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BMJ Open

The current and possible future role of 3D modelling within upper gastrointestinal surgery: a scoping review protocol

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Title: The current and possible future role of 3D modelling within upper gastrointestinal surgery: a scoping review protocol

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Title: The current and possible future role of 3D modelling within upper gastrointestinal surgery: a scoping review protocol

Abstract:

Introduction

Constructing three-dimensional (3D) models from two-dimensional (2D) medical images was first described by Alberti in 1979 (1). With the advancement of both computing power and imaging modalities, the creation of high-fidelity 3D models has become ubiquitous throughout surgery with revolutionary applications (2). The benefits of 3D modelling within surgery are evident in a vast array of forms, however upper gastrointestinal surgery has been a comparatively 'late adopter'. Herein the authors outline a scoping review protocol that aims to be the first literature to consolidate and analyse the current and possible future role of 3D modelling in upper gastrointestinal surgery.

Methods and Analysis

The scoping review protocol was developed using internationally accepted methodological frameworks (3-6). A succinct primary question has been devised and studies will be identified using tailored searches of key selected databases. Reference lists will be reviewed by hand and grey literature identified using OpenGrey and Grey Literature Report.

Two independent reviewers will screen titles, abstracts and perform full text reviews for study selection. There will be no methodological quality assessment to ensure a full thematic analysis is possible. A data charting tool will be created by the investigatory team. Results will be analysed to generate descriptive numerical tabular results and a thematic diagrammatical map for future research will be generated.

Ethics and Dissemination

Ethical approval was not required for the collection and analysis of the published data. The scoping review report will be disseminated through a peer-reviewed publication and international conferences.

Registration details

The scoping review protocol has been registered on the Open Science Framework (osf.io/ta789)

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Article Summary

Strengths and limitations of this study:

- This scoping review will be the first literature summarising and condensing the role of 3D modelling technology within upper gastrointestinal surgery.
- The review will map and guide future research into major avenues currently unexplored in existing literature.
- Both the scoping review protocol and final report will follow internationally accepted guidelines and frameworks.
- To highlight the breadth of research, rather than the depth, the review will not exclude studies based on methodological quality.
- The study will be limited to those published in English.

Introduction:

The creation of three-dimensional (3D) models of anatomical structures from two-dimensional (2D) medical images was first described by Alberti in 1979 (1). With the rapid advancement of both computing and medical imaging, the ability to generate 3D reconstructions has become more accessible to clinicians (2, 7). Applications for this technology within healthcare are wide ranging, from 3D printing to Virtual Reality (VR) simulations (8, 9).

The benefits of 3D modelling within surgery are evident in a vast array of forms. From a surgical planning perspective, surgeons can visualise complex anatomical relationships pre-operatively to guide decision-making. This was well demonstrated by Sahnan et al in their reconstructions of perianal Crohn's fistulae (10). Furthermore, the prospect of intra-operative guidance through Augmented Reality (AR) has become feasible through the fusion of 3D modelling and computer-assisted surgery, the combination of which has been shown to improved patient outcomes (11). As the traditional surgical training model becomes unsuitable to modern practice, the role of 3D simulation and VR training continues to expand (12). From the first surgical simulator repairing an Achilles tendon (13), simulators have grown far more intricate, providing realistic haptic and stereoscopic feedback (14). Promisingly, there is a growing body of evidence that demonstrates skills developed through VR simulation translate to greater intra-operative surgical performance (15). Undoubtedly 3D modelling will become pivotal to future surgical practice.

The advantages of 3D modelling are not limited to the practicing clinician and could bring a new degree of personalised medicine to the patient. It has become clear that 3D models, either virtual or 3D printed, enhance patient education when compared to standard imaging, across a range of specialities (16, 17). Moreover, early studies have shown that patient-specific pathological 3D models help individuals gain a greater insight into their disease and this improves shared decision-making (18). One can foresee a time when individualised reconstructed models will be commonplace in surgical practice, for the benefit of both patients and clinicians.

