 , 70.83]
Frohlich 2011	12	30	0	30	0.8%	25.00 [1.55 , 403.99]
Hirabayashi 2009	0	264	2	256	0.7%	0.19 [0.01 , 4.02]
Kill 2013	0	30	3	30	0.8%	0.14 [0.01 , 2.65]
Kim 2018	0	110	0	110		Not estimable
Lim 2005	0	30	0	30		Not estimable
Liu 2016	2	90	1	90	1.1%	2.00 [0.18 , 21.67]
Park 2010	2	37	7	37	2.3%	0.29 [0.06 , 1.29]
Silverberg 2015	5	57	16	60	4.1%	0.33 [0.13 , 0.84]
Taylor 2013	0	44	18	44	0.8%	0.03 [0.00 , 0.43]
Walker 2009	1	60	0	60	0.7%	3.00 [0.12 , 72.20]
Wasinwong 2017	0	23	1	23	0.7%	0.33 [0.01 , 7.78]
Zhao 2014	9	74	25	75	5.3%	0.36 [0.18 , 0.73]
Subtotal (95% CI)		**1099**		**1057**	**28.2%**	**0.62 [0.32 , 1.18]**
Total events:	66		110			
Heterogeneity: Tau² = 0.58; Chi² = 32.21, df = 13 (P = 0.002); I² = 60%						
Test for overall effect: Z = 1.46 (P = 0.14)						
Total (95% CI)		**7086**		**6009**	**100.0%**	**0.44 [0.34 , 0.58]**
Total events:	211		333			
Heterogeneity: Tau² = 0.23; Chi² = 94.64, df = 61 (P = 0.004); I² = 36%						



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Analysis 4.8. (Continued)

Total events:	211	333

Heterogeneity: Tau² = 0.23; Chi² = 94.64, df = 61 (P = 0.004); I² = 36%
Test for overall effect: Z = 5.92 (P < 0.00001)
Test for subgroup differences: Chi² = 1.40, df = 1 (P = 0.24), I² = 28.6%

Footnotes
(1) Two failed due to equipment failure prior to intubation attempt and therefore excluded from analysis by authors.
(2) Multi-arm study. Data combined for each VL group.
(3) Intubators experienced with both VL and DL, but not with double-lumen tube insertion.
(4) 4 patients were excluded from analysis in the DL arm due to poor view by authors as per protocol.
(5) One failed intubation in the Macintosh group. This patient was excluded from further analysis.

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Experience of intubator

APPENDICES

Appendix 1. Videolaryngoscope classification

Device name	Manufacturer	Studies
Macintosh-style		
C-MAC	Karl Storz SE & Co. KG, Tuttlingen, Germany	Aggarwal 2019; Akbar 2015; Altun 2018; Ander 2017; Aziz 2012; Bhat 2015; Blajic 2019; Caparlar 2019; Cattano 2013; Cavus 2011; Cengiz 2019; Chandrashekaraiah 2017; Dey 2020; Driver 2016; Goksu 2016; Gupta 2013; Hostic 2016; Kapadia 2021; Kucukosman 2020; Maassen 2012; Macke 2020; Marsaban 2017; McElwain 2011; Ninan 2016; Rabbani 2020; Rajasekhar 2020; Sarkilar 2015; Serocki 2010; Sulser 2016; Teoh 2010
McGrath MAC	Medtronic plc, Dublin, Ireland	Altaiee 2020; Altun 2018; Anandraja 2021; Bakshi 2019; Cakir 2020; Colak 2019; Foulds 2016a; Frohlich 2011; Ing 2017; Janz 2016; Kaur 2020; Kido 2015; Kreutziger 2019; Kriege 2020; Lascarrou 2017; Loughnan 2019; Peck 2009; Ruetzler 2020; Shimazaki 2018; Shippey 2013; Thion 2018; Toker 2019; Verma 2020; Wallace 2015; Yoo 2018
X-lite	Rüsch, Karl Storz Production	Bensghir 2010; Bensghir 2013; Marrel 2007
V-MAC	Karl Storz SE & Co. KG, Tuttlingen, Germany	Jungbauer 2009; Lee 2012; Yumul 2016
CEL-100	Connell energy Technology Co. Ltd, Shanghai, China	Lin 2012
GlideScope Mac	Verathon Inc, WA, USA	No studies
AP Advance Mac	Venner Medical, Singapore, Singapore	No studies

