Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Pushing the arytenoids open: endoscopic silicone laryngeal stenting in 31 dogs with laryngeal paralysis — how it works, where it goes, and outcomes

Steven Garner

docgarner@safarivet.com

SAFARI VETERINARY CARE CENTERS https://orcid.org/0000-0003-0841-6636

Melinda Wharton

safari veterinary care centers

Case Report

Keywords: dog, laryngeal paralysis, GOLPP, laryngeal stent, arytenoid abduction, esophageal dysfunction, aspiration pneumonia

Posted Date: November 16th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11650657/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations:
The authors declare no competing interests.

Animal Ethics statement: This study was a retrospective review of the medical records of client-owned dogs presented to Safari Veterinary Care Centers (League City, Texas, USA) for treatment of laryngeal paralysis. All dogs were clinical patients, and laryngeal stent placement was performed as a therapeutic clinical procedure within a valid veterinarian-client-patient relationship, in accordance with applicable state and federal regulations governing veterinary practice and the American Veterinary Medical Association's guidelines. Written informed consent was obtained from each owner before the procedure, including consent for the use of anonymized clinical data for research and publication. Because the study involved no experimental animals and no procedures beyond routine clinical care, and consisted

solely of a retrospective analysis of clinical records, approval by an institutional animal care and use committee was not required.

Pushing the arytenoids open: endoscopic silicone laryngeal stenting in 31 dogs with laryngeal paralysis — how it works, where it goes, and outcomes

Garner S[1] and **Wharton M**[2]

[1] Safari Veterinary Care Centers, League City, Texas, USA

[2]

Running head: Laryngeal stenting for canine laryngeal paralysis

Corresponding author:

Manuscript word count: 5828 (main text) Tables: 2 Figures: 6

Conflict of interest: The operating clinician (S.D.G.) offers endoscopic laryngeal stenting clinically. The author has no commercial or financial relationship with the device manufacturer; the only relationship is a working clinical one, in which the manufacturer produced the stent sizes required to meet patients' needs.

Acknowledgements: The authors thank Lacey Webber, CVT, for clinical and technical support, and Emily Laughrun for data management.

Ethics and consent: Owners provided informed consent for stent placement as an alternative to arytenoid lateralization and for the use of anonymized clinical data.

Structured Summary

Objectives To report outcomes and complications of endoscopic silicone laryngeal stenting in dogs with laryngeal paralysis, describe how the stent works, and assess whether presentation influences outcome.

Methods Single-center, single-surgeon retrospective series of 31 dogs (August 2022 to August 2026). Before outcomes were known, dogs were assigned to Group A (stent as treatment, n = 24) or Group B (presented in crisis, with aspiration pneumonia, after failed airway surgery or with structural laryngeal disease, n = 7). Deaths and aspiration pneumonia were adjudicated blind to outcome. A printed model of a cadaver larynx with a stent in place was scanned by computed tomography.

Results No death and no aspiration pneumonia was adjudicated stent-related; one dog regurgitating before placement developed aspiration pneumonia of indeterminate cause. Three dogs (9.7%) died within 30 days. Four (12.9%) developed delayed cricotracheal stricture, managed by bougienage and longer stents; 13 (41.9%) needed revision. Kaplan–Meier all-cause survival was 54.1% at 1 year (median 465 days, 95% CI 154 to 1390). Mortality was 10 of 24 dogs in Group A and 4 of 7 in Group B. Stridor and effort were relieved in 22 of 27 evaluable dogs. In the model, the stent pressed both arytenoids outward.

Clinical Significance Seated from the vocal process to the first or second tracheal ring and sized to fill the larynx, the stent pushes both arytenoids open while leaving the epiglottis free to close. Because this disease also affects the esophagus, aftercare is esophageal care, and presentation should guide counseling.

Keywords: dog; laryngeal paralysis; GOLPP; laryngeal stent; arytenoid abduction; esophageal dysfunction; aspiration pneumonia

41

42

Introduction

The dog that comes to us cannot catch his breath, cannot sleep peacefully and makes noise when he breathes. He is usually an older, larger dog — very often a Labrador retriever — and a highly valued member of the family. Laryngeal paralysis is among the most common causes of upper-airway obstruction in these dogs. In most geriatric dogs it is not idiopathic: it is the first and loudest sign of a slowly progressive, length-dependent polyneuropathy, geriatric-onset laryngeal paralysis polyneuropathy (GOLPP) (Stanley et al. 2010). The recurrent laryngeal nerves are among the longest nerves in the body, so they fail first.

GOLPP is three problems, not one. The larynx cannot open: inspiratory stridor, exercise and heat intolerance, voice change and, at worst, acute obstruction. The esophagus cannot clear: esophageal dysfunction is documented in dogs with laryngeal paralysis (Stanley et al. 2010), and regurgitation is common. And the hind limbs grow weak. Of the three, the esophagus gets the least attention, yet it is where most aspiration starts. When the esophagus is failing, the glottis is the last line of defense.

What kills these dogs is aspiration pneumonia; in a hot climate, heat stroke runs a close second. Unilateral arytenoid lateralization (tie-back) is the treatment of choice. It pulls one arytenoid open from the outside, reliably relieves obstruction — immediate improvement in more than 90% of dogs, with a median survival of about five years (MacPhail & Monnet 2001) — but it fixes that arytenoid open for life. Aspiration pneumonia is its most common serious complication, reported in about 10–32% of dogs and continuing for life; in one large series it occurred in 18.6%, 31.8% and 31.8% of dogs at 1, 3 and 4 years (Wilson & Monnet 2016).

The job of a laryngeal stent is simple to state: give the dog an airway without making aspiration more likely. Most of us start by thinking of the stent as a tube — a conduit for air from the

trachea to the pharynx that happens to pass through the larynx. Three small case series have tested stents in dogs. Ricart et al. (2020) treated seven dogs with laryngeal paralysis, or stenosis after earlier laryngeal surgery; signs improved substantially and the technique was described as easy to learn. Théron et al. (2022) treated six dogs whose owners declined tie-back; all improved at once, one aspirated water until the stent was repositioned, and one stent migrated caudally and the dog went to tie-back because no larger stent was then made. Most recently, David et al. (2026) treated 14 dogs, ten with laryngeal paralysis. All improved at first; aspiration pneumonia occurred in about 30% of the paralysis dogs, two stents were removed, and the three stent-related deaths were all in dogs stented for something other than paralysis. The reading of these series is that stents have a place in emergency and critical care, but that complications are common and serious. None described a standard way to size or seat the device, or explained why stents work when they work and fail when they fail.

What changed our results was to stop thinking of the stent as a conduit and to think of it as a way to abduct the arytenoids. The tie-back pulls on one arytenoid from outside the larynx. A stent pushes on both from inside. The whole challenge is where to push and how hard: not enough, and the stent is coughed out or inhaled; too much, and the mucosa dies from pressure.

This study had four aims: to report outcomes and complications in 31 dogs — to our knowledge the largest series of laryngeal stenting reported; to describe how the stent works, as a push on the arytenoid that mirrors the pull of a tie-back; to describe the placement rules we learned, dog by dog, and how each was found; and to see whether the way a dog presents predicts its outcome.

Materials and Methods

Study design and setting

This was a single-center, single-surgeon retrospective case series. We reviewed the records of all dogs that had an endoscopic silicone laryngeal stent placed at Safari Veterinary Care Centers (League City, Texas, USA) between August 2022 and August 2026. One clinician (S.D.G.) did every procedure. Enrollment closed on 10 August 2026. Survival was censored at owner-verified vital status on 27 August 2026.

Case selection

Dogs were eligible if laryngeal paralysis was confirmed by laryngoscopy, a silicone laryngeal stent was placed transorally, and the owner consented to stenting as an alternative to arytenoid lateralization. Dogs whose main obstructive or swallowing problem was not laryngeal were excluded. Of 32 consecutive dogs, one was excluded (cricopharyngeal achalasia with esophageal dysmotility), leaving 31 for analysis (Fig 1).

Clinical groups

Dogs were grouped using only information recorded at or before placement, and the grouping was applied blind to outcome. Group A (laryngeal paralysis) received the stent as intended first- or second-line treatment and had none of the Group B features. Group B (came in sick) had one or more of: cyanosis or acute respiratory crisis at presentation; aspiration pneumonia at presentation; failed earlier laryngeal or upper-airway surgery; or a structural laryngeal problem. Three dogs with non-geriatric onset (2, 3 and 5 years old) were kept in the series and flagged.

