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Laryngeal silicone stent as a treatment option for laryngeal paralysis in dogs: a preliminary study of 6 cases

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ABSTRACT

Background: Laryngeal paralysis is a common idiopathic degenerative neurological disease in older medium-to-large breed dogs, with surgical correction of the obstruction being the treatment of choice.
Objectives: This study evaluated the use of laryngeal silicone stents to treat canine laryngeal paralysis in dogs where classic surgical treatment was not accepted by the owners.
Methods: Dogs diagnosed with laryngeal paralysis, for which the owners refused arytenoid lateralization surgery as a first-line treatment, were treated with laryngeal silicone stents.
Results: Six dogs with bilateral laryngeal paralysis were included in the study. All dogs showed improvement in clinical signs immediately after the procedure. No clinical signs or radiographic changes were noted in four out of six dogs in the follow-up visit performed 1 wk later. One dog was suspected of aspirating water while drinking, but the signs disappeared after repositioning the stent. Another dog had a relapse of stridor due to caudal migration of the stent. This dog underwent arytenoid lateralization surgery because larger stents are not commercially available. At the time of writing, between seven and 13 mon after stent placement, no significant incidents have occurred in four dogs, and all owners report a satisfactory quality of life.
Conclusions: Laryngeal silicone stenting is an interesting alternative for treating dogs with acquired laryngeal paralysis when the owners refuse classic arytenoid lateralization surgery. Furthermore, stent placement can be a temporary solution to stabilize these dogs until a permanent surgical treatment can be performed.

Keywords: Laryngeal paralysis; silicone stent; dogs

INTRODUCTION

Laryngeal paralysis is a common idiopathic degenerative neurological disease in older medium-to-large breed dogs that is often associated with a polyneuropathic syndrome [1,2]. This condition causes an inability to abduct the arytenoid cartilage during inspiration, resulting in respiratory signs consistent with airway obstruction. Laryngeal paralysis results in varying degrees of upper airway obstruction and can be a life-threatening emergency.

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Conflict of Interest
The authors declare no conflicts of interest.

The diagnosis of laryngeal paralysis is typically made either by direct observation of the larynx or by video laryngoscopy. During inspiration, there is a reduced or absent abduction of the arytenoid cartilages that leads to increased airway resistance and prevents correct airflow.

Currently, surgical correction of the obstruction is the gold standard for treating laryngeal paralysis in dogs [3]. Laryngeal surgery aims to decrease airway resistance by removing, repositioning, stabilizing, or bypassing the laryngeal cartilages that obstruct the rima glottidis during inspiration. In general, unilateral arytenoid cartilage lateralization is the preferred surgical technique [1,3-5]. The respiratory signs improve significantly in most patients after surgery. On the other hand, the postoperative complication rates can be high, and patients have a lifelong risk of developing respiratory tract disease [4,6,7].

Surgical treatment cannot always be performed in an emergency setting because it needs an experienced surgeon. Furthermore, it is an invasive procedure that is sometimes refused by owners because of the old age of the pet, significant comorbidities, polyneuropathy, or financial constraints. In human medicine, the use of silicone laryngeal stents has been described for both temporary or long-term management of upper airway obstructions, particularly in the proximal half of the trachea and in the subglottic region [8-11]. This technique is associated with excellent clinical outcomes, and silicone airway stents are well tolerated, easy to manage, durable, and generally cause little or no injury to the underlying airway mucosa.

A case series describing the use of laryngeal stents for treating acute and chronic respiratory distress in seven dogs was recently published [12]. All seven dogs presented with laryngeal paralysis from various causes (laryngeal neoplasia, laryngeal stenosis due to fibrosis, or idiopathic neuropathy), with encouraging treatment results.

The aim of this study was to evaluate the use of laryngeal silicone stents for treating acquired canine laryngeal paralysis in dogs for which their owners did not accept classic surgical treatment.