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(Continued)

Hyperangulated		
GlideScope	Verathon Inc, WA, USA	Abdelgalel 2018; Ahmad 2015; Ahmadi 2015; Akbarzadeh 2017; Al-Ghamdi 2016; Amini 2015; Andersen 2011; Aqil 2016; Aqil 2017; Arslan 2017; Bilehjani 2009; Carassiti 2013; Choi 2011; Cordovani 2019; Dashti 2014; Dostalova 2019; El-Tahan 2017b; Griesdale 2012a; Gunes 2020; Hsu 2012; Hu 2017; Huang 2020; Inangil 2018; Ithnin 2009; Jafra 2018; Kill 2013; Kim 2016; Lee 2012; Lim 2005; Loughnan 2019; Malik 2008; Malik 2009b; Masoumifar 2020; Misirlioglu 2016; Najafi 2014; Nakayama 2010; Nandakumar 2018; Parasa 2016; Pournajafian 2014; Rewari 2017; Risse 2020; Robitaille 2008; Rovsing 2010; Russell 2012; Russell 2013; Sandhu 2014; Sanguanwit 2021; Sbeghen 2021; Serocki 2010; Serocki 2013; Siddiqui 2009; Silverberg 2015; Sun 2005; Teoh 2010; Trimmel 2016; Tsan 2020; Turkstra 2005; Wasinwong 2017; Wei 2016; Xue 2007; Yeatts 2013; Yousef 2012; Yumul 2016
McGrath Series 5	Medtronic plc, Dublin, Ireland	Arici 2014; Bakshi 2015; Foulds 2016a; Golboyu 2016; Ilyas 2014; Karaman 2016; Laosuwan 2015; Lee 2012; Postaci 2015; Sargin 2016; Taylor 2013; Tempe 2016; Walker 2009; Yao 2015; Yumul 2016
C-MAC D-BLADE	Karl Storz SE & Co. KG, Tuttlingen, Germany	Agrawal 2020; Buhari 2016; Echeverri 2020; Hostic 2016; Huang 2020; Paik 2020; Pappu 2020; Pazur 2016; Serocki 2013; Shah 2016; Tosh 2018
King Vision (without channel)	Ambu A/S, Copenhagen, Denmark	Avula 2019; Koennecke 2014
Truview PCD/EVO	Truphatek International Limited, Netanya, Israel	Arora 2013; Bag 2014; Bakshi 2015; Barak 2007; Colak 2015; Inal 2016; Kaur 2020; Kurnaz 2016; Malik 2008; Pappu 2020; Tempe 2016
UEScope	Taizhou Hanchuang Medical Apparatus Technology Co Ltd, Taizhou, China	Abdelgawad 2015; Chen 2019; Gao 2018
AP Advance	Venner Medical, Singapore, Singapore	Kleine-Brueggeney 2017; Koennecke 2014
McGrath Series 3	Medtronic plc, Dublin, Ireland	Liu 2016
Tosight	Shanghai Jingshen Electronic Technology, China	Liu 2019
Airtraq (without channel)	Prodol, Vizcaya, Spain	Koennecke 2014
Channelled		
Airtraq	Prodol, Vizcaya, Spain	Abdallah 2019; Abdelgalel 2018; Acarel 2018; Al-Ghamdi 2016; Amor 2013; Bensghir 2013; Bhandari 2013; Castillo-Monzon 2017; Chalkeidis 2010; Colak 2015; Das 2016; El-Tahan 2017b; Erden 2010; Erturk 2015; Ferrando 2011; Gandhi 2019; Gavrilovska-Brzanov 2015; Hamp 2015; Hindman 2014; Hirabayashi 2008; Hosalli 2017; Kleine-Brueggeney 2017; Koh 2010; Maharaj 2006; Maharaj 2007; Maharaj 2008; Mahmood 2015; Marco 2011; Mathew 2018; McElwain 2011; Ndoko 2008; Park 2010; Rabbani 2020; Ranieri 2012; Sansone 2012; Saracoglu 2014; Shukla 2017; Tolon 2012; Trimmel 2011; Turkstra 2009; Varsha 2019; Vijayakumar 2016; Wasem 2013; Yallapragada 2016; Zhao 2014