Evaluation before placement

All dogs had a physical examination, complete blood count and serum biochemistry. Laryngoscopy confirmed the paralysis and its laterality and allowed the trachea and mainstem

bronchi to be examined. Our work-up grew over the series: cervicothoracic radiographs and a videofluoroscopic swallow study before placement became routine later on and were not done in every dog.

Anatomic model and bench test

To see how a seated stent loads the larynx, we built a model from the larynx of a 17.5-year-old dog euthanized for progressive neurological disease. The cartilages were scanned by CT, segmented and printed in resin at 129% of natural size, then assembled by hand on their natural joints. The vocal folds, the interarytenoid area and the epiglottic attachment were rebuilt in polymer clay, a 20 mm silicone stent was seated, and the whole assembly was scanned by CT. Each printed piece was registered back into the scan, so every part could be located against the stent. Earlier clay scale models, built to a 22 mm stent, were used to watch how a round stent changes shape inside the larynx. On the bench, a 1 cm segment of 22 mm stent stock was compressed from round to an 18 mm oval while the load was measured, first across the body and then across the nub rows. These are model and bench observations, not patient data, and are reported as such.

Stent size

Silicone laryngeal stents (ABT Stenting) are supplied as stock and cut to length for each dog. The surface carries cylindrical nubs in two opposing, staggered rows about 10 mm apart. Diameter was chosen during the procedure by endoscopy and fluoroscopy; radiographic measurement alone proved unreliable. A stent sized to the first tracheal ring sat too loose in the larynx, so we chose a diameter about 2 mm larger than the first tracheal ring and confirmed the fit before release. Seated diameter ranged from 15 to 22 mm.

Length is set by two landmarks. The cranial edge sits at the vocal process of the arytenoid, caudal to the corniculate processes; the caudal edge sits at the first or second tracheal ring. In most dogs this is 40–45 mm. For most of the series we used a shorter stent of about 31 mm (three nubs per row), ending at the caudal edge of the cricoid; how and why that changed is described in the Results. Where length was not recorded at the time, it was recovered from post-placement radiographs by counting the nubs in one row.

Placement

Anesthesia was induced with propofol given slowly to effect, so that laryngeal movement could be judged as the dog went to sleep; dexamethasone was given for peri-procedural swelling. The airway was surveyed to the carina, with bronchial brush cytology and culture. The stent was folded on itself and clamped in long Carmalt forceps with the box lock engaged. Because the nubs tend to hang on the mucosa at the laryngeal opening, flat Doyen intestinal forceps were used to hold the rima open. The folded stent was slid along the inside of the Doyen jaws, just past the corniculates, to the level of the vocal process, and released. It was allowed to unfold, and we helped it expand with forceps from the inside until it filled the larynx. The most caudal nub was turned ventrally to sit at the narrow ventral ring of the cricoid, and the lateral nubs were seated just caudal to the vocal folds. Position was confirmed by fluoroscopy, and the stent was repositioned, when needed, by rotating it.

Aftercare is esophageal care

Because the esophagus is part of this disease, our aftercare is mostly esophageal care. Every dog had a 7-day inpatient period: food from an elevated bowl, head up after meals and during sleep, water given in steps (gelatin cubes or thickened water first), a promotility drug (metoclopramide or cisapride) and acid suppression (famotidine or omeprazole); long-term maropitant was

avoided. Before discharge a videofluoroscopic swallow study confirmed that the dog was not aspirating. Early in the series this used one consistency; later we used water, thickened water, gruel and canned food.

Concurrent stem cell therapy

Five of the 31 dogs (16.1%) received intravenous mesenchymal stem cell therapy during their course — two for the laryngeal or neurological disease (one at 2×10^6 cells/kg) and three for other conditions. This is disclosed as a co-intervention and identified for each dog in Table 1.

Outcome definitions and statistics

Aspiration pneumonia required compatible clinical signs and thoracic radiographic changes. It was categorized a priori as present at presentation, stent-related, secondary to comorbid illness, or mild/non-fatal; only stent-related episodes counted as device-related events. Episodes without radiographic confirmation were recorded but not counted. At final re-adjudication, one dog whose aspiration pneumonia could not be attributed to the device, the procedure or comorbid disease was classified indeterminate; this category was not specified a priori. Revision was sub-classified as trimming, resizing, or replacement for mucus or scar. Delayed stricture was defined as endoscopically confirmed scar narrowing at or next to a stent edge.

Survival ran from placement to death from any cause or to the censoring date. Kaplan–Meier survival was estimated for the whole cohort and for each group and compared by log-rank test; because Group B was defined by how sick the dogs were at presentation, any difference was read as prognosis, not as an effect of the stent. A sensitivity analysis excluded peri-procedural deaths. Group assignment, death attribution and aspiration pneumonia category were adjudicated blind to outcome and reconciled case by case by the co-author statistician (M.W.), who also did the analyses.

178

Results

The dogs

Thirty-one dogs met the inclusion criteria (Fig 1). Median age at placement was 12.3 years (range 2.9–15.6 years); three dogs had non-geriatric onset (2.9, 3.9 and 5.0 years). There were 19 males (13 neutered) and 12 females (11 spayed); median body weight was 30.9 kg (range 8.7–52.2 kg). Labrador retrievers predominated (11 dogs), with four more retriever-type dogs; the other 16 were of 14 other breeds or crosses. Paralysis was bilateral in 25 dogs and unilateral in two; one dog had obstructive everted laryngeal saccules, and in three dogs laterality was not recorded. Seated stent diameter ranged from 15 to 22 mm. Survival times ranged from 1 to 1390 days (median follow-up 486 days by reverse Kaplan–Meier; 17–577 days among dogs alive at censoring), and 17 of 31 dogs (54.8%) were alive at the censoring date.

What the model showed

In the CT of the assembled model, the stent sat between the vocal folds, with the folds at its cranial edge, and pressed outward on both arytenoids (Fig 2). It touched the cricoid ring, the trachea and both arytenoids; the snuggest point was the cricoid ring. It stayed at least 1 mm clear of the thyroid cartilage. The stent was no longer round: it took the oval shape of the larynx. In the clay scale models, the same round stent deformed from circular to oval to match the rima glottidis. On the bench, compressing a 1 cm segment of 22 mm stock to an 18 mm oval took about 100 g across the body and about 150 g when the load was carried by the nub rows alone.

How the placement rules were found

Each rule in our current technique came from a dog. Each time we broke one, the dog showed us, and each time we fixed it, the problem went away (Fig 3).

Too long. Early on we thought that further down the trachea was better. Once the stent reached past the second tracheal ring, dogs had constant coughing, gagging and intolerance that did not fully settle with time. In three dogs, trimming as little as 2 mm produced a stent the dog tolerated.

Inside the larynx only. We then kept the stent short and inside the larynx, sized about 2 mm over the measured tracheal diameter. Tolerance and air movement were excellent.

In front of the corniculates. At first we kept the stent behind the root of the epiglottis and took normal epiglottic motion on fluoroscopy as the measure of success. That was not the right test. Epiglottic closure is passive: the hyoid apparatus pulls the whole larynx forward and the epiglottis folds over. During the swallow, food waits in the piriform recess, and a stent sitting in front of the corniculates and vocal folds held the inlet open, so food and especially water got in, with coughing and gagging at meals. Seating the cranial edge at the vocal process, caudal to the corniculates, left nothing in the laryngeal vestibule, and the epiglottis could again seal the inlet.

Too short. A 31 mm stent ending at the caudal edge of the cricoid looked ideal: the nubs caught ventrally on the narrow cricoid ring and the stent could not move forward or back, it took the shape of the rima, and it stayed round where it left the cricoid. Then four dogs (12.9%), all with 31 mm stents, developed a stricture at the cricotracheal ligament (below). All four were managed by bougienage and a longer stent reaching the first or second tracheal ring, which set the caudal limit.