In comparison to other surgical specialities, general surgery, especially upper gastrointestinal surgery, has been a 'late adopter' to 3D modelling and its associated innovations(19). There are a variety of reasons for this, including limited resources as well as imaging-related and organ-specific complexities (20, 21). As can be expected, it is considerably easier to reconstruct solid bony structures in contrast to distensible and rapidly changing organs such as the stomach. However, as costs plummet and technological capabilities improve, 3D models will have increasing prevalence within upper

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gastrointestinal surgery (22). For example, this may exist as personalised 3D models to assist with informed consent for oesophagectomy or AR intra-operative guidance during gastrectomy.

To the authors' knowledge, there is no published literature reviewing the role of 3D reconstruction within upper gastrointestinal surgery. A scoping review is the most appropriate recognised technique to systematically analyse the use of 3D modelling in upper gastrointestinal surgery and map avenues for future research (23, 24). Herein the authors outline a scoping review protocol that aims to consolidate and evaluate the current and possible future role of 3D modelling in upper gastrointestinal surgery, highlighting gaps in the literature, as well as implications for future practice and research.

Methods and analysis:

The scoping review protocol was developed following the accepted six-step methodological framework created by Arksey and O'Malley (3), further refined by Levac et al (4) and the Joanna Briggs Institute(JBI)(5). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses—Extension for Scoping Reviews (PRISMA-ScR) checklist and guideline were also utilised in the construction of this protocol and will be used for the final scoping review report.

Stage 1: Identify Research Question:

To articulate a broad yet clear primary review question, the investigatory team used the 'Population, Concept and Context' structure as recommended the by JBI 'Manual for Evidence Synthesis'(25). This created the primary research question:

"What is the current and possible future role of 3D modelling within upper gastrointestinal surgical practice?"

By answering this question, the scoping review will be the first literature to summarise and condense the heterogenous applications of 3D modelling within upper gastrointestinal surgery (26). Furthermore, as upper gastrointestinal surgery is a relatively 'late-adopter' to 3D modelling, in comparison to other surgical specialities, this review is expected to map significant gaps within current literature and guide future researchers (19).

Stage 2: Identify studies

A comprehensive search strategy has been developed through the collaboration of the lead investigator and a medical science librarian. After numerous pilot searches, tailored search strategies using keywords, thesauri terms (MeSH terms (MEDLINE) and EMTREE (Embase)) and Boolean Operators were created for selected databased including MEDLINE, Embase, Elsevier Scopus and ISI Web of Science (see Table 1). Databases are to be searched from their inception to 1/6/2020.

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Table 1: Search Strategy for MEDLINE

Search	Query	Results
1	*Exp Esophageal Diseases/*	*142020*
2	*Exp stomach diseases/*	*204194*
3	*Exp upper gastrointestinal tract/*	*199153*
4	*Exp duodenal diseases/*	*97861*
5	*$esophagus.mp.*	*82392*
6	*Stomach/ or stomach.mp.*	*239092*
7	*Duodenum.mp.*	*58650*
8	*Upper gastro*.mp.*	*23904*
9	*1 or 2 or 3 or 4 or 5 or 6 or 7 or 8*	*537167*
10	*General surgery.mp. or exp General Surgery/*	*47586*
11	*Surgery.mp.*	*2632129*
12	*Surgical.mp.*	*1342309*
13	*Operation.mp.*	*338843*
14	*$esophagectomy.mp. or exp esophagectomy/*	*13749*
15	*Gastrectomy.mp. or exp Gastrectomy/*	*45450*
16	*10 or 11 or 12 or 13 or 14 or 15*	*3181552*
17	*9 and 16*	*164788*
18	*(3D or three dimension*).mp.*	*338859*
19	*Exp imaging, Three-dimensional/ or volume render.mp.*	*81153*
20	*18 or 19*	*342110*
21	*17 and 20*	*791*

The reference lists from key sources identified will be hand-searched for additional studies missed through initial database searches. Grey literature will be identified through OpenGrey and Grey Literature Report.

Identified material shall be collated using EndNote X9 (Clarivate) prior to being transferred to Covidence, a web-based software platform for literature reviews recommended by the Cochrane Collaboration(27).

Stage 3: Study selection

The two-stage screening process 'title and abstract screening' and 'full text review' will be used to identify studies for inclusion, using the Covidence platform. Two reviewers (HR and GS) will independently screen and assess for topic relevance. Any disagreement will be resolved through discussion, and if required, a third reviewer (CK) will provide the decisive vote. Results of the selection process will be recorded on a 'PRISMA flow diagram'(28). Inter-rater agreement will be assessed using Cohen's Kappa(29).