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(Continued)

Pentax AirwayScope (AWS)	Nihon Kohden Corporation, Tokyo, Japan	Abdallah 2011; Aoi 2010; Arima 2014; Cha 2009; Enomoto 2008; Hirabayashi 2009; Kanchi 2011; Kim 2013; Kim 2018; Komatsu 2010; Lee 2013; Malik 2008; Malik 2009a; Malik 2009b; Maruyama 2008a; Maruyama 2008b; Nakayama 2010; Nishikawa 2009; Suzuki 2008; Takenaka 2011; Teoh 2010; Woo 2012
King Vision	Ambu A/S, Copenhagen, Denmark	Aleksandrowicz 2018; Al-Ghamdi 2016; Ali 2017; Barman 2017; Blajic 2019; Dharanindra 2020; El-Tahan 2017a; El-Tahan 2017b; Erdivanli 2018; Gupta 2020; Kleine-Brueggeney 2017; Kumar 2019; Lopez 2017; Reena 2019

Notes: we excluded the Bullard videolaryngoscope from our review as it is no longer used in regular clinical practice.

Appendix 2. Search strategies

MEDLINE ALL (OvidSP)

1. videolaryngoscop*.mp.
2. ((video* or indirect) adj5 laryngoscop*).mp.
3. hyperangulat*.mp.
4. (Airtraq or Pentax or King Vision or Airway Scope or Vividtrac or Res-Q-Scope or Storz or McGrath or Glidescope or ClearVue or Truview or Bullard or CoPilot or UE Scope or UEScope or i-view or C-MAC or Intubrite or Anatech or Coopdech or Venner).mp.
5. 1 or 2 or 3 or 4
6. ((randomized controlled trial or controlled clinical trial).pt. or randomi?ed.ab. or placebo.ab. or drug therapy.fs. or randomly.ab. or trial.ab. or groups.ab.) not (exp animals/ not humans.sh.)
7. 5 and 6
8. limit 7 to dt=20150101-20210227

Embase (OvidSP)

1. videolaryngoscop*.mp.
2. ((video* or indirect) adj5 laryngoscop*).mp.
3. hyperangulat*.mp.
4. (Airtraq or Pentax or King Vision or Airway Scope or Vividtrac or Res-Q-Scope or Storz or McGrath or Glidescope or ClearVue or Truview or Bullard or CoPilot or UE Scope or UEScope or i-view or C-MAC or Intubrite or Anatech or Coopdech or Venner).mp.
5. 1 or 2 or 3 or 4
6. (randomized controlled trial/ or randomization/ or placebo/ or crossover procedure/ or double blind procedure/ or single blind procedure/ or (crossover* or cross over*).ti,ab. or ((singl* or doubl* or trebl* or tripl*) adj (blind* or mask*)).ti,ab. or (controlled adj3 (study or design or trial)).ti,ab. or (placebo* or allocat* or trial* or random* or groups).ti,ab.) not ((exp animal/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans).ti,ab.))
7. 5 and 6
8. limit 7 to dd=20150101-20210227

Cochrane Database of Systematic Reviews (CDSR)

1. videolaryngoscop*
2. ((video* or indirect) near/5 laryngoscop*)
3. hyperangulat*
4. (Airtraq or Pentax or “King Vision” or “Airway Scope” or Vividtrac or “Res Q Scope” or Storz or McGrath or Glidescope or ClearVue or Truview or Bullard or CoPilot or “UE Scope” or UEScope or “I view” or “C MAC” or Intubrite or Anatech or Coopdech or Venner)
5. #1 or #2 or #3 or #4
6. #5 in Trials