Too narrow. A stent sized to the trachea never displaced the arytenoids and had nothing to hold it: it was coughed out or slid caudally into the cervical trachea — never past the thoracic inlet in this series. One device was expelled entirely in a dog that depended on it for its airway; the dog

223 came to no harm and was re-stented, but we do not call this event benign. Sizing to the larynx,
224 about 2 mm over the first tracheal ring, prevented it.
225 ***Safety and deaths***
226 No death in this series was adjudicated stent-related. Fourteen of 31 dogs died (45.2%). On
227 outcome-blind adjudication and manual reconciliation of every case, 8 deaths were not stent-
228 related, 3 were peri-procedural (≤30 days; 1, 5 and 6 days after placement — the last with
229 profuse haemorrhage and inappetence) and 3 were indeterminate (cause unknown or
230 unconfirmed: one remote death and two deaths at 32 and 154 days reported by owners without a
231 determined cause). Causes included end-stage disease present at admission, unrelated infection,
232 neurological disease leading to euthanasia, aspiration in a dog with a prior splenectomy,
233 presumptive terminal aspiration in a dog with progressive polyneuropathy and suspected
234 hyperadrenocorticism (stent seen intact and in laryngeal position at euthanasia by the attending
235 veterinarian), and a peri-anesthetic hyperthermic event (Table 1). Even under the most
236 conservative attribution, no death was consistent with device failure.
237 Device-related mucosal necrosis was not seen. When stents were exchanged, the pockets the
238 nubs had made in the mucosa bled but showed no necrosis, and the floor of each pocket was soft
239 tissue, not bare cartilage. One dog (2024) formed scar at the stent opening and needed a
240 replacement. Early after placement, coughing, gagging, salivation, more mucus and transient
241 dysphagia were common and generally settled on their own; early problems were secretory and
242 reflexive, while late problems were scar at the stent edge.
243 ***Aspiration pneumonia***
244 Using the a priori categories and the radiographic case definition, no aspiration pneumonia was
245 adjudicated stent-related. One dog (3.2%) was classified indeterminate: regurgitation was

recorded before placement; aspiration pneumonia developed 7 days after placement (culture-positive, with the stent in position and patent at endoscopy) and resolved; and a second episode at 130 days came with anorexia and progressive neurological disease. Aspiration pneumonia was present at admission in 4 dogs (12.9%), was secondary to comorbid disease (adjudicated not device-related) in 2 dogs (6.5%), and was mild and non-fatal in 2 dogs (6.5%); 22 dogs (71.0%) had no aspiration pneumonia. No episode came from device failure or airway obstruction (Table 2).

Revisions and the learning curve

Thirteen of 31 dogs (41.9%) had a stent revision, in two distinct groups (Table 1). Early revisions — trimming, resizing or reseating, generally within the first month — occurred in 11 dogs and were about size and seating; they were more frequent in the earliest cases (3 of 6 [50%] in 2022–2024 vs 8 of 25 [32%] in 2025–2026), as expected for one surgeon learning a technique. Late revisions were about scar: one dog (2024) needed replacement for scar at the stent opening, and dogs with delayed stricture needed bougienage and a longer stent. No revision caused lasting harm. Crude mortality in early and late cohorts is confounded by follow-up time and is not a mortality learning curve.

Delayed stricture at the cricotracheal segment

Four dogs (12.9%) developed a delayed stricture at the cricotracheal segment — the soft, cartilage-free ring of tissue at the caudal edge of a 31 mm stent. The first coughed out her stent on day 112; on day 114 endoscopy showed laryngotracheal stenosis with a pressure and granulation injury at the caudal edge of the original stent, and after bougienage a 17 × 45 mm stent was placed (the stricture would not admit a 20 mm stent), reaching just past the first tracheal ring, with good function since. The second had weeks of progressive night-time throat-

clearing before a circumferential scar ring was found on day 63; the stent was replaced with a 17 × 38 mm stent seated at the first tracheal ring. The third developed a cricotracheal stricture. The fourth was diagnosed on day 53 and had a 20 × 45 mm stent placed on day 57; this dog's stent had earlier migrated caudally and been retrieved, and retrieval trauma may have contributed. All four were stented between April and June 2026 and diagnosed 7–16 weeks after placement; whether this is true clustering, detection by our surveillance at the time scar matures, or missed cases earlier cannot be decided retrospectively. Recurrent, progressive throat-clearing or expectoration weeks after a smooth start was the consistent sign, and we now use it as the trigger for endoscopy. No stricture was fatal.

Survival and clinical groups

Whole-cohort Kaplan–Meier all-cause survival was 83.4% at 90 days, 65.6% at 6 months, 54.1% at 1 year and 42.1% at 2 years, with a median of 465 days (95% CI 154–1390) (Fig 4A); median follow-up was 486 days. Mortality was 10 of 24 (41.7%) in Group A and 4 of 7 (57.1%) in Group B. Median survival was 472 days in Group A (n = 24) and 154 days in Group B (n = 7); the difference was not significant (log-rank $\chi^2 = 1.87$, $p = 0.17$) (Fig 4B). Excluding the three peri-procedural deaths, the whole-cohort median was 472 days. These are all-cause figures in old dogs: they fall with longer follow-up as dogs die of age-related disease, and they are not for comparison with survival after arytenoid lateralization.

Unilateral paralysis

Two dogs had unilateral paralysis. One (left-sided) had a notably intense reflex course after placement, with aspiration pneumonia 7 days after placement (regurgitation pre-dated placement; attribution indeterminate), and was later euthanized for progressive neurological signs (presumptive intracranial disease; no imaging). The other (right-sided, after removal of a

prescapular liposarcoma with probable recurrent laryngeal nerve injury and a heavy comorbidity burden) improved at first, then stridor returned when the stent migrated about 5 cm into the trachea; at endoscopy around day 10 the nubs were embedded in the tracheal mucosa, and the stent was removed and repositioned. This dog was later found to have advanced comorbid neoplasia (renal mass with probable metastases) and, on day 53, a cricotracheal stenosis. The migrated stent caused no evident discomfort, yet the dog had stridor again — tolerance and benefit are separate, and benefit needs the stent seated in the larynx. The migration also showed directly that the nubs embed in the mucosa within about ten days.

Function and owner-reported response

In 22 of the 27 dogs evaluable at the prior data lock, the record or owner described clear improvement — most often loss or marked reduction of stridor and breathing effort, return of exercise and heat tolerance, and normal activity; several dogs could bark again. Relief was often quick: noise eased within the first day in several dogs; one dog that had arrested and needed CPR at presentation was later recorded running to play; and one dog managed an outdoor walk in high humidity the day after placement, which the owner said had been impossible before. [These reports come from records and owner communication, not a validated quality-of-life or respiratory instrument, and were not graded the same way across the series; structured owner-reported outcomes are being collected and will be reported separately.]

Discussion

The stent is not a tube. In this series, the largest reported, it worked by pushing both arytenoids open from inside the larynx, and it did so without a death adjudicated stent-related. Early complications were secretory and reflexive — coughing, gagging, salivation and mucus — not obstructive. Late in follow-up a mechanical complication appeared, stricture at the cricotracheal segment, which was found by a consistent sign and fixed by bougienage and a longer stent. Most dogs breathed more easily, often within days.

Pull one end, or push the other

The dog's arytenoid is a complicated cartilage, but for this purpose it can be reduced to three points (Fig 5). The first is its joint with the cricoid: any movement of the arytenoid is on or around this joint. The second is the muscular process, on the lateral side, where the cricoarytenoideus dorsalis and lateralis attach. The third is the vocal process, on the medial side, where the vocalis muscle and vocal ligament attach and run ventromedially to the floor of the thyroid cartilage; these pull the vocal process inward.

Seen this way, the arytenoid is a lever on its cricoid joint. The cricoarytenoideus dorsalis pulls the muscular process caudomedially; the tie-back imitates that pull with a suture from the muscular process to the caudodorsal cricoid, and fixes it there. The stent pushes the vocal process laterally from the lumen, just caudal to the rima glottidis. These are forces at opposite ends of the same lever, pointing roughly opposite ways, and so they turn the arytenoid the same way: the vocal process swings out. The tie-back does this to one side, from outside, and fixes it there. The stent does it to both sides, from inside, and holds against the vocal ligament and the adductors where their pull lands on the vocal process. We present this lever as our explanation;

the abduction itself was seen in the clay models and in the printed-model CT (Fig 2), and the oval shape of the seated stent was seen on CT in treated dogs.

A normal airway is not maximal abduction; it is mid-range abduction. We are not trying to open the arytenoids as far as they go. The stent holds both at mid-range, and because nothing sits in the laryngeal vestibule, the epiglottis can still close over the inlet when the dog swallows. Treated dogs often kept or regained their bark, which a sutured, lateralized arytenoid does not allow. In dogs with long-standing bilateral disease, the rima opened less and the seated stent was a narrower oval, consistent with fibrosis around chronically adducted cartilages; the stent still worked, but earlier treatment may open the glottis more. [Observational; not measured systematically.]