MATERIALS AND METHODS

Dogs presenting with clinical signs consistent with laryngeal paralysis, such as dyspnea, dysphonia, stridor, dysphagia, or chronic cough that did not improve with steroid therapy, underwent an endoscopic examination to confirm the presumptive diagnosis. The animals were treated with a laryngeal stent as an alternative to classical surgical treatment when the owners refused the procedure. Informed consent was obtained in all cases.

As part of the diagnostic work-up, all dogs underwent a complete blood count and full biochemistry, including the total T4 and TSH measurements. Anti-acetylcholine receptor antibody assays were proposed when concurrent signs of neuromuscular disease or megaoesophagus were present but were not measured systematically due to financial constraints.

Thoracic radiographs (two lateral and one ventrodorsal view) were obtained after sedation with 0.1 to 0.3 mg/kg of butorphanol intravenously to screen for secondary aspiration pneumonia, concurrent megaoesophagus, and other possible concomitant respiratory diseases.

Before induction, pre-oxygenation with an oxygen facemask for several minutes at 100 mL/kg/min. The diagnoses were made by a flexible laryngeal endoscopy examination under a light plane of anesthesia after administering propofol titrated to the effect. A board-certified specialist in internal medicine performed the endoscopic examinations. The movement of the arytenoid cartilages was observed throughout the respiratory cycle. Inadequate abduction of arytenoid cartilage during inspiration by remaining in a paramedian position was suggestive of laryngeal paralysis. Paradoxical movement, which was observed as bilateral abduction during the expiratory phase, was suggestive of bilateral laryngeal paralysis. An assistant aided in the evaluation by informing the examiner of the phases of the respiratory cycle. Doxapram at 1 mg/kg was injected intravenously in cases where the diagnosis was unclear to increase respiratory rate and arytenoid cartilage movement.

Following the endoscopic examination and while the dog was still in sternal recumbency, the dog's head was lifted, and the tongue was pulled cranially to improve visualization of the larynx. The ideally sized stent allows complete expansion inside the glottis and a good grip on the vocal cords. Currently, two sizes are commercially available: 14 and 20 mm in diameter (STENING, Spain). The surface of the prosthesis is covered with 1 mm studs to increase stability after insertion and prevent necrosis by limiting contact with the laryngeal mucosa. The stent was folded into four parts using two long Bengolea forceps: one curved and one straight. The stent was lubricated with sterile ultrasound gel and introduced into the glottis (**Fig. 1**). The distal forceps were released first, and the stent was pushed delicately until the first stubs were positioned in front of the vocal cords to ensure stable positioning (**Figs. 2** and **3**). Epiglottis movement was observed to check for any nuisance caused by the stent. A right lateral radiograph was then obtained to confirm positioning. Finally, 0.1 mg/kg dexamethasone was injected intravenously after insertion to prevent laryngeal swelling.

Each patient was actively monitored for 4 h after the procedure, with particular attention to the development of abnormal respiratory sounds, cough, and dyspnea. A small amount of water was then offered to ensure the absence of dysphagia or aspiration. The animal was discharged if no problems were encountered. The stent was repositioned if any discomfort was seen. Instructions were given to the owners after the procedure to feed small quantities of food and water under supervision for the first 24 h to avoid aspiration. The quantities of food were then increased over the next 2 d, and normal feeding habits were resumed 3 d after the procedure. A 5-d course of prednisolone at approximately 0.5–1.0 mg/kg once daily orally was started the day after the procedure. A cough suppressant (codeine at 0.2 mg/kg twice daily orally) was given if the dog developed a cough not associated with feeding.

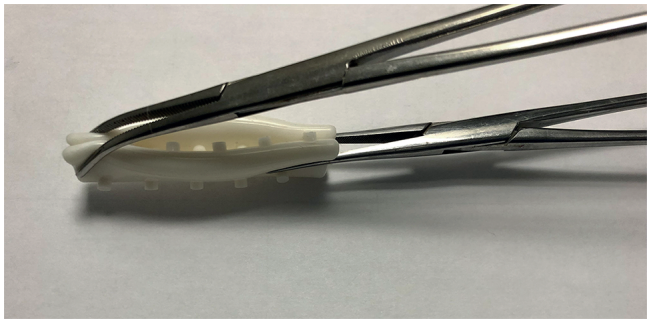

Fig. 1. Technique of stent placement. The stent is folded in four parts using two long Bengolea forceps, one curved and one straight, prior to introduction into the glottis.