Web of Science

1. TS=videolaryngoscop*
2. TS=((video* or indirect) near/5 laryngoscop*)
3. TS=hyperangulat*
4. TS=(Airtraq or Pentax or “King Vision” or “Airway Scope” or Vividtrac or “Res Q Scope” or Storz or McGrath or Glidescope or ClearVue or Truview or

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5. #4 OR #3 OR #2 OR #1
6. TS=(randomised OR randomized OR randomisation OR randomization OR placebo* OR (random* AND (allocat* OR assign*)) OR (blind* AND (single OR double OR treble OR triple)))
7. #6 AND #5
8. #7 AND PY=(2015-2021)

ClinicalTrials.gov

Other terms: videolaryngoscopy OR "video laryngoscopy" OR videolaryngoscope OR "video laryngoscope" OR "indirect laryngoscopy" OR "indirect laryngoscope" OR Airtraq OR "King Vision" OR McGrath OR Glidescope OR "C MAC" OR C-MAC

Filters: Interventional Studies | Adult

WHO International Clinical Trials Registry Platform (ICTRP)

videolaryngoscope OR video laryngoscope OR videolaryngoscopy OR video laryngoscopy OR indirect laryngoscopy OR indirect laryngoscope

Appendix 3. Template data extraction form

Methods	Randomized controlled trial; parallel design or cross-over design Quasi-randomized controlled trial; parallel design or cross-over design
Participants	**Total number of participants:** **Country:** **Setting:** **Inclusion criteria:** **Exclusion criteria:** **Baseline characteristics:** **Intervention 1** (specify by name) • Age, mean (SD): X (± X) years • Gender M/F, n: • Weight, mean (SD): X (± X) kg • Height, mean (SD): X (± X) m • BMI, mean (SD): X (± X) kg/m^2 • ASA I/II/III/IV, n: • Mallampati 1/2/3/4, n: **Intervention 2** (specify by name) • Age, mean (SD): X (± X) years • Gender M/F, n: • Weight, mean (SD): X (± X) kg • Height, mean (SD): X (± X) m

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(Continued)

	• BMI, mean (SD): X (± X) kg/m^2 • ASA I/II/III/IV, n: • Mallampati 1/2/3/4, n: Notes: (e.g. pregnancy, obesity, urgency of intubation)
Interventions	**General details:** to include number of intubators (and their skills and experience), use of additional equipment (stylet, bougie) **Intervention 1** (specify by name) • Randomized = n; losses = n; analysed = n • blade size, other descriptors **Intervention 2** (specify by name) • Randomized = n; losses = n; analysed = n • blade size, other descriptors **Videolaryngoscope classification:** Hyperangulated, Macintosh-style, Channelled Notes:
Outcomes	**Outcomes relevant to the review reported by study authors:** *list outcomes reported by authors, list outcomes of interest to the review and describe definitions of outcomes, do not report results* **Dichotomous outcomes:** Failed intubation: Hypoxia: Number of attempts: Airway trauma: Patient-reported sore throat: Cormack-Lehane grade: Mortality: **Continuous outcomes:** Time for tracheal intubation: Intubation Difficulty Scale (IDS): POGO score: Notes:
Notes	**Funding/sponsor/declarations of interest:**

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(Continued)

Study dates:

WHAT'S NEW

Date	Event	Description
4 April 2022	New citation required and conclusions have changed	Conclusions: we made some changes to the conclusions to reflect findings from critical outcomes and other outcomes for which we found effect estimates that favoured one or other treatment.
4 April 2022	New search has been performed	Title: we edited the title to reflect current terminology and avoid the word 'patients'. Review authors: we added two new review authors (JH, AR), and removed two review authors (JP, AB). Methods: we updated review methods to reflect current methodological expectations, and altered the outcomes to be more specific. We broadened our inclusion criteria to not exclude individuals in cardiac arrest so as to be able to include prehospital studies. We categorized the interventions into three discrete categories according to device design. Searches and data extraction: we updated and re-ran the searches for studies, extracted data on new studies, conducted risk of bias assessments on all included studies, and incorporated new data into the review. Results: this review update includes an additional 158 studies.