Where to push: the corridor

The placement rules in the Results define a corridor (Fig 3). Cranially, the edge belongs at the vocal process, caudal to the corniculates: that is where the push abducts the arytenoid, and anything further forward holds the inlet open during the swallow. The corniculates are part of the arytenoid, so they come along when the arytenoid is pushed; the stent does not need to touch them. Caudally, the edge belongs at the first or second tracheal ring. Ending at the caudal cricoid left the soft, cartilage-free cricotracheal segment against a free stent edge, and it scarred. Going past the second ring brought constant coughing and gagging, which stopped with as little as 2 mm of trimming. Between these limits, most dogs need 40–45 mm.

The shape of the opening matters too. Dorsally, the rima is set by the interarytenoid cartilage and ligament, where the two arytenoids join at the front of the cricoid — not by each arytenoid's own joint. Ventrally, it is set by the vocal folds, running from the vocal process forward to the floor of

the thyroid. A round stent does not stay round in this space; it takes the oval of the larynx, and that shared shape is what leaves no gap.

Why not a short ring that sits only between the vocal processes? Because the push has to be anchored, and the anchor is the cricoid. A ring a few millimetres long has nothing to hold it against coughing, breathing and the forward movement of the larynx during the swallow; it would tip and be coughed out or inhaled. It would put all of its force on two small spots over the vocal processes, and both of its edges would sit at the glottis, where scar would narrow the very opening we are trying to hold. The body of the stent is what reaches from where it pushes, at the vocal process, to what it pushes against, the ventral cricoid ring, where the nubs lock on either side.

How hard to push: fill the larynx

Not enough, and the stent is coughed out or inhaled; too much, and the mucosa dies. We size about 2 mm over the first tracheal ring — the larynx consistently takes a larger diameter than the trachea next to it, and a stent sized to the trachea sat loose — and we expand the stent until it fills the larynx. Filling the larynx leaves no gap where ingesta can collect, and it engages the nubs. Over about a week the nubs work into the mucosa and come to rest against the cartilage, with soft tissue still at the floor of each pocket, and they act as standoffs that hold the body of the stent off the mucosa. That keeps the capillaries from blanching and is, we believe, why we did not see pressure necrosis. The forces involved are modest: on the bench, about 100 g compressed a 1 cm segment of 22 mm stock to an 18 mm oval, and about 150 g did so when only the nubs carried the load. Radiographs and body weight were poor guides to laryngeal size, which varies widely between dogs (Dzierżęcka & Charuta 2021), so the final size was set during the

procedure. Larger stents, up to 24 mm, are now available, removing the size ceiling that ended one dog's stent treatment in an earlier series (Théron et al. 2022).

The esophagus, and aspiration

Because GOLPP includes the esophagus, a stent that relieved the obstruction but made the glottis leak would trade one problem for a worse one. The corridor protects against that: the stent abducts the arytenoids to mid-range and stays out of the vestibule, so the epiglottis can still seal. It does not treat the esophagus. That is why our aftercare is esophageal care — elevated feeding, head up, water in steps, a promotility drug, acid suppression and a swallow study before discharge.

No aspiration pneumonia in this series was adjudicated stent-related, but aspiration pneumonia did occur after placement (Table 2). The one indeterminate dog shows how hard attribution is in GOLPP: he was regurgitating before the stent went in, developed pneumonia a week later with a patent, well-placed stent, and had a second episode during progressive neurological disease. The categories used here differ from the all-cause definitions of tie-back series, and a single-arm study cannot show superiority, so we do not compare rates; a direct comparative study is needed.

Safety compared with other stent series

Our results differ from the most recent series, in which three of 14 dogs died of stent-related airway obstruction (David et al. 2026). All three of those deaths were in dogs stented for conditions other than paralysis — recurrent granuloma in two dogs stented against proliferative disease, and aspiration in one — and neither death among the ten paralysis dogs was device-related. Our indication was confirmed laryngeal paralysis, and no death was adjudicated device-related among 31 dogs. Together these suggest that stent safety depends on the indication: a stent can hold open a paralyzed but structurally normal larynx, but not an airway that granulation or

scar is actively closing. The recurrent granulomas in that series are plausibly the same edge-on-soft-tissue process as our cricotracheal strictures, acting on tissue already committed to granulation; in our dogs, the restricted indication and scheduled endoscopy meant it showed up as a fixable stricture. Differences in sizing, placement, surveillance and aftercare between centers may also contribute, and small series cannot separate these effects.

The strictures, and what they changed

The strictures formed at the one ring of tissue in the stented field that is neither cartilage-caged larynx nor ringed trachea: the cricotracheal segment. We think the free edge of a 31 mm stent, moving against this unsupported membrane, provoked granulation and then scar — the same kind of device–tissue interaction as the 2024 opening-scar case. A longer stent that bridges the segment and ends on the first or second tracheal ring puts the edge on cartilage instead. Where the stricture limited diameter, a 17 mm stent was needed even though the larynx takes about 2 mm more; a stent that is wider at the rima and narrower across the cricotracheal segment would fit this anatomy better [proposed; not yet manufactured]. Endoscopic surveillance is now scheduled for every dog.

Who to stent, and what to tell the owner

The stent was safe across the series, but outcome followed presentation. Two of the three peri-procedural deaths were in Group B dogs, and all-cause mortality was 57.1% (4 of 7) in Group B against 41.7% (10 of 24) in Group A (Fig 4B); the difference was not significant, and later deaths in Group A largely reflect longer follow-up of old dogs. This is prognosis, not treatment effect: no Group B death was attributed to the stent. Most dogs in this series travelled to us after seeing a specialist near home, and some arrived on oxygen; we cannot show that they were harder or easier than dogs seen elsewhere. A stent can stabilize even a critically presented dog,

but it cannot reverse the disease that governs its longer course. Presentation should guide case selection and counseling (Fig 6), and it argues for offering the stent earlier rather than as a last resort.

Unilateral paralysis (hypothesis only)

Of our two unilateral dogs, one had an intense reflex course and early aspiration pneumonia of indeterminate cause, and the other's stent migrated. A dog with unilateral disease keeps sensation on the working side and may react more strongly to something in the airway, and a lopsided larynx may grip a stent less evenly. These are two dogs, one confounded by earlier surgery, and we offer the idea only for prospective study.

Limitations

This is a retrospective, uncontrolled, single-surgeon, single-center series; one technique strengthens internal consistency but limits how far the results travel. Comparisons with arytenoid lateralization come from the literature, not a control group. Follow-up varied (1–1390 days; median 486 days), and recently treated dogs contribute short follow-up, so survival estimates — especially group medians in small groups — are imprecise. Survival is all-cause in old dogs (median age 12.3 years); it reflects background mortality as much as treatment and must not be compared with survival after arytenoid lateralization. Grouping, cause of death and aspiration pneumonia category involve clinical judgment; they were adjudicated blind to outcome by an independent reviewer (M.W.). Five dogs received stem cell therapy, a disclosed co-intervention. Only two dogs had unilateral paralysis. Referral patterns probably enriched Group B. The strictures were found late in the observation period, partly through active surveillance, so their true incidence and timing are not yet known; the most recent dogs had 17–112 days of follow-up at censoring. Vital status was verified by owner contact on 27 August 2026; three dogs died after

that date and are censored alive per protocol. Three deaths have no determined cause and are classified indeterminate rather than assumed unrelated. One death (presumptive terminal aspiration) could not be adjudicated blind to outcome because it was found during data reconciliation. The aspiration pneumonia category of one dog was revised from stent-related to indeterminate after a full review of records from five clinics, requested by the surgeon-author and confirmed by the independent reviewer; the indeterminate category was not specified a priori. The mechanism rests on models, a bench test, endoscopic views, and patient CT appearance, not on direct measurement of force or arytenoid rotation in living dogs. Endoscopic views and post-placement CT in treated dogs showed the stent seated between the vocal folds, taking the oval shape of the larynx and pressing on both arytenoids, consistent with the model findings and the proposed push mechanism.

Conclusions

Three things. First, the stent is not a tube: it pushes both arytenoids open from the inside, the mirror image of the tie-back's pull, and holds them at mid-range while leaving the epiglottis free to close. Second, it belongs in a corridor — from the vocal process, caudal to the corniculates, to the first or second tracheal ring, sized about 2 mm over the first tracheal ring so that it fills the larynx; every limit of that corridor was found by a dog that crossed it. Third, GOLPP is a disease of the esophagus as well as the larynx, so aftercare is esophageal care. In this series the stent relieved obstruction without a cervical incision, without a permanent suture and without a death adjudicated stent-related, and how a dog presented set its prognosis. A prospective comparative study with validated respiratory and quality-of-life measures is needed to confirm these findings and to test the mechanism proposed here.