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Fig. 2. Endoscopic image in a dog with laryngeal paralysis. Note the narrow lumen of the glottis.

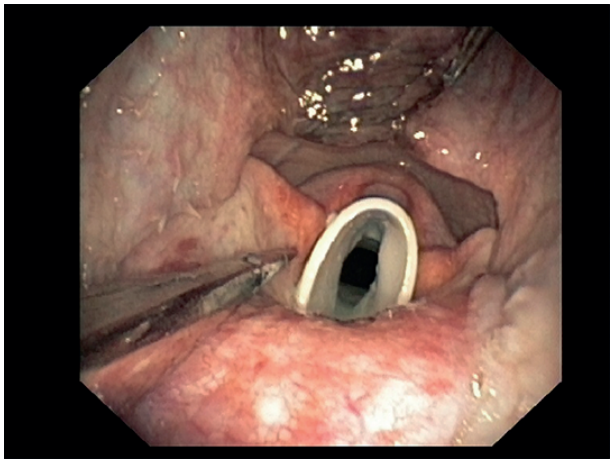

Fig. 3. Same animal in **Fig. 2** after stent placement. The diameter of the glottis is significantly larger.

A check-up visit with thoracic radiographs was scheduled 1 wk later to ensure correct positioning of the stent. One month later, a follow-up phone call was performed. The dog's owners were instructed to look for signs indicating stent displacement, such as dysphagia or cough, as well as other signs, such as halitosis, that could indicate an infection of the stent. Another follow-up phone call was performed at the time of writing.

If the stent was not well tolerated or the clinical signs persisted despite the intervention, a surgical intervention (unilateral arytenoid cartilage lateralization) was proposed, despite refusal prior to stent placement.

RESULTS

Patient signalment

Six dogs diagnosed with laryngeal paralysis were enrolled prospectively in the study, including two Labrador Retrievers, one Golden Retriever, one Springer Spaniel, one Brittany Spaniel, and one Rhodesian Ridgeback. The median age was 11 yr (nine to 12 yr). Four dogs were intact males, one was a neutered male, and one was an intact female. The weight ranged

Table 1. Cases summary of the six dogs with laryngeal paralysis treated with placement silicone stents

Dog	Signalment	Weight (kg)	Comorbidities	Stent size (mm)	Short term follow-up	Long term follow-up
1	Labrador Retriever 11 yr ME	48	Previous arytenoid lateralization 6 mon before Hypothyroidism	20 × 60	Unremarkable	Still alive 13 mon later No dyspnoea, stridor, or aspiration
2	Golden Retriever 10 yr MN	39	None	20 × 60	Unremarkable	Still alive 12 mon later No dyspnoea, stridor, or aspiration
3	British Spaniel 12 yr FE	27	None	14 × 40	Unremarkable	Still alive 9 mon later No dyspnoea, stridor, or aspiration
4	Rhodesian Ridgeback 9 yr ME	51	None	20 × 60	Relapse of stridor Caudal stent migration	Arytenoid lateralization 15 d after stent placement 7 mon later still alive
5	Labrador Retriever 11 yr ME	33	Hypothyroidism Suspected generalised peripheral polyneuropathy	20 × 60	Suspected aspiration while drinking Resolved after stent repositioning	Megaoesophagus and progressive tetraparesis Euthanasia 4 wk later due to worsening quality of life
6	Springer Spaniel 12 yr MN	28	None	14 × 40	Rare episodes of throat clearing	Still alive, 7 mon Infrequent throat-clearing cough

ME, male entire; MN, male neutered; FE, female entire.

from 27 kg to 51 kg. The signalments are detailed in **Table 1**. All dogs received a previous course of prednisolone with a mean duration of 10 d and a mean dose of 0.7 mg/kg.