HISTORY

Protocol first published: Issue 5, 2014
Review first published: Issue 11, 2016

Date	Event	Description
4 April 2022	Amended	This review was republished to revert to the current version, following an accidental replacement of the text with an updated version. That update will now be published as a new version.
5 December 2016	Amended	Acknowledgement section updated

CONTRIBUTIONS OF AUTHORS

Jan Hansel (JH), Andrew Rogers (AR), Sharon R Lewis (SL), Andrew R Butler (AB), Joshua Parker (JP), Tim M Cook (TC), Andrew F Smith (AS)

Conceiving the review: AS

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Co-ordinating the review update: JH

Undertaking manual searches: JH

Screening search results: JH, AR

Organizing retrieval of papers: JH

Screening retrieved papers against inclusion criteria: JH, AR, SL

Appraising quality of papers: JH, AR, SL

Abstracting data from papers: JH, AR, SL

Writing to authors of papers for additional information: JH

Managing data for the review: JH

Entering data into Review Manager (RevMan Web 2021): JH, AR

Analysing Review Manager statistical data: JH

Interpreting data: JH, AR, SL, AS, TC

Making statistical inferences: JH, AR, SL, TC, AS

Writing the review: JH, AR, SL, AS, TC

Securing funding for the review: AS

Performing previous work that was the foundation of the present review: SL, AB, TC, AS

Serving as guarantor for the review (one review author): AS

Taking responsibility for reading and checking the review before submission: JH

DECLARATIONS OF INTEREST

Sharon R Lewis, systematic reviewer: none known

Jan Hansel: none known

Andrew Rogers: none known

Tim M Cook was paid for lecturing, several years ago (> 36 months), by Intavent Orthofix and the LMA Company. This company manufactures and distributes several supraglottic airway devices and one videolaryngoscope: AP Venner. Dr Cook's department has received free or at-cost airway equipment from numerous 'airway' companies for evaluation or research. He and his family have no financial investments and no ownership of any such company of which he is aware. Dr Cook has reported no other conflicts of interest. He spoke at a Storz educational meeting in 2015, and the company paid the costs of travel to this meeting and accommodations. He received no financial benefit from the meeting and was not paid to speak.

Andrew F Smith has received funding for market research relating to airway devices, but not for videolaryngoscopes, nor for any company that produces them.

SOURCES OF SUPPORT

Internal sources

- North West School of Anaesthesia Health Education England, UK

  Provided protected non-clinical time for undertaking the review to JH.

External sources

- None, Other

  None

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We made the following changes to the previous version of this review (Lewis 2016). Changes made from the protocol to the review are reported in Lewis 2016.

Title

We changed the title from the original review "Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation" to "Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation" because this better reflects the scope and focus of the review.

Review authors

Andrew Butler and Joshua Parker contributed to the previous version of the review but not to the update. Jan Hansel and Andrew Rogers contributed to this version of the review.

Types of studies

We included cluster-randomized controlled trials.

Types of participants

We did not exclude adults in cardiac arrest. The rationale for this was that excluding these studies would have rendered a large number of non-theatre studies ineligible.

Types of interventions

Unlike in the previous version of the review, we conducted three separate comparisons based on videolaryngoscope design: Macintosh-style, hyperangulated, channelled. Further to optical stylets, we also excluded flexible fibreoptic intubating devices, tracheal tubes with an integrated camera and McCoy or Miller direct laryngoscopy blades. We took a more inclusive approach and included studies that were previously excluded (including the Airtraq videolaryngoscope). We still excluded the Bullard laryngoscope, which is no longer used in routine clinical practice.

