# Article

## Long-term outcome of permanent tracheostomies in dogs: 21 cases (2000–2012)

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**Abstract —** This retrospective study reports long-term outcome, survival, and complications in dogs which received a permanent tracheostomy due to upper airway obstruction. Data were collected from medical records ($n$ = 21) in 2 institutions over a 12-year period. Patients were followed until death, complications, causes of death, and survival times are reported. Major complications were reported in 50% of patients with 20% of patients receiving revision surgery. The most common complications were aspiration pneumonia and need for revision surgery. Median survival time was 328 days with 25% of patients surviving 1321 days or longer. Some (26%) patients died acutely at home at various times after surgery. Permanent tracheostomy is a viable procedure for patients with end stage upper airway obstruction; however, a subpopulation of patients suffers acute death at various times after surgery, which is thought to be due to airway obstruction.

**Résumé — Résultat à long terme des trachéostomies chez les chiens : 21 cas (2000–2012).** Cette étude rétrospective présente les résultats, la survie et les complications à long terme chez les chiens qui ont subi une trachéostomie permanente en raison d'une obstruction des voies respiratoires supérieures. Les données ont été recueillies dans les dossiers médicaux ($n$ = 21) de 2 institutions sur une période de 12 ans. Les patients ont été suivis jusqu'à la mort à la suite de complications; les causes de décès et les temps de survie sont signalés. Des complications majeures ont été signalées chez 50 % des patients et 20 % des patients ont subi une reprise chirurgicale. Les complications les plus fréquentes étaient la pneumonie de déglutition et le besoin de reprise chirurgicale. Le temps de survie moyen était de 328 jours avec 25 % des patients qui ont survécu 1321 jours ou plus. Certains patients (26 %) sont morts de façon aiguë à la maison à divers moments après la chirurgie. Une trachéostomie permanente est une intervention viable pour les patients ayant une obstruction des voies respiratoires de stade final. Cependant, une sous-population de patients sont décédés de façon aiguë à divers moments après la chirurgie, que l'on croit attribuable à l'obstruction des voies respiratoires.

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## Introduction

Permanent tracheostomy is an uncommonly performed procedure in small animals. Indications for a permanent tracheostoma include upper airway obstruction due to laryngeal collapse, laryngeal paralysis, laryngeal neoplasia, and trauma (1–3). In the early post-operative period, nursing care is intensive due to increased secretion of mucus which may occlude the respiratory tree. In the post-operative period, tracheal mucosa undergoes squamous metaplasia and contains inflammatory infiltrates. By 16 wk after surgery, tracheal mucosa returns to a more normal state and mucus secretion is diminished (4). Reported complications of permanent tracheostomy include acute death due to asphyxiation from mucus obstruction, stenosis of the tracheostoma, and obstruction due to skin fold occlusion.

Two studies in cats showed short median survival times of 20.5 and 42 d (2,5). Deaths in 9 of 21 and 3 of 7 cases were documented or suspected to be due to mucus obstruction of the respiratory tract or tracheostoma leading to acute death due to asphyxiation (2,5). Limited information on long-term complications and follow-up is reported in dogs. There is only 1 study on perioperative and long-term data after permanent tracheostomy for naturally occurring disease; these are described for 34 cases of cats and dogs (3). In this study, few complications were reported and owner assessment of response to treatment in 22 dogs was fair to good. To the authors' knowledge, long-term outcome and survival times have not been previously reported in dogs after

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permanent tracheostomy for naturally occurring disease. More information regarding outcome after this procedure would be useful in advising owners about treatment options. The goal of this study was to report the long-term outcome, survival time, and complications after permanent tracheostomy in dogs.

## Materials and methods

Medical records of dogs undergoing permanent tracheostomy at Veterinary Specialists of Rochester and Michigan State University between 2000 and 2012 were examined. Dogs were included in the study if they received a permanent tracheostomy to relieve any cause of upper airway obstruction. Dogs that underwent the procedure were not excluded from the study for any reason. Medical records of dogs receiving permanent tracheostomy were reviewed and information was obtained including signalment, history, previous medical and surgical treatments, diagnosis (cause of upper airway obstruction), operating surgeon (faculty or resident), size of the tracheostoma, revision surgery performed (if any), complications, survival time, and cause of death. Long-term follow-up information was obtained via the medical records and through telephone conversation with owners and primary care veterinarians. Survival time was defined as the time from permanent tracheostomy surgery until the date of death.

In all cases, permanent tracheostomy was performed routinely as described elsewhere (4), but peritracheal sutures were not placed. The number of partial tracheal rings removed was based upon surgeon's preference.