References

David M, Giraud L, Dumont R, Gibert S, Dunié-Mérigot A, Boiron L, Sériot P & Jolivet F (2026) Silicone stent placement for laryngeal diseases: a retrospective study of 14 dogs (2022-2025). Journal of Small Animal Practice. https://doi.org/10.1111/jsap.70143.

Dzierżęcka M, Charuta A (2021) Morphometric description of the larynx in the dog (Canis familiaris). *Acta Scientiarum Polonorum Zootechnica* 20(4).

MacPhail CM, Monnet E (2001) Outcome of and postoperative complications in dogs undergoing surgical treatment of laryngeal paralysis: 140 cases (1985–1998). *Journal of the American Veterinary Medical Association* 218, 1949–1956.

Ricart MC, Rodriguez SM, Dure RM (2020) Laryngeal stent for acute and chronic respiratory distress in seven dogs with laryngeal paralysis. *Open Veterinary Journal* 10, 168–175.

Stanley BJ, Hauptman JG, Fritz MC, Rosenstein DS, Kinns J (2010) Esophageal dysfunction in dogs with idiopathic laryngeal paralysis: a controlled cohort study. *Veterinary Surgery* 39, 139–149.

Théron ML, Lahuerta-Smith T (2022) Laryngeal silicone stent as a treatment option for laryngeal paralysis in dogs: a preliminary study of 6 cases. Journal of Veterinary Science 23, e58. https://doi.org/10.4142/jvs.22068

Wilson D, Monnet E (2016) Risk factors for the development of aspiration pneumonia after unilateral arytenoid lateralization in dogs with laryngeal paralysis: 232 cases (1987–2012). *Journal of the American Veterinary Medical Association* 248, 188–194.

Figure legends

Figure 1. Case disposition and clinical groups. Thirty-two dogs received a stent; one was excluded (cricopharyngeal achalasia), leaving 31. Group assignment, cause of death and aspiration pneumonia category were adjudicated blind to outcome; vital status censored 27 August 2026. Survival is all-cause in a geriatric cohort.

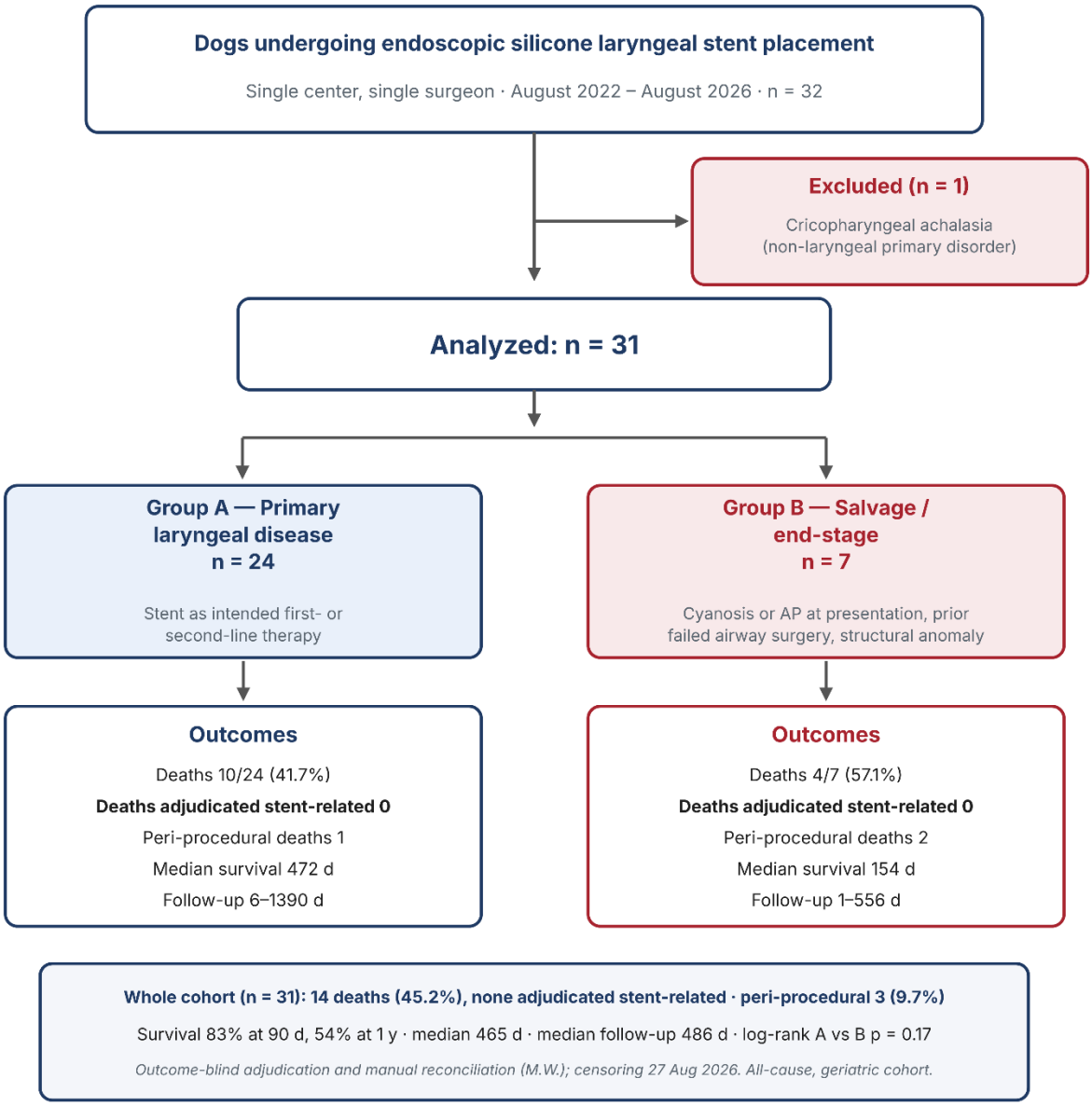
Figure 2. CT of the assembled 129% resin model printed from a cadaver larynx, viewed from cranioventral (thyroid and epiglottis hidden): the stent (teal) is seated between the vocal folds (pink, polymer clay) with the arytenoids (green) on the cricoid (tan) above the trachea (beige). Model observation, not patient data.

Figure 3. The placement corridor, midsagittal schematic (cranial left, ventral down), drawn from a CT of the assembled printed model and scaled to a typical case with a 41 mm stent. The cranial edge is at the vocal process, caudal to the corniculates; the caudal edge at tracheal ring 1–2; ventral nubs lock either side of the ventral cricoid ring. Arytenoid and vocal fold lie lateral to the midline and are shown faded. Dimensions approximate.

Figure 4. Kaplan–Meier all-cause survival after laryngeal stent placement (n = 31): (A) whole cohort with 95% confidence band; (B) by clinical group, Group A (laryngeal paralysis, n = 24) vs Group B (came in sick, n = 7); log-rank p = 0.17. Tick marks are censored dogs; numbers at risk below each panel. All-cause estimates in old dogs; not for comparison with arytenoid lateralization.

