PAPER

Extended palatoplasty as surgical treatment for nasopharyngeal stenosis in six cats

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Objective: To describe the use of extended palatoplasty as treatment of caudal nasopharyngeal stenosis in cats.

Materials and Methods: CT was used to confirm the diagnosis in cats with clinical signs consistent with nasopharyngeal stenosis. Extended palatoplasty rostral to the tonsils using monopolar electrocautery allowed simultaneous removal of the caudal soft palate together with the stenotic area. Cats were re-evaluated 2 weeks postoperatively. Telephone interview was used to obtain long-term follow-up.

Results: Six domestic shorthair cats were diagnosed with nasopharyngeal stenosis, with clinical signs of snoring (n=4), stertor (n=4), nasal discharge (n=3) and sneezing (n=1). CT scan identified a soft-tissue stricture at the level of the caudal nasopharynx in all cats. Other abnormalities included bilateral rhinitis (n=3), retropharyngeal adenomegaly (n=2), unilateral sinusitis (n=1) and bilateral otitis externa with unilateral otitis media (n=1). Excision of the caudal soft palate and the entire stenotic soft-tissue membrane was successful in all six cats. No pre-, intra- or postoperative complications were observed. Short-term outcome revealed clinical improvement in all cases. Long-term outcome revealed no recurrence of clinical signs in four cats. In one cat, occasional sneezing was reported. One cat died 1 month postoperatively for reasons unrelated to the respiratory condition.

Clinical Significance: Extended palatoplasty was an effective technique to treat caudal nasopharyngeal stenosis and provide improvement of clinical signs without postoperative complications in all cases.

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INTRODUCTION

Nasopharyngeal stenosis is a rare condition in cats (Glaus *et al.* 2002). It is defined as a complete or partial obstruction of the nasopharynx by a soft-tissue membrane. This membrane is mostly located within the caudal nasopharyngeal (71% of cats) (Burdick *et al.* 2018). Most cases are acquired, secondary to upper respiratory tract inflammatory diseases or previous surgery of the nasopharynx (Mitten 1988, Coolman *et al.* 1998, Allen *et al.* 1999, Novo & Kramek 1999, Berent *et al.* 2006, Billen *et al.* 2006, Berent *et al.* 2008, Berent 2016). Clinical signs include stertorous breathing, snoring, open-mouth breathing, reverse sneezing, chronic nasal discharge or lack of nasal airflow.

Two treatment strategies have been described. A palatal midline approach to resect the stenotic membrane was the first reported (Mitten 1988, Coolman *et al.* 1998, Griffon & Tasker 2000). Currently, there is no published evidence of long-term successful treatment with this technique and it has been reported to have a high rate of recurrence (Coolman *et al.* 1998, Novo & Kramek 1999, Glaus *et al.* 2002). A minimally invasive technique with endoscopy-guided balloon dilatation has also been described (Glaus *et al.* 2002, Boswood *et al.* 2003, Glaus *et al.* 2005, Berent *et al.* 2006, DeSandre-Robinson *et al.* 2011). This technique also has been associated with a high rate of recurrence of the stenosis, and multiple dilatation procedures may be necessary (Glaus *et al.* 2002, Schafgans *et al.* 2012, Berent 2016, Burdick *et al.* 2018).

To reduce the risk of recurrent stenosis, the use of metallic or soft stents has been proposed in addition to balloon dilation in order to maintain the nasopharyngeal opening during the healing phase (Novo & Kramek 1999, Berent *et al.* 2008, Cook *et al.* 2013, De Lorenzi *et al.* 2015). Unfortunately, stent placement can be technically demanding, and complications such as tissue in-growth, obstruction, local intolerance and dysphagia are common (Novo & Kramek 1999, Berent *et al.* 2008, Cook *et al.* 2013, Berent 2016, Burdick *et al.* 2018).

Enlarged palatoplasty techniques have been previously described in dogs with brachycephalic airway obstructive syndrome (Brdecka *et al.* 2008, Findji & Dupré 2008). A modification of the original technique was described in dogs in which a large amount of soft palate is removed to just rostral to the tonsils, and without any subsequent oropharyngeal or nasopharyngeal adverse effects (Dunié-Mérigot *et al.* 2010). Based upon the surgical landmarks published in dogs, we believed that the soft palate and nasopharyngeal stenosis could be similarly excised in cats.