### Statistical analysis

All response variables were tested for normality via the normal probability plot and the Shapiro-Wilk test. Some variables were not distributed normally; therefore, non-parametric testing via the Wilcoxon rank sum test was used to determine if there was a difference in survival between occurrence of major and minor complications, surgeon, and revision. The Kruskal-Wallis test was used to determine if diagnosis significantly affected survival time. Fisher's exact test was used to evaluate association between signalment factors (weight, gender), diagnosis, and cause of death. This test was also used to evaluate the association of operating surgeon (faculty or resident) and the need for revision surgery. Median survival time, 25th and 75th quartiles were reported. $P < 0.05$ was considered significant.

## Results

The 21 dogs that met the criteria for inclusion in the study were: 3 Pug dogs, 2 Labrador retrievers, 2 Chihuahuas, 2 Yorkshire terriers, 2 mixed breed dogs, and 1 each of 10 other breeds. Fifteen dogs were female (10 spayed) and 6 dogs were male (all castrated). The mean age +/− standard deviation (SD) at the time of surgery was 7 +/− 3.5 y (range: 0.3 to 13 y); mean weight at the time of surgery was 11.8 +/− 9.5 kg (range: 0.5 to 31 kg).

Presenting complaints included dyspnea in 13 dogs, respiratory distress in 6 dogs, and bite wounds to the cervical region in 2 dogs. Mean duration of clinical signs was 359 d (range: 0 d to 5 y). Fourteen of 21 dogs had previously received medical treatment; some had received corticosteroids ($n$ = 10), antibiotics ($n$ = 8), bronchodilators ($n$ = 4), diuretics ($n$ = 2), sedative medication ($n$ = 2), and an antihistamine ($n$ = 1). Seventeen of 21 patients had received airway surgery prior to permanent tracheostomy. Surgical procedures performed prior to permanent tracheostomy included unilateral arytenoid lateralization ($n$ = 9), temporary tracheostomy ($n$ = 6), partial staphylectomy ($n$ = 4), sacculectomy ($n$ = 2), laryngeal biopsy ($n$ = 2), rhinoplasty ($n$ = 1), and castellated laryngofissure ($n$ = 1).

Results of pre-operative laryngeal examination were available for all patients. Diagnoses included 5 cases of laryngeal collapse due to brachycephalic upper airway syndrome, 5 cases of bilateral acquired laryngeal paralysis, 2 cases each of laryngeal neoplasia, laryngeal collapse of undetermined origin, severe laryngospasm, traumatic laryngeal collapse due to cervical bite wounds, and 3 cases of laryngeal malformation.

Permanent tracheostomy was performed by a faculty board-certified surgeon in 10 cases and by a surgical resident in 11 cases. The number of partial tracheal rings removed was recorded in 18/21 cases. The average number of partial tracheal rings removed to create the stoma was 4.6 (range: 3 to 7).

All patients survived the surgical procedure. Nineteen of 21 patients survived to discharge. One patient with severe cervical bite wounds suffered cardiopulmonary arrest in the immediate post-operative period. One patient was euthanized 24 h after surgery due to severe aspiration pneumonia. Nineteen of 21 patients were followed until death. One patient was lost to follow-up and 1 patient remained alive at the end of the study time.

Complications occurred in 12/20 patients. Complications were defined as major if they required subsequent surgery, necessitated hospitalization, or resulted in death of the patient. Complications were defined as minor if no further medical or surgical therapy was required. Complications were major in 10 of the 12 patients with complications and included aspiration pneumonia in 5, obstruction of the tracheostoma with need for revision surgery in 4, and cardiopulmonary arrest in 1. Minor complications included tracheitis in 1 dog and cervical swelling in another.

Four patients required revision of their tracheostoma. Three patients required revision due to skin-fold occlusion of the tracheostoma resulting in respiratory distress. One patient required revision due to stenosis of the stoma site. Two of 3 patients with skin-fold obstruction also had poor tracheal rigidity which resulted in medial collapse of the tracheostoma into the tracheal lumen causing obstruction. No significant difference was found between operating surgeon (faculty or resident) and need for revision surgery ($P$ = 0.58).