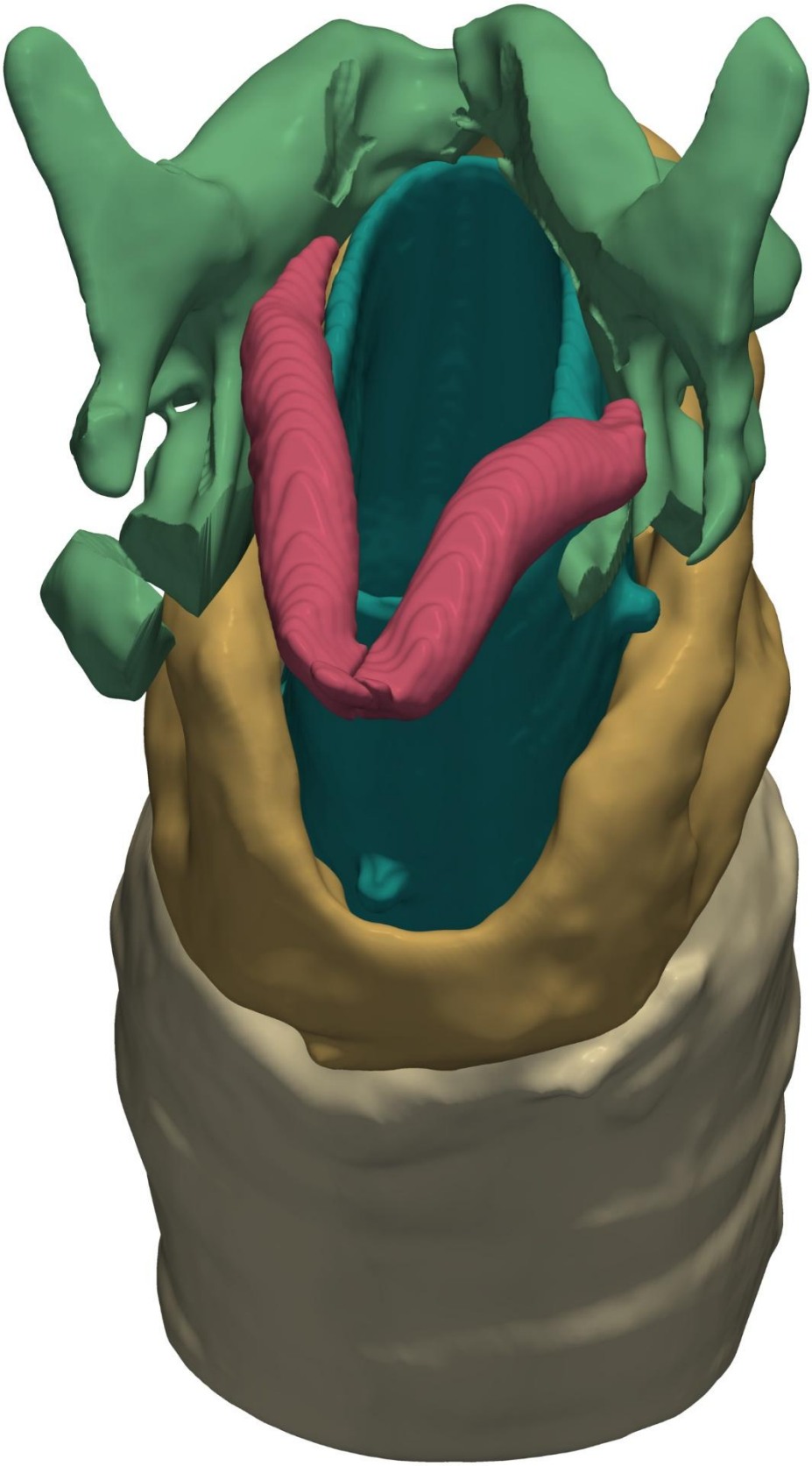
Figure 5. Pull one end, or push the other. Cranial view of the larynx, dorsal at top, with the arytenoid drawn as a simple lever on its cricoid joint. Left: the cricoarytenoideus dorsalis, or a tie-back suture, pulls the muscular process and the vocal process swings out (one side). Right:

514 the stent pushes both vocal processes outward from the lumen, against the vocal ligament and
515 adductors (grey). Dashed outlines show the paralysed position. Schematic, not to scale.
516 **Figure 6.** Case selection and counseling by presentation, with the shared placement and aftercare
517 pathway.
518

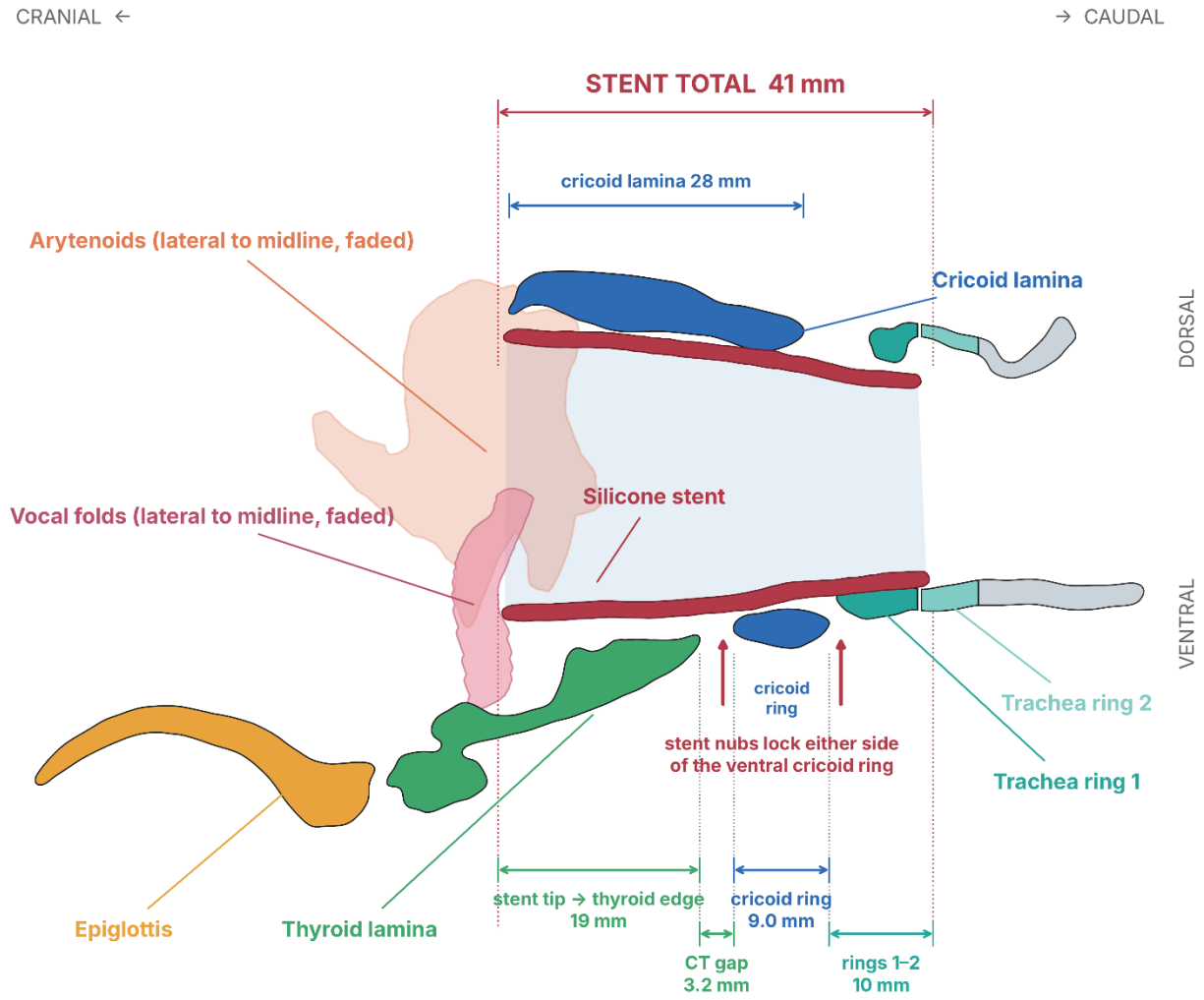


Within-series flags: 3 non-geriatric-onset dogs (ages 2.9, 3.9, 5.0 y); 2 unilateral paralysis; 5/31 received concurrent IV mesenchymal stem cell therapy (disclosed co-intervention).