Initially a wide-ranging inclusion criterion will be applied (Table 2), however the study selection stage is an iterative process that may require limiting to generate a practical and applicable final study selection. This post-hoc protocol development is an accepted norm in scoping reviews and any deviations will be stated in final report publication(30).

3D modelling is an emerging technology and it is anticipated that most research will be of low-grade evidence comprised mainly of case reports and case series. Therefore, selecting studies based on methodological quality (using tools such as Newcastle-Ottawa Scale or ROBINS-1) was deemed

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inappropriate as it could restrict the scope of the results to a harmful degree (31, 32). This is in accordance with the accepted guidance for scoping reviews(4).

Table 2: Inclusion and Exclusion Criteria

	Inclusion Criteria	*Exclusion Criteria*
Population	Adult patients with surgical pathologies of stomach and oesophagus	Non-surgical patients and pathologies, paediatric patients (<16 years old)
Context	Upper Gastrointestinal surgical practice and surgical education, all environments considered from lab to theatre	Nil
Concept	All forms of 3D reconstruction, 3D modelling and 3D printing applied to surgical practice	3D reconstruction technologies not applicable to surgical practice
Studies	All forms of studies published in peer reviewed literature	Nil

<u>Stage 4: Charting data</u>

The research team will collectively develop a data charting tool. Once the data charting template has been finalised, two reviewers (HR and GS) will independently chart data on selected studies. Any disagreement will be resolved through discussion, and if required, a third reviewer (CK) will provide the decisive vote.

The data charting tool will follow the 'descriptive-analytical' method described by Arksey and O'Malley(3). Fundamental study descriptors will be extracted including:

- Author(s), year of publication and study location
- Study aims
- Study population and sample size
- Study design
- Intervention
- Main findings

Studies will be analysed and categorised based on the reviewers' qualitative thematic summarisation of the work. The thematic summaries are expected to be divided into overarching themes found in comparative literature(33):

- Surgical Education and Training
- Patient Education and Engagement
- Surgical Planning and Procedure

The data charting tool will be drafted by the research team and then be piloted by the two independent reviewers (HR and GS) over 5 to 10 of the selected studies for inter-rater agreement and relevance. Again, this is expected to be in iterative process with numerous adaptions required throughout this stage. Charting and extraction will be completed on the Covidence platform, with results transferred to Microsoft Excel.

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Stage 5: Collating summarising and reporting

As recommended by Levac et al, the fifth stage will be divided into analysing data, reporting results, and applying meaning to the results. Charted data from selected studies will be collated and analysed using descriptive numerical summary tables and diagrammatical mapping of the qualitative thematic analysis. A narrative descriptive summary will report the results within the context of the stated objectives and consider the implications for future practice and research.

Stage 6: Expert consultation

Once results have been collated and summarised, key stakeholder experts in the field of 3D modelling, upper gastrointestinal surgery and radiology shall be consulted. These consultations will provide insights beyond the current literature and provide invaluable guidance into disparities within the existing body of evidence. This will allow the research team to highlight areas for future development and advance the use of 3D modelling within upper gastrointestinal surgery - for the benefit of patients and clinicians alike.

Patient and public involvement

No patient or members of the public were consulted in the generation of this protocol. However, the results may well guide the research team in their aim to improve patient engagement through 3D reconstruction.

Ethics and dissemination

Ethical approval was not required for the collection and analysis of the published data. The scoping review report will be disseminated through peer-reviewed publication, international and nation conferences, appropriate social media channels and patient liaison groups.

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Author Contributions

HR is the lead investigator, reviewer and generated the scoping review protocol. GS is a reviewer and contributed to the creation of the protocol. PB and SB revised the draft paper and provided guidance for the scoping review. GB and FB provided expert consultations on the topic. CK is the senior consultant lead and assisted in the production of the protocol.

Funding Statement

No funding was required in the generation of the scoping protocol.

Conflicts of Interests

None of the registered authors have any conflicting interests in relation to this scoping protocol.

Data Statement Section

All the data collated is publicly available and will be consolidated on the Open Science Framework (osf.io/ta789).