The objective of this study is to describe the enlarged palatoplasty technique and long-term outcome in treatment of caudal nasopharyngeal stenosis in cats and report complications.

MATERIALS AND METHODS

Medical records of cats with clinical signs consistent with nasopharyngeal stenosis, such as stertor, stridor, snoring, reverse sneezing, nasal discharge and sneezing presenting to our referral centre between January 2011 and December 2016 were retrospectively reviewed. Only cats with confirmation of nasopharyngeal stenosis by CT were eligible. Only cats with homogenous soft-tissue stenosis located in the caudal nasopharynx, at the level of the caudal one-half of the soft palate, were included in this report. A complete blood count and biochemistry panel were performed in all cases. Rhinoscopy was performed at the discretion of the surgeon.

Surgical treatment

Cats were premedicated with doses of 0.05 mg/kg acepromazine intramuscularly (im) (Calmivet; Vetoquinol) and 0.2 mg/kg morphine im (Morphine Aguettant; Aguettant). A dose of 4 mg/kg intravenous propofol (PropoVet Multidose; Zoetis) was administered intravenously to effect. General anaesthesia was maintained with isoflurane (Vetflurane; Virbac) in 100% oxygen *via* routine endotracheal intubation. A dose of 20 mg/kg amoxicillin (Clamoxyl; GlaxoGmithKline) and 0.1 mg/kg dexamethasone (Dexadreson; Intervet) were administered intravenously at induction. All cats were positioned in ventral recumbency, and the mouth secured in an open position by tape placed across the maxillary canine teeth, and with the tongue taped rostrally. Ventral and cranial retraction of the caudal tip of the soft palate facilitated exposure of the area of the incision, and also provided continuous tension to more easily incise these tissues (Fig. 1). An extended palatoplasty, as previously described by Dunié-Mérigot *et al.* (2010), was performed with a 10-W monopolar electrocautery

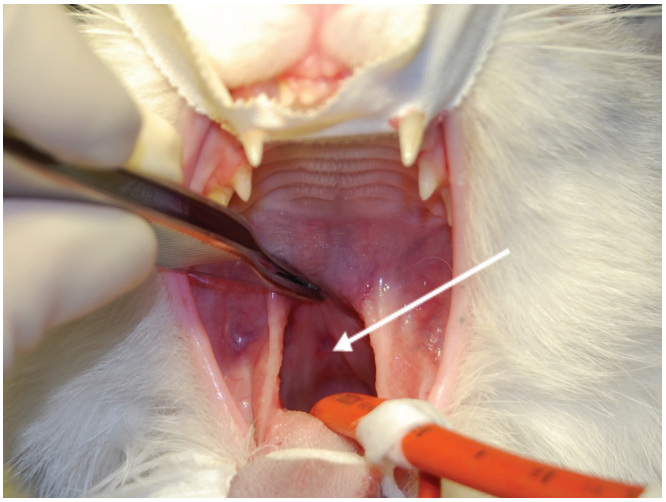

FIG 1. Pre-operative view of the nasopharynx. Cranial retraction of the caudal tip of the soft palate facilitating access to the stenosis (white arrow)

FIG 2. Pre-operative view showing the landmarks of the extended palatoplasty, including the area of stenosis (white double-headed arrow)

(ICC 300; Erbe Medical). The incision was made rostral to the tonsils when crossing the mid-sagittal line, and passed medially to the tonsils, with an arch shape (Figs. 2 and 3). The caudal soft palate rostral to the stenosis and then soft tissue stenosis itself were removed e*n bloc* (Fig. 4). Excision of the entire stenotic region was verified by direct visual inspection after soft palate removal. If feasible, the oropharyngeal and nasopharyngeal mucosa were re-apposed over the cut edge with a single-layer, simple, continuous suture pattern with a 4.0 braided multifilament absorbable suture material (Polysorb, polyglactin 910; Covidien). If excessive tension was observed when suturing, the mucosa was not sutured. Perioperative complications were recorded.