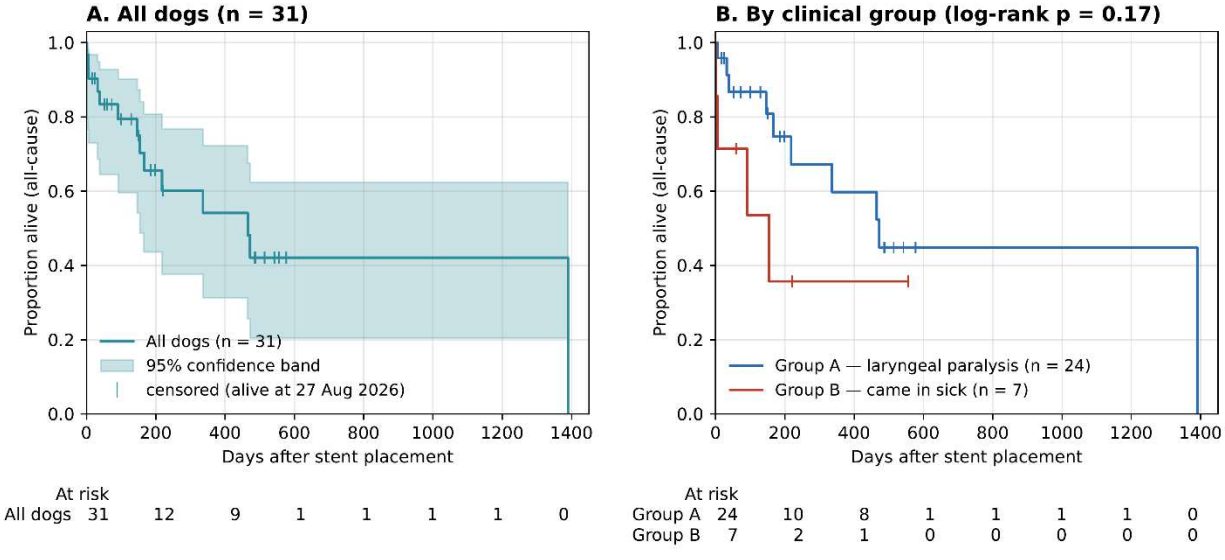
519



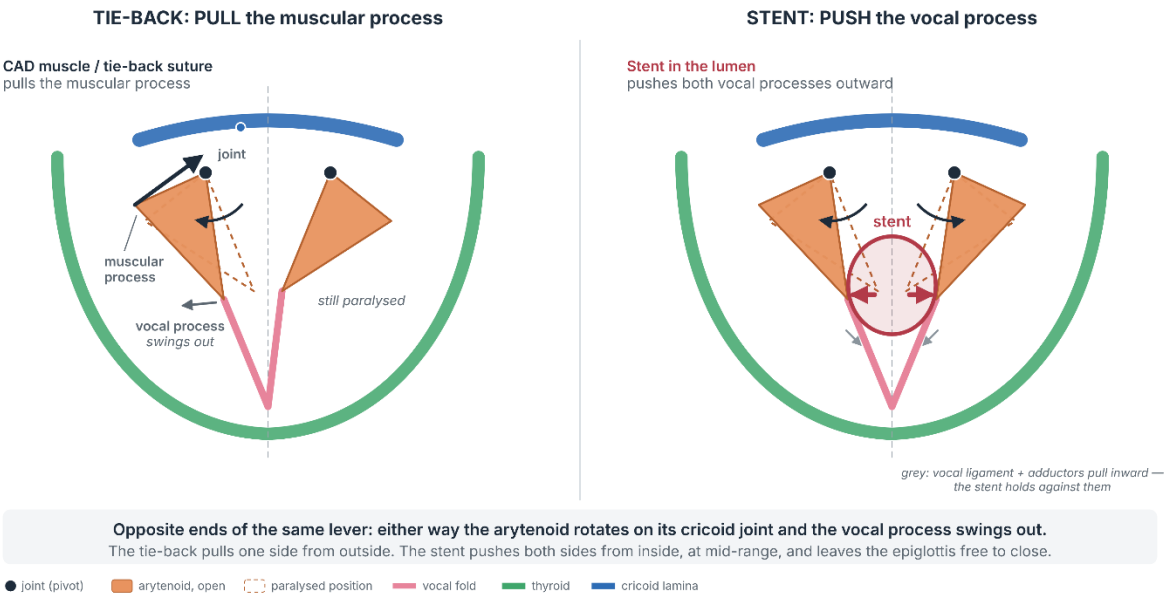
520


CRANIAL ←
→ CAUDAL
STENT TOTAL 41 mm
cricoid lamina 28 mm
Arytenoids (lateral to midline, faded)
Cricoid lamina
DORSAL
Silicone stent
Vocal folds (lateral to midline, faded)
VENTRAL
cricoid ring
Trachea ring 2
stent nubs lock either side of the ventral cricoid ring
Trachea ring 1
Epiglottis
Thyroid lamina
stent tip → thyroid edge 19 mm
cricoid ring 9.0 mm
CT gap 3.2 mm
rings 1–2 10 mm

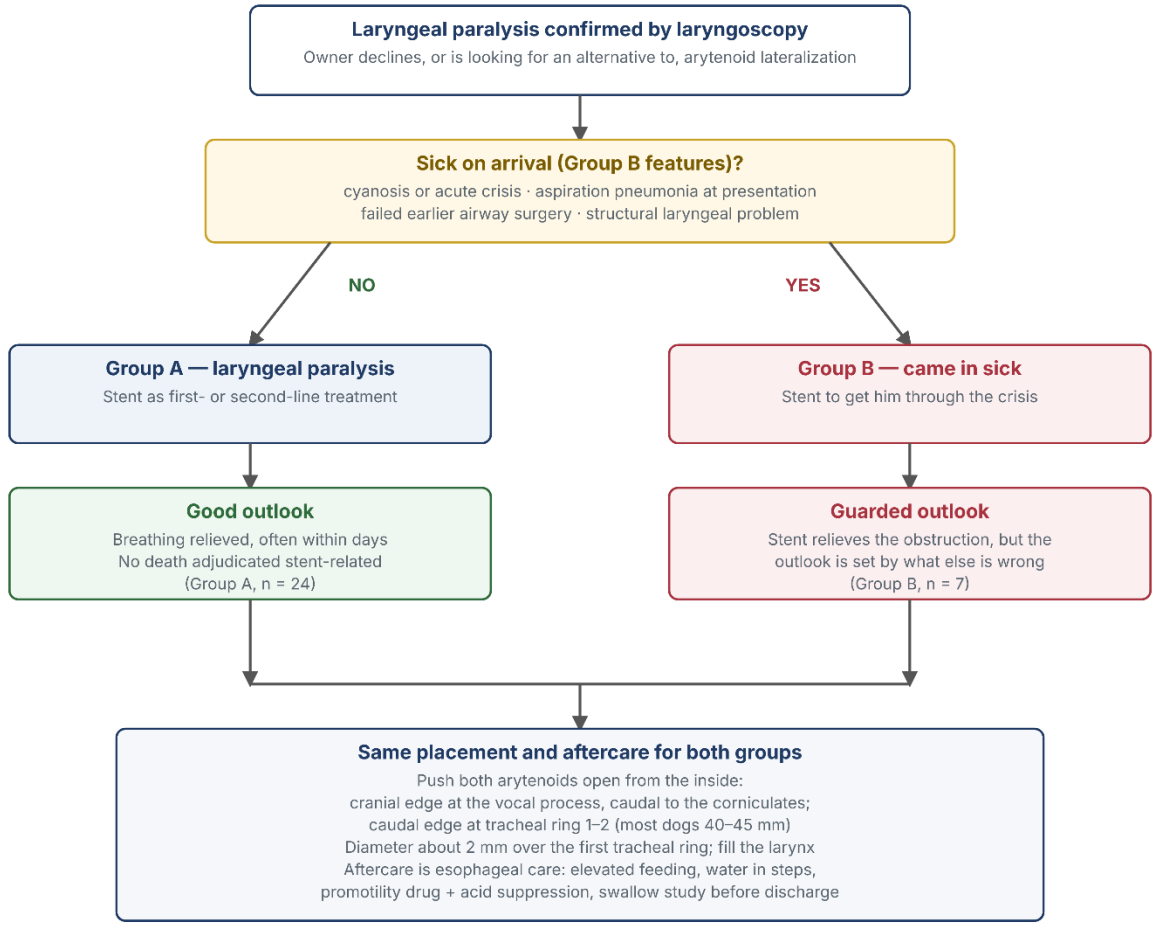
521


A. All dogs (n = 31)
Proportion alive (all-cause)
All dogs (n = 31)
95% confidence band
censored (alive at 27 Aug 2026)
Days after stent placement
At risk
All dogs 31 12 9 1 1 1 1 0
B. By clinical group (log-rank p = 0.17)
Proportion alive (all-cause)
Group A — laryngeal paralysis (n = 24)
Group B — came in sick (n = 7)
Days after stent placement
At risk
Group A 24 10 8 1 1 1 1 0
Group B 7 2 1 0 0 0 0 0

522


TIE-BACK: PULL the muscular process
CAD muscle / tie-back suture
pulls the muscular process
joint
muscular process
still paralysed
vocal process swings out
STENT: PUSH the vocal process
Stent in the lumen
pushes both vocal processes outward
stent
grey: vocal ligament + adductors pull inward — the stent holds against them
Opposite ends of the same lever: either way the arytenoid rotates on its cricoid joint and the vocal process swings out.
The tie-back pulls one side from outside. The stent pushes both sides from inside, at mid-range, and leaves the epiglottis free to close.
joint (pivot)
arytenoid, open
paralysed position
vocal fold
thyroid
cricoid lamina
schematic, not to scale