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The current and possible future role of 3D modelling within oesophagogastric surgery: a scoping review protocol

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Primary Subject Heading:	Surgery
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Keywords:	Gastroduodenal disease < GASTROENTEROLOGY, Oesophageal disease < GASTROENTEROLOGY, Protocols & guidelines < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Gastrointestinal imaging < RADIOLOGY & IMAGING, Adult surgery < SURGERY

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Authors:

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Title: The current and possible future role of 3D modelling within oesophagogastric surgery: a scoping review protocol

Abstract:

Introduction

Three-dimensional (3D) reconstruction describes the generation of either virtual or physically printed anatomically accurate 3D models from two-dimensional (2D) medical images. Their implementation has revolutionised medical practice. Within surgery, key applications include growing roles in operative planning and procedures, surgical education and training as well as patient engagement and education. In comparison to other surgical specialties, oesophagogastric surgery has been slow in their adoption of this technology. Herein the authors outline a scoping review protocol that aims to analyse the current role of 3D modelling in oesophagogastric surgery and highlight any unexplored avenues for future research.

Methods and Analysis

The protocol was generated using internationally accepted methodological frameworks. A succinct primary question was devised, and a comprehensive search strategy developed for key databases (MEDLINE, Embase, Elsevier Scopus and ISI Web of Science). These were searched from their inception to 1/6/2020. Reference lists will be reviewed by hand and grey literature identified using OpenGrey and Grey Literature Report. The protocol was registered to the Open Science Framework (osf.io/ta789).

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Registration details

The scoping review protocol has been registered on the Open Science Framework (osf.io/ta789)

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Article Summary

Strengths and limitations of this study:

- This scoping review will be the first literature summarising and condensing the role of 3D modelling technology within oesophagogastric surgery.
- The review's thematic analysis aims to demonstrate gaps in the current literature and suggest avenues for future research by considering work done in other surgical specialties
- Both the scoping review protocol and final report will follow internationally accepted guidelines and frameworks.
- To highlight the breadth of research, rather than the depth, the review will not exclude studies based on methodological quality.
- The study will be limited to those published in English.

Introduction:

Three-dimensional (3D) reconstruction describes the generation of either virtual or physically printed anatomically accurate 3D models from two-dimensional (2D) medical images. First described by Alberti in 1979 (1), the rapid technological advancement of computing and medical imaging has allowed 3D modelling to revolutionise medical practice. Within surgery, key applications include growing roles in operative planning and procedures, surgical education and training as well as patient engagement and education (2, 3).

The benefits of 3D reconstruction within surgery are evident in a vast array of forms. From a surgical planning perspective, surgeons can now visualise complex anatomic relationships pre-operatively to guide decision-making. As demonstrated by Shen et all, pre-operative 3D reconstructions can improve surgical outcomes and reduce complication rates (4). Furthermore, in terms of operative procedure, the prospect of intra-operative guidance through Augmented Reality (AR) has become feasible through the fusion of computer-generated 3D reconstructions and the real environment (5). As the traditional apprenticeship model of surgical training becomes incompatible with modern practice and working patterns (6), physical and virtual 3D model simulations may play an increasingly pivotal role in surgical training (7). Since the first Virtual Reality (VR) simulators introduced in the 1990's (8), VR simulators have grown more intricate with greater realistic haptic and stereoscopic feedback (3). Promisingly, there is a growing body of evidence that demonstrates skills developed through simulation translate to greater intra-operative surgical performance (9-11). Undoubtedly 3D modelling will become key to future surgical practice.

The advantages of 3D reconstruction are not limited to the practicing clinician and could bring a new degree of personalised medicine to the patient. It has become clear that 3D models, either virtual or 3D printed, are beneficial for patient understanding across a range of specialties (12-14). Early studies have demonstrated that patient-specific pathological 3D models could help individuals gain a greater understanding of their disease and this has the potential to improve shared decision-making (15). One can foresee a time when individualised reconstructed models will be commonplace in surgical practice, for the benefit of both patients and clinicians.

Oesophagogastric and gastrointestinal surgery, compared to subspecialties like neurosurgery and orthopaedics, have been relative 'late adopters' of 3D reconstruction techniques and technologies (16-18). There are a variety of reasons for this, including imaging-related and organ-specific complexities (19). As can be imagined, it is considerably easier to reconstruct solid bony structures in

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contrast to distensible and rapidly changing organs such as the stomach. However, as technologies advance and more work is done to make 3D reconstruction methodologies affordable (20), it can be expected that 3D modelling will have increasing prevalence within oesophagogastric surgery.