Presenting complaint

The clinical signs present at the time of diagnosis included stridor, exercise intolerance, and heat intolerance, which were present in all dogs. No dogs presented with episodes of cyanosis or syncope.

Comorbidities

One dog (dog number 1) had been diagnosed with primary hypothyroidism 10 mon before. Despite treatment with levothyroxine twice daily and with a good biological control, the respiratory signs worsened progressively. The dog had already undergone a unilateral left arytenoid lateralization 6 mon before re-presentation because of the same clinical signs: stridor and exercise intolerance.

Dog number 5 was diagnosed with primary hypothyroidism at the time of presentation. Stenting was performed before initiating treatment with levothyroxine owing to the severity of the respiratory signs. Both dogs (dogs 1 and 5) also presented with proprioceptive deficits in both pelvic limbs and generalized muscle atrophy, which led to the suspicion of generalized peripheral polyneuropathy. Measurement of anti-acetylcholine receptor antibody titers was recommended in these two dogs but was refused due to financial costs.

Imaging findings

All dogs had bilateral laryngeal paralysis on the endoscopic examination. No dogs had radiographic signs consistent with megaoesophagus or aspiration pneumonia.

Procedure

No significant events occurred during endoscopy or stent placement. Each stent was implanted in less than 3 min. No complications were observed in the post-procedure period. The clinical signs, such as stridor, resolved immediately after stent placement.

Outcome

No clinical signs or radiographic changes were observed in four out of six dogs in the follow-up visit performed 1 wk later. According to dog number 1's owners (which had already undergone surgical arytenoid lateralization), there was more significant improvement in the clinical signs after stent placement than after surgical correction.

On the other hand, abnormalities were observed 1-wk post-stent placement in dogs four and five. Dog number four developed the same stridor present before stent placement, and thoracic radiography showed migration of the stent into the proximal trachea (**Figs. 4** and **5**). Stent removal was preferred as the diameter of the current device was deemed too small for the dog, and no larger stents are currently commercially available. Therefore, surgical arytenoid lateralization was proposed as an alternative because there had been significant improvement in the clinical signs the first few days before stent migration. Surgery was performed, and the clinical signs disappeared.

Dog number 5 coughed systematically during drinking but did not present any signs while eating. Radiographic control did not show displacement of the stent. Endoscopic control was

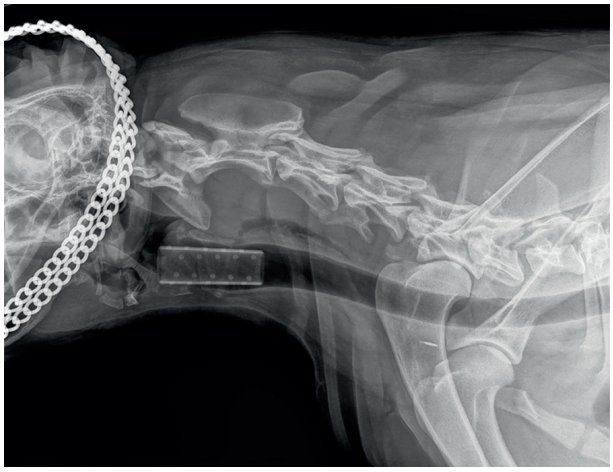

Fig. 4. Right lateral thoracic radiograph showing stent placement immediately after insertion.