Doses of 0.2 mg/kg morphine or 0.02 mg/kg buprenorphine were given intravenously as needed during the 24 hours of hospitalisation. Postoperatively, doses of 12.5 mg/kg oral amoxicillin/clavulanate (Kesium, Ceva) or 75,000 UI/kg spiramycin/metronidazole and 12.5 mg/kg metronidazole (Buccoval, Ceva) were

administered for 7 days as commonly used in nasopharyngeal disease therapy. A dose of 0.5 mg/kg oral prednisolone (Dermipred, Ceva) was also administered for 10 days. Buprenorphine was continued for several days at the surgeon's discretion. Diet was limited to canned food for 2 weeks postoperatively.

Short-term follow-up (within 2 weeks) was assessed by in-hospital clinical examination. Long-term follow-up (>6 months) was obtained by telephone interviews with referring veterinarians and owners (Appendix 1). An excellent outcome was defined as no clinical signs. A good outcome was defined as occasional respiratory signs. Frequent respiratory signs necessitating medical treatment was considered a fair outcome, and absence of improvement was considered a poor outcome. Owner satisfaction was also determined: an excellent level satisfaction was defined when the owners thought their cat was dramatically improved and they would recommend the surgery to others. A good level of satisfaction was defined if the cat was considered improved by their owners but they would not recommend the surgery to others. Partial improvement and unwillingness to do the surgery another time were considered to indicate a fair level of satisfaction. No improvement considered by the owners and unwillingness to recommend the surgery was considered a poor level of satisfaction.

FIG 3. Intra-operative view. An incision is made rostral to the horizontal line between the tonsils and continues medially to the tonsils, with an arch shape

FIG 4. Postoperative view. Extended palatoplasty enables the removal of the caudal soft palate rostral to the stenosis with simultaneous excision of the soft-tissue stenosis

RESULTS

Five domestic shorthair and one Birman cat were successfully operated for nasopharyngeal stenosis with the technique described. All cats had been unsuccessfully medically treated previously by the referring veterinarian; previous treatments included antibiotics (n=3), prednisolone (n=2), and non-steroidal anti-inflammatory drugs (n=2) with only mild (n=2) or no improvement (n=4). On presentation for surgical evaluation, clinical signs included snoring (n=4), stertor (n=4), nasal discharge (n=3) and sneezing (n=6). All blood test results were within normal limits.

All CT scans indicated a soft-tissue membrane and stricture located in the region of the caudal nasopharynx (Figs. 5 and 6). Three cats had bilateral rhinitis, two moderate rhinitis and one had atrophic rhinitis (mild erosion of the most rostral turbinates). There was retropharyngeal lymhadenomegaly in two cats and bilateral otitis externa with unilateral otitis media in one cat. Retroflex rhinoscopy was performed in three cats, and revealed severe stenosis in two and a complete stenotic membrane in one. Excision of the caudal soft palate and the entire stenotic soft-tissue membrane was achieved without difficulty in all six cases. In one cat (case #3), the oropharyngeal and nasopharyngeal mucosa were not sutured together because of excesssive tension and friability of the tissues. No intra-or postoperative complications were observed and all follow-up evaluations were rated as either excellent or good (Table 1).

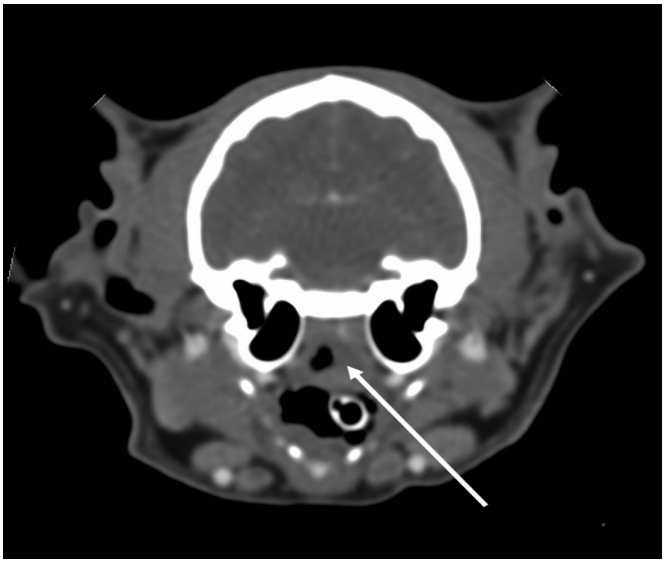

FIG 5. Transverse CT image following intravenous contrast. Attenuation of the caudal portion of the nasopharyngeal lumen by soft-tissue attenuating material consistent with nasopharyngeal stenosis (white arrow)