523


Laryngeal paralysis confirmed by laryngoscopy
Owner declines, or is looking for an alternative to, arytenoid lateralization
Sick on arrival (Group B features)?
cyanosis or acute crisis · aspiration pneumonia at presentation
failed earlier airway surgery · structural laryngeal problem
NO
YES
Group A — laryngeal paralysis
Stent as first- or second-line treatment
Group B — came in sick
Stent to get him through the crisis
Good outlook
Breathing relieved, often within days
No death adjudicated stent-related
(Group A, n = 24)
Guarded outlook
Stent relieves the obstruction, but the outlook is set by what else is wrong
(Group B, n = 7)
Same placement and aftercare for both groups
Push both arytenoids open from the inside:
cranial edge at the vocal process, caudal to the corniculates;
caudal edge at tracheal ring 1–2 (most dogs 40–45 mm)
Diameter about 2 mm over the first tracheal ring; fill the larynx
Aftercare is esophageal care: elevated feeding, water in steps,
promotility drug + acid suppression, swallow study before discharge

524

Table 1. Per-case attribution (audit table).

#	Dog	Grp	Age (y)	Laterality	Stent (mm)	Days	Outcome	Cause of death	AP category	Revision
1	Biscuit	A*	12.3	Bilateral	20	17	Alive	—	None	None
2	Sophia	A*	12.0	Bilateral	16 (×23 L)	24	Alive	—	None (severe pre-stent dysphagia; laryngeal-origin adjudication pending)	None
3	Mello	A*	13.1	Bilateral	22→23	52	Alive	—	None	Resize (d24)
4	Shooter	B	12.0	Unilateral (R)	20→22	59	Alive	—	None (swallow PASS)	Migration/re (d9); cricotra stenosis d53 replacement (d57)
5	Beau	A	13.4	Bilateral	20	32	Dead	Died — cause unknown (indeterminate)	None	None
6	Bowser	A	14.1	Bilateral	20→17 (×38 L)	73	Alive	—	None	Stricture — l replacement
7	Bear (Baty)	A	12.1	Bilateral	17	100	Alive	—	None	Cricotrachea
8	Izzy	A	13.4	Bilateral	18 (trimmed)	6	Dead	Died — profuse haemorrhage, inappetence (peri-procedural, d6)	None	Resize/trim
9	Scout	A	11.9	Bilateral	22 (×35)→17 (×45 L)	129	Alive	—	None (endoscopic secretions at presentation; not AP per definition)	Stricture — l bridging repl (d114)
10	Dazey Mai	B	14.1	Bilateral	20	5	Dead	Euthanized — end-stage (lung collapse/hemorrhage, AP)	Pre-existing	None
11	Ace	A	12.2	Bilateral	20	150	Alive	—	Mild non-fatal	None
12	Buddy	B*	7.5	Not notated	[not recorded]	154	Dead	Died — cause unknown (indeterminate)	None	None
13	Ruger	A	13.8	Bilateral	15→20	185	Alive	—	None	Resize (slipp
14	Pluto	A	10.3	Bilateral	20	198	Alive	—	None	None
15	Hank	B	11.4	Bilateral	18	221	Alive	—	None	None
16	Gus	B	3.9	Bilateral (collapse)	15	91	Dead	Unknown (owner-reported)	Pre-existing/recurrent	None
17	Koda	A	13.0	Bilateral	18	38	Dead	Staphylococcal infection (paw) — unrelated	Pre-existing (hx)	Replace (sho
18	Macy	A	11.0	Bilateral	20	486	Alive	—	Mild non-fatal	Replace
19	Harper	A	5.0	Bilateral	17	488	Alive	—	None	Trim
20	Hardy	EXCL	8.1	Bilateral	22	7	Dead	Excluded — cricopharyngeal achalasia	—	Replace
21	Bear (Rodriguez)	A	10.5	Bilateral	20	514	Alive	—	None	None
22	Miss Rosie	A	11.8	Bilateral	18	336	Dead	Euthanized — presumptive aspiration with progressive GOLPP; suspected hyperadrenocorticism; device intact and in laryngeal position at	Pre-existing	None

#	Dog	Grp	Age (y)	Laterality	Stent (mm)	Days	Outcome	Cause of death	AP category	Revision
								euthanasia		
23	Nestle	A	14.6	Bilateral	16→14	542	Alive	—	None	Resize
24	Harley	B	13.0	Bilateral	20	556	Alive	—	None (prior failed tie-back)	None
25	Daphne	A	15.6	Bilateral	16	577	Alive	—	None	None
26	Grady	A	15.0	Bilateral	16	166	Dead	Euthanized — aspiration pneumonia (asplenic)	None	None
27	Gryffin	A	12.4	Not notated	16	218	Dead	Deceased — no details	Comorbid (GOLPP aspiration; radiographically documented)	None
28	Dre	A	13.0	Not notated	18→16	472	Dead	Remote; cause unconfirmed	None	Replace ×3 (aperture scar mucus d343)
29	Keller	A	12.7	Unilateral (L)	18	146	Dead	Euthanized — progressive neurological signs (presumptive intracranial disease; no imaging)	Indeterminate (regurgitation before placement; AP at days 7 and 130)	Replace
30	Roxy	A	12.7	Bilateral	18	465	Dead	Deceased — adjudicated not stent-related (cause not recorded)	Comorbid	Trim
31	Jasmine	B	10.3	Everted saccules	17	1	Dead	Peri-anesthetic hyperthermic event	None	None
32	Io	A	2.9	Bilateral	18	1390	Dead	Deceased — adjudicated not stent-related (cause not recorded)	None	None

Grp, group (A primary / B salvage / EXCL excluded); group, death attribution and AP category adjudicated outcome-blind and reconciled case-by-case by M.W. (* assigned on presentation criteria; confirm before submission). Dog 20 (Hardy) was excluded from analysis (cricopharyngeal achalasia) and is shown for completeness. AP, aspiration pneumonia. Arrows in stent size denote resizing; dimensions given as diameter × length where recorded. Day counts are censored at 27 August 2026 (owner-contact vital-status sweep).

Table 2. Outcomes and complications by clinical group.

Outcome	Group A (n=24)	Group B (n=7)	Total (n=31)
All-cause mortality, n (%)	10 (41.7)	4 (57.1)	14 (45.2)
Confirmed stent-related mortality, n (%)	0 (0)	0 (0)	0 (0)
Peri-procedural (≤30 d) mortality, n (%)	1 (4.2)	2 (28.6)	3 (9.7)
Median all-cause survival (Kaplan–Meier)	472 d	154 d	465 d (95% CI 154–1390)
Aspiration pneumonia — stent-related, n (%)	0 (0)	0 (0)	0 (0)
Aspiration pneumonia — indeterminate, n (%)	1 (4.2)	0 (0)	1 (3.2)
Aspiration pneumonia — at presentation, n (%)	2 (8.3)	2 (28.6)	4 (12.9)
Aspiration pneumonia — comorbid, n (%)	2 (8.3)	0 (0)	2 (6.5)
Aspiration pneumonia — mild, non-fatal, n (%)	2 (8.3)	0 (0)	2 (6.5)
Delayed peristent stricture, n (%)	3 (12.5)	1 (14.3)	4 (12.9)
Any stent revision, n (%)	12 (50.0)	1 (14.3)	13 (41.9)
Concurrent IV stem cell therapy, n (%)	3 (12.5)	2 (28.6)	5 (16.1)
Notes	Elective stent as treatment for laryngeal paralysis	Presented in crisis, with pre-existing AP, after failed surgery, or with structural laryngeal disease. Many published series exclude such dogs.	No death or AP adjudicated stent-related

Final data lock (outcome-blind adjudication, M.W.; vital-status sweep 27 August 2026). No death in either group was adjudicated stent-related; no aspiration pneumonia was adjudicated stent-related (one dog, 3.2%, indeterminate). Survival figures are all-cause and are not for comparison with arytenoid lateralization. Group B dogs presented with markers of greater illness that many published surgical series exclude.

Note: Group assignment, death attribution and aspiration pneumonia category were adjudicated blind to outcome by an independent reviewer (M.W.).

540