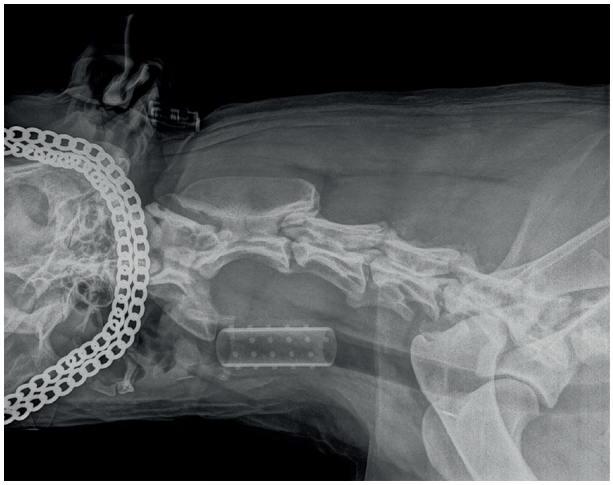

Fig. 5. Radiograph of the same dog in **Fig. 4** at the recurrence of the clinical signs. Note the caudal migration of the stent.

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performed, and the stent was pushed 1 mm caudally to enable correct epiglottal movement, which was sufficient to resolve the symptoms. Three weeks later, the dog presented with worsening paresis, dysphagia, and regurgitations. Thoracic radiography showed signs consistent with the megaoesophagus. Despite feeding in an upright position, the quality of life worsened steadily, and euthanasia was performed 1 wk later.

At the moment of the follow-up phone call 1-mon post-stenting, none of the four dogs had a recurrence of clinical signs, signs of aspiration pneumonia, or discomfort. At the time of writing, between seven and 13 mon after stent placement, no significant incidents have occurred, and all owners report a satisfactory quality of life.

DISCUSSION

This case series describes an alternative technique for treating acquired canine laryngeal paralysis in dogs. This technique is non-invasive, quick, inexpensive, and easy to perform. The reduced cost and short anesthetic time mean that this technique could be particularly interesting for dogs whose owners are unwilling to perform classic surgical therapy because of the financial costs, old age, or significant comorbidities. Furthermore, stent placement can be a temporary solution to stabilize these dogs until they undergo permanent surgical treatment.

This study included only dogs with acquired bilateral idiopathic laryngeal paralysis. This differs from Ricart et al. [12], who included a more comprehensive array of laryngeal diseases, such as laryngeal neoplasia, or laryngeal stenosis. The signalment of these dogs is similar to that previously reported in the veterinary literature in terms of age (mean age of 11 yr) and breed (Retrievers and Brittany Spaniels) [1,7]. Two dogs had concurrent primary hypothyroidism, a disease that can develop into polyneuropathy and laryngeal paralysis [13,14]. Moreover, in a study of 140 dogs with laryngeal paralysis, 30 dogs were diagnosed with hypothyroidism [1]. On the other hand, surgical intervention is usually required to treat laryngeal paralysis, and the response to thyroid hormone supplementation alone has not been reported widely. In one study of 66 hypothyroid dogs, two dogs had laryngeal paralysis that did not resolve with thyroid supplementation alone [14]. Furthermore, despite treatment with levothyroxine, dog number 5 required surgical treatment for laryngeal paralysis. Indeed, thyroid supplementation should be instituted in cases where hypothyroidism and laryngeal paralysis develop concurrently, but as shown here, this may not resolve the clinical signs due to laryngeal paralysis.

Surgery is currently the treatment of choice, and surgical procedures include unilateral or bilateral arytenoid cartilage lateralization, ventricular cordectomy with partial arytenoidectomy, and permanent tracheostomy [3]. Unilateral arytenoid lateralization is the most commonly used technique, but it requires an experienced surgeon and is a more invasive procedure than stent placement. This can be problematic in an emergency setting because it usually means traveling to a referral center with a dyspnoeic animal. Therefore, it may be necessary to intubate these animals under constant infusion of anesthetics or perform a temporary tracheostomy to stabilize them while awaiting surgical therapy, with the associated financial costs and complications. In these rare cases, having an alternative, such as the silicone stents described here, can be useful for avoiding euthanasia while awaiting definitive surgical treatment.