Types of outcome measures

In line with current GRADE recommendations, we re-classified the outcomes as critical or important. We classified four outcomes as critical (failed intubation, hypoxaemia, successful first attempt at tracheal intubation, oesophageal intubation) and eight outcomes as important (number of attempts, dental trauma, patient-reported sore throat, Cormack-Lehane grade, Intubation Difficulty Scale (IDS), percentage of glottic opening (POGO) score, time for tracheal intubation, mortality).

We made the following changes to the outcome measures.

- We changed the definition of "Failed intubation" to be more specifically defined as: "more than three attempts or change of device or intubator required".
- We changed the definition of "Hypoxaemia" to "oxygen saturation less than 94% between start of induction and recovery from anaesthesia".
- We removed the outcome of "Serious respiratory complications" as it is a heterogeneous outcome and difficult to define, and our clinical judgement was that we did not expect laryngoscopy to meaningfully impact it.
- We changed "Patient-reported sore throat and hoarseness" to "Patient-reported sore throat" to simplify the outcome for data extraction and reporting.
- We changed "Laryngeal or airway trauma" to "Dental trauma" only. In order to avoid unit of analysis issues we extracted data only for dental trauma. A number of studies reported both combined separate events where they could have occurred in the same individual, but this was not clear from the manuscript. Furthermore, the review group felt the dental trauma outcome measure was the most patient-centred, albeit infrequently occurring, of the ones listed.
- For the outcome "Improved visualization of the larynx as measured on a validated scale" we reported Cormack-Lehane grade views and POGO scores as separate outcomes.
- We added the outcome of "Oesophageal intubation"; the rationale for this was that oesophageal intubation, when unrecognized, can lead to further complications and mortality, and is an easily assessed outcome at the time of intubation.

Measures of treatment effect

We did not collect time-to-event data for mortality. We did not convert continuous outcome data to means with standard deviation where they were reported as median (interquartile range) as we could not assume normal data distribution.

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Given a large number of studies with zero events in both arms for three of the four critical outcomes, we conducted a sensitivity analysis of these outcomes in all three comparisons, including zero-event studies.

Risk of bias

On peer-review advice, we performed an additional analysis of quantitative statistical testing of funnel plot asymmetry for the Macintosh-style videolaryngoscope versus direct laryngoscope comparison for the outcome of failed intubation, where there was discrepancy between the funnel plot suggesting visual asymmetry and Harbord's test not confirming this.

Unit of analysis issues

By separately extracting data for different device types into discrete comparisons we avoided the unit of analysis issues encountered in the previous version of this review. However, where studies reported data for multiple devices of the same type, we did combine those data.

For cross-over studies reporting more than one set of observations for the same participant (such as Cormack-Lehane grade views), we extracted data from the first attempt, where this was reported clearly.

Effects of interventions

We altered time points for the sore throat outcome to reflect the time points commonly reported in the included studies. When reported, we included data closest to six hours postoperatively.

Subgroup analysis and investigation of heterogeneity

We carried out subgroup analyses for the critical outcome of failed intubation across the three device types for setting, obesity, features of airway difficulty, and intubator experience. These analyses were prespecified. We performed a prespecified sensitivity analysis, where we combined all device designs and looked at the four critical outcomes of failed intubation, hypoxaemia, successful first attempt and oesophageal intubation.

We also performed four post hoc sensitivity analyses, combining all videolaryngoscope designs and comparing subgroups for setting, obesity, features of airway difficulty, and intubator experience.

We added a sentence to the review to explain how we had defined intubator experience by number of uses.

Summary of findings tables

We created three separate summary of findings tables, one for each comparison. We re-arranged the outcomes of interest reported in the summary of findings tables in the following order. Critical outcomes: failed intubation, hypoxaemia, successful first attempt, oesophageal intubation. Important outcomes: dental trauma, Cormack-Lehane grade, time for tracheal intubation.

INDEX TERMS

Medical Subject Headings (MeSH)

Critical Illness; Intubation, Intratracheal; *Laryngoscopes; *Laryngoscopy [methods]

MeSH check words

Adult; Humans

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