To the authors' knowledge, there is no published literature reviewing the role of 3D reconstruction within oesophagogastric surgery. A scoping review is the most appropriate standardised technique to systematically analyse the use of 3D modelling in oesophagogastric surgery, identify gaps in the literature and therefore highlight avenues for future investigation (21, 22). Herein the authors outline a scoping review protocol that aims to consolidate and evaluate the current role of 3D modelling in oesophagogastric surgery, explore gaps in the literature, as well as implications for possible future practice and research.

Methods and analysis:

The scoping review protocol was developed following the accepted six-step methodological framework created by Arksey and O'Malley (23), further refined by Levac et al (24) and the Joanna Briggs Institute (JBI) (25). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses—Extension for Scoping Reviews (PRISMA-ScR) checklist and guideline (26) were utilised in the construction of this protocol and will be used in the final scoping review report.

Stage 1: Identify Research Question:

To articulate a broad yet clear primary review question, the investigatory team used the 'Population, Concept and Context' structure as recommended the by JBI 'Manual for Evidence Synthesis' (27). This created the primary research question:

"What is the current and possible future role of 3D modelling within oesophagogastric surgical practice?"

By answering this question, the scoping review will be the first literature to summarise and condense the current heterogenous applications of 3D modelling within oesophagogastric surgery. As we believe oesophagogastric surgery to be a relative 'late adopter' to 3D modelling, we expect our thematic analysis to demonstrate unexplored avenues of research, in comparison to other surgical specialities. By highlighting these gaps in the literature and considering the work done in parallel specialties, we hope to recommend areas for future research and therefore possible future roles for 3D modelling within oesophagogastric surgery.

Stage 2: Identify studies

A comprehensive search strategy has been developed through the collaboration of the lead investigator and a medical science librarian. After numerous pilot searches, tailored search strategies using keywords, thesauri terms (MeSH terms (MEDLINE) and EMTREE (Embase)) and Boolean Operators were created for selected databased including MEDLINE, Embase, Elsevier Scopus and ISI Web of Science (see Table 1). Databases are to be searched from their inception to 1/6/2020.

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Table 1: Search Strategy for MEDLINE

Search	Query	Results
1	*Exp Esophageal Diseases/*	*142020*
2	*Exp stomach diseases/*	*204194*
3	*Exp upper gastrointestinal tract/*	*199153*
4	*Exp duodenal diseases/*	*97861*
5	*$esophagus.mp.*	*82392*
6	*Stomach/ or stomach.mp.*	*239092*
7	*Duodenum.mp.*	*58650*
8	*Upper gastro*.mp.*	*23904*
9	*1 or 2 or 3 or 4 or 5 or 6 or 7 or 8*	*537167*
10	*General surgery.mp. or exp General Surgery/*	*47586*
11	*Surgery.mp.*	*2632129*
12	*Surgical.mp.*	*1342309*
13	*Operation.mp.*	*338843*
14	*$esophagectomy.mp. or exp esophagectomy/*	*13749*
15	*Gastrectomy.mp. or exp Gastrectomy/*	*45450*
16	*10 or 11 or 12 or 13 or 14 or 15*	*3181552*
17	*9 and 16*	*164788*
18	*(3D or three dimension*).mp.*	*338859*
19	*Exp imaging, Three-dimensional/ or volume render.mp.*	*81153*
20	*18 or 19*	*342110*
21	*17 and 20*	*791*

The reference lists from key sources identified will be hand-searched for additional studies missed through initial database searches. Grey literature will be identified through OpenGrey and Grey Literature Report.

Identified material shall be collated using EndNote X9 (Clarivate) prior to being transferred to Covidence, a web-based software platform for literature reviews recommended by the Cochrane Collaboration (28).

Stage 3: Study selection

The two-stage screening process 'title and abstract screening' and 'full text review' will be used to identify studies for inclusion, using the Covidence platform. Two reviewers (HR and GS) will independently screen and assess for topic relevance. Any disagreement will be resolved through discussion, and if required, a third reviewer (CK) will provide the decisive vote. Results of the selection process will be recorded on a 'PRISMA flow diagram' (29). Inter-rater agreement will be assessed using Cohen's Kappa (30).