Median survival in this population was 328 d (range: 0 to 3335 d). Causes of death included euthanasia due to non-respiratory disease in 8/19 (42%), acute death due to suspected respiratory obstruction in 5/19 (26%), euthanasia due to respiratory disease in 4/19 (21%), and death due to non-respiratory disease in 2/19 (11%). Acute death due to suspected respiratory obstruction occurred at various times including 6 d, 6 mo, 2 at 11 months, and 1 at 4 y after surgery. No significant association was found between factors of weight, gender, or diagnosis and cause of death ($P$ = 0.51, 0.87, and 0.34, respectively). Survival

**Table 1.** Association of diagnosis with survival time ($P = 0.09$)

| Diagnosis | Median days (25th, 75th) |
|---|---|
| Brachycephalic airway syndrome | 1062 (728, 1744) |
| Bilateral acquired laryngeal paralysis | 91 (8, 329) |
| Laryngeal neoplasia | 1399 (760, 2037) |
| Laryngeal collapse of undetermined origin | 628 (320, 937) |
| Severe laryngospasm | 22 (11, 32) |
| Traumatic laryngeal collapse due to bite wounds | 164 (82, 245) |
| Laryngeal malformation | 1760 (1645, 2006) |

**Table 2.** Complications and association with survival in days

| Factor | Positive median (25th, 75th) | Negative median (25th, 75th) | *P*-value |
|---|---|---|---|
| Minor complication | 1960 (1603, 2317) | 255 (20, 1138) | 0.13 |
| Major complication | 82 (9, 728) | 183 (328, 1631) | 0.12 |
| Revision | 1230 (728, 1996) | 225 (11, 1221) | 0.14 |

time was not significantly affected by diagnosis (Table 1), occurrence of major or minor complications (Table 2), or the need for revision surgery ($P$ = 0.09, 0.12, 0.13, and 0.14, respectively). There was no significant association between operating surgeon (faculty or resident) and survival time ($P$ = 0.93).

## Discussion

Results of the present study show that permanent tracheostomy is an uncommon procedure performed in dogs with upper airway obstruction, as only 21 procedures were performed over a 12-year period at 2 institutions. The most common indications for permanent tracheostomy in this study were laryngeal collapse associated with end stage brachycephalic airway syndrome and bilateral acquired laryngeal paralysis.

All patients survived the surgical procedure and 90% of patients survived to discharge. Median survival time in the present study was 328 d with 25% of patients surviving 1321 days or longer. Additionally, 10/19 (53%) patients died or were euthanized due to causes not associated with respiratory disease. A finding of interest in this study was that 5/19 patients (26%) died acutely at home at various times after surgery. Upon further questioning of owners and referring veterinarians, all 5 patients were reported to be doing very well without signs of respiratory disease prior to acute death. All patients were found deceased at home and had been normal within the previous 24 h. This is a similar finding to a previous study in cats in which 5/15 patients died acutely after discharge with mucus plug obstruction of the tracheostoma being the suspected cause of death (2). Proposed causes of acute death in our patient population include asphyxiation due to obstruction of the tracheostoma site with foreign material, skin folds, or mucus. Unfortunately, necropsy was not performed in any patient to determine cause of death. Concurrent disease cannot be ruled out as a cause of acute death; however, this is unlikely as all owners reported that their pet was normal in the 24 hours preceding death.

There was no significant association between cause of death and factors of diagnosis, weight, or gender. In addition, none of the factors evaluated (diagnosis, complications, operating surgeon, need for revision surgery) was significantly associated with survival time. Diagnosis was the only factor that approached significance when evaluating survival times. While not significant, survival times varied greatly between diagnoses with shortest survival times reported in patients with laryngeal paralysis, severe laryngospasm, and laryngeal collapse due to cervical bite wounds. Type II error is suspected as the number of patients in each group was very small.

In the present study, major complications occurred in 50% of patients, which is higher than previously reported (3). Revision surgery was required in 4/20 patients (20%), similar to findings reported by Hedlund et al (3). Three out of 4 of our patients required revision due to skin-fold obstruction of the tracheostoma, which was the most common complication reported previously (3). Unlike that study, only 1 episode of tracheostomal stenosis occurred. In our population this is likely due to the known risk of stenosis and resultant surgical planning to create a large stoma. Additionally, 2 of 4 patients requiring revision also had medial collapse of the cervical trachea. Both of these patients were Pug dogs without supporting clinical history or evidence of collapsing trachea on pre-operative survey cervical and thoracic radiographs. In both cases this was addressed with enlarging the stoma site and alleviating skin-fold obstruction. Prosthetic tracheal rings were not placed in either patient in this study. Placement of prosthetic rings has been recommended previously in any patient with suspected tracheal collapse to prevent collapse proximal or distal to the stoma site (3). As both patients were Pug dogs it is possible that they may have had early or subclinical collapsing trachea that was exacerbated by permanent tracheostomy. Pre-operative tracheal fluoroscopy or tracheobronchoscopy or both are warranted to help to identify patients with subclinical collapsing trachea prior to performing permanent tracheostomy.