These stents can be placed easily by veterinarians without requiring specialized equipment. Moreover, in contrast to surgical therapy, this technique does not require significant expertise. Furthermore, these devices can be moved and placed as many times as necessary until the ideal positioning is found. They can also be extracted easily if the stent is not well tolerated by the patient. Multiple-sized stents were used in the present case series compared to Ricart et al. [12], where only a one-sized stent was used. The availability of different sizes means many different breeds could benefit from this technique.

Surgical complications in dogs treated with arytenoid lateralization were reported to be approximately 35% to 58% depending on the study, and included seroma formation, intramural hematoma, aspiration pneumonia, persistent coughing or gagging, persistent or recurrent respiratory signs, residual stridor on auscultation, surgical failure from suture breakage, or arytenoid cartilage fragmentation [4,5,7]. On the other hand, aspiration pneumonia was the most commonly reported postoperative complication of unilateral lateralization in dogs treated for laryngeal paralysis [1,7]. Post-surgical recurrence of the clinical signs has been reported in eight out of 45 dogs in one study, which required additional surgery [5]. In this setting, such as that in dog number 4, placing a laryngeal stent can be a cheaper, less invasive alternative to re-intervention. Although the stent does not eliminate the risk of aspiration pneumonia, as the rima glottidis remains permanently open, it does avoid the risks associated with the surgery itself.

In humans, laryngeal silicone stents are used for either temporary or long-term management of upper airway obstructions and are associated with low morbidity and excellent clinical outcomes. Silicone airway stents are well tolerated and generally cause little or no injury to the underlying airway mucosa [8-11]. Nevertheless, dysphonia and stent migration can occur [9].

In the present study, a low incidence of complications was observed at 1-wk post-implantation and was well tolerated in four out of six (67%) dogs exhibiting no discomfort at 1 wk and in the medium term (between seven and 13 mon later). Furthermore, the benefits could be seen immediately as all dogs showed an improvement in dyspnea and resolution of stridor after stent placement. Some dogs might develop a cough due to stent placement because this is a foreign body. Surprisingly, no dogs showed a cough sufficient to warrant cough suppressant administration. One dog had suspected aspiration episodes during drinking, which resolved after minimal repositioning of the stent. The stent may have interfered with the correct functioning of the epiglottis. Ricart et al. [12] reported that cough was more frequent than in this case series because all dogs presented a mild to moderate cough, which was considered acceptable by the owners. Two dogs developed halitosis, which resolved after extracting and disinfecting the stent. Infections due to *Candida spp.* are possible and have been described [15]. A longer time is needed to determine if the risk of complications of these stents is low, such as granuloma formation, which has been described previously in an experimental study in sheep [15]. A long observational period is also necessary to ensure that these stents are well tolerated over time. On the other hand, Ricart et al. [12] described a good quality of life in four out of seven dogs over 12 to 30 mon. The present results confirm those of Ricart et al. [12] because no other case series has been published in veterinary medicine.

The most important limitation of this technique is the size of the animal. The largest dog in the study had a caudal migration of the stent due to insufficient attachment of the studs to the laryngeal mucosa. Because there is currently no stents larger than 20 mm in diameter, classical surgery was needed to alleviate the clinical signs. 3D printing may solve this problem by designing personalized stents for each animal.

This study evaluated the outcomes of an alternative treatment for dogs with acquired laryngeal paralysis whose owners refused surgical therapy or those requiring immediate stabilization in an emergency setting as a temporary solution until surgery. The aim was not to replace surgical therapy as a first-line treatment, which remains the gold standard. The limitations of this case series are the small sample size and the short follow-up period.

This case series describes the implantation of laryngeal stents in an easy and quick procedure, with immediate improvement of dyspnea and stridor. This makes them an interesting alternative to the current standard surgical approach in dogs with laryngeal paralysis, particularly in those where financial costs or comorbidities are an issue or where an effective treatment is needed in an emergency setting, and surgical correction is not an option. Further investigation will be needed to determine the long-term outcomes of patients treated with silicone stents and the real incidence of complications following their implantation.

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