Initially a wide-ranging inclusion criterion will be applied (Table 2), however the study selection stage is an iterative process that may require limiting to generate a practical and applicable final study selection. This post-hoc protocol development is an accepted norm in scoping reviews and any deviations will be stated in final report publication (31). For the purposes of the Scoping Review, oesophagogastric surgery is considered to include surgery involving the stomach and oesophagus in benign and malignant states. This will also include bariatric surgery.

3D modelling is an emerging technology and it is anticipated that most research will be of low-grade evidence comprised mainly of case reports and case series. Therefore, selecting studies based on

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methodological quality (using tools such as Newcastle-Ottawa Scale (32) or ROBINS-1 (33)) was deemed inappropriate as it could restrict the scope of the results to a harmful degree. This is in accordance with the accepted guidance for scoping reviews (24).

Table 2: Inclusion and Exclusion Criteria

	Inclusion Criteria	*Exclusion Criteria*
Population	Adult patients with surgical pathologies of stomach and oesophagus	Non-surgical patients and pathologies, paediatric patients (<16 years old)
Context	Oesophagogastric surgical practice and surgical education, all environments considered from lab to theatre	Nil
Concept	All forms of 3D reconstruction, 3D modelling and 3D printing applied to surgical practice	3D reconstruction technologies not applicable to surgical practice
Studies	All forms of studies published in peer reviewed literature	Nil

Stage 4: Charting data

The research team will collectively develop a data charting tool. Once the data charting template has been finalised, two reviewers (HR and GS) will independently chart data on selected studies. Any disagreement will be resolved through discussion, and if required, a third reviewer (CK) will provide the decisive vote.

The data charting tool will follow the 'descriptive-analytical' method described by Arksey and O'Malley (23). Fundamental study descriptors will be extracted including:

- Author(s), year of publication and study location
- Study aims
- Study population and sample size
- Study design
- Intervention
- Main findings

Studies will be analysed and categorised based on the reviewers' qualitative thematic summarisation of the work. The thematic summaries are expected to be divided into overarching themes found in comparative literature (34) :

- Surgical Education and Training
- Patient Education and Engagement
- Surgical Planning and Procedure

The data charting tool will be drafted by the research team and then be piloted by the two independent reviewers (HR and GS) over 5 to 10 of the selected studies for inter-rater agreement and relevance. Again, this is expected to be in iterative process with numerous adaptions required throughout this stage. Charting and extraction will be completed on the Covidence platform, with results transferred to Microsoft Excel.

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Stage 5: Collating summarising and reporting

As recommended by Levac et al (24), the fifth stage will be divided into analysing data, reporting results, and applying meaning to the results. Charted data from selected studies will be collated and analysed using descriptive numerical summary tables and diagrammatical mapping of the qualitative thematic analysis. A narrative descriptive summary will report the results within the context of the stated objectives and consider the implications for future practice and research.

Stage 6: Expert consultation

Once results have been collated and summarised, key stakeholder experts in the field of 3D modelling shall be consulted. These consultations will provide insights beyond the current literature and provide invaluable guidance into disparities within the existing body of evidence. This will allow the research team to highlight areas for future development and advance the use of 3D modelling within oesophagogastric surgery - for the benefit of patients and clinicians alike.

Patient and public involvement

No patient or members of the public were consulted in the generation of this protocol. However, the results may well guide the research team in their aim to improve patient engagement through 3D reconstruction.

Ethics and dissemination

Ethical approval was not required for the collection and analysis of the published data. The scoping review report will be disseminated through peer-reviewed publication, international and nation conferences, appropriate social media channels and patient liaison groups.

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Author Contributions

HR is the lead investigator, reviewer and generated the scoping review protocol. GS is a reviewer and contributed to the creation of the protocol. PB and SB revised the draft paper and provided guidance for the scoping review. GB and FB provided expert consultations on the topic. CK is the senior consultant lead and assisted in the production of the protocol.

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No funding was required in the generation of the scoping protocol.

Conflicts of Interests

None of the registered authors have any conflicting interests in relation to this scoping protocol.

Data Statement Section

All the data collated is publicly available and will be consolidated on the Open Science Framework (osf.io/ta789).

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