Although a meticulous technique is required for this procedure, there was no significant difference between the two categories of operating surgeons (faculty or resident) and the need for a revision surgery.

Limitations of the present study include its retrospective nature. As permanent tracheostomy is an infrequently performed procedure, a small number of cases was evaluated, potentially leading to type II error. Also, necropsies were not performed in cases of acute death to confirm asphyxiation due to obstruction of the tracheostoma. Larger studies are needed to determine if diagnosis is associated with survival time and to help elucidate a cause for acute death in these patients.

In conclusion, permanent tracheostomy is a viable procedure for patients with end-stage upper airway obstruction. The most common complications encountered were aspiration pneumonia and need for revision of the tracheostoma due to skin-fold obstruction. Long-term survival (1 to 9 y) was achieved in 50% of cases. However, a subset of patients succumbed to acute death due to suspected respiratory obstruction at various times up to 4 y after surgery. There were no significant factors that were associated with acute death. Diagnosis was the only factor that approached significance when evaluating survival times. Larger multi-institutional studies with higher case numbers would help to evaluate if diagnosis is truly correlated with survival time and may also help to determine an underlying cause for acute death after permanent tracheostomy. CVJ

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# Book Review
# Compte rendu de livre

## Sheep and Goat Medicine, 2nd edition

Pugh DG, Baird AN. Elsevier, St. Louis, Missouri, USA, 2012. 621 pp. ISBN: 9781-4377-2353-3. $144.50.

The title is somewhat misleading: this is so much more than a medicine text. Interspersed between the hyperbole, the back cover gives a realistic description "including medical treatments, surgery, theriogenology, heard health and nutrition." The editors are a boarded theriogenologist and surgeon, respectively and its multi-author approach draws on specialists from a wide variety of disciplines.

The section on physical examination is useful but suffers from some minor errors. The rectal temperature ranges are given in both Celsius and Fahrenheit but are not the same. The attempt to differentiate between cortical and cerebral disease is confusing. Chapter 1 also gives straightforward and well-illustrated directions for the safe and efficient handling of small ruminants.

Chapter 2 is a helpful overview of small ruminant nutrition and gives guidelines for appropriate dietary TDN and protein concentrations. These are probably expressed on a 100% dry matter basis, although this is not always explicitly stated. The mineral section is appropriately comprehensive and highlights the differences in copper requirements between different breeds of sheep and between sheep and goats. The chapter contains instruction on how to reliably feed minerals as well as different methods to balance the ration. There are also detailed instructions on feeding sheep and goats at different stages of their life and guidelines on preventing and treating the common nutrition-related diseases.

Chapters 4 to 17 describe the various conditions of sheep and goats on a system-by-system basis. Clinical signs, medical and surgical treatment, and prevention are all appropriately covered. The text is easy to read and clearly laid out. There are many high quality photographs, which are often in color. In general the number of images is more than typically found in printed textbooks. There are occasional omissions — photographs of foot-and-mouth disease lesions would be helpful to those practicing in exotic locations. The index is good but could be more comprehensive — for example, it refers to very useful sections on bluetongue in the hemolymphatic and other chapters but does not reference the section in the oral-esophageal disease chapter.

An excellent chapter is the newly added Chapter 6 on internal parasites. This gives detailed instructions on how to inexpensively perform a fecal float using the modified McMaster's technique in your practice laboratory. It discusses the use and limitations of the FAMACHA system for in the field decision-making. The section on control measures discusses methods to limit resistance, gives dosages and formulations appropriate for use in small ruminants, and emphasizes different treatment recommendations for sheep and goats. For the future, there are short sections on methods of parasite control that are not yet commercialized.

The theriogenology section (Chapter 8) is another comprehensive and excellent chapter. For example, the section on ram breeding soundness examination carefully takes you through the steps of physical examination, semen collection, and laboratory evaluation. It gives guidelines on the categorization of rams and also on appropriate rates of use.

Throughout the text, there are excellent descriptions of surgical techniques. As someone in private practice for the first time, I found the step-by-step illustrated descriptions of how to perform various techniques very handy.

Chapter 18 describes anesthesia, Chapter 19 herd health, and Chapter 20 necropsy.

Overall, I found this book to be an excellent and comprehensive treatment of the diseases and management of sheep and goats. I would very highly recommend it for the library for any practice involved in sheep or goat practice (I intend to keep my copy handy) and for students with a strong sheep or goat interest.

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