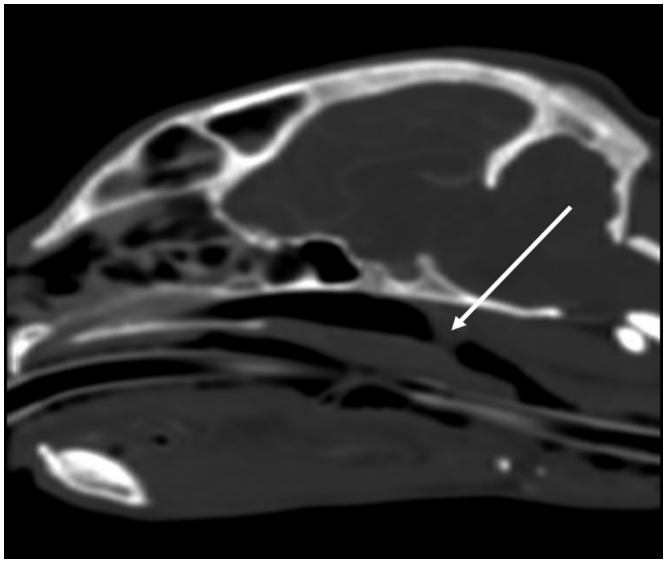

FIG 6. CT image reformatted in the sagittal plane following intravenous contrast. Soft-tissue stenosis (white arrow) within the caudal nasopharynx, at the level of the soft palate

Short-term outcome (within 2 weeks postoperatively) was excellent for all cases, with each cat showing marked clinical improvement with resolution of all respiratory clinical signs. Long-term outcome (minimum 6 months postoperatively) was excellent in four cats, revealing no recurrence of clinical signs (20 to 81 months postoperatively). In one cat (# 4, with atrophic rhinitis), the long-term outcome was considered good with occasional sneezing. One cat (# 3) died 1 month postoperatively for reasons unrelated to the respiratory condition (hit by car). Owner satisfaction was excellent for all cats.

DISCUSSION

This report indicates that extended palatoplasty is likely to be a successful and repeatable method to treat caudal nasopharyngeal stenosis and with low risk of complications. The surgical procedure is relatively simple, and has been described previously for successful surgical correction of soft palate elongation in brachycephalic dogs. In all six cats in which this procedure was performed, both the short- and long-term prognosis was good to excellent, with improvement of clinical signs in all individuals. Similar to brachycephalic dogs (Dunié-Mérigot *et al.* 2010), a large amount of soft palate could be safely removed in cats and the procedure described was straightforward. Neither dysphagia nor aspiration pneumonia occurred and no additional surgical procedure was necessary.

Based on published reports, it would appear that while balloon dilation (Burdick *et al.* 2018) is a good first-line technique, recurrence is common. In humans, recurrence of stenosis is frequent after all current surgical techniques: curettage, puncture, drill-out and laser resections (Novo & Kramek 1999). Additional procedures, including further surgery, repeated dilation or stenting are often needed (Mitten 1988, Coolman *et al.* 1998, Novo & Kramek 1999, Henderson *et al.* 2004). Stenting has been

Table 1. Signalment, clinical signs, previous treatments, results of CT, rhinoscopy, complications, follow-up, outcome and owner satisfaction in six cats treated with extended palatoplasty for caudal nasopharyngeal stenosis

Case	Breed	Age (years)	Sex	Clinical signs	Duration of clinical signs (months)	Previous treatment	CT	Rhinoscopy	Perioperative complications	Outcome, follow-up time (outcome)	Owner satisfaction
1	Domestic shorthair	2	Neutered male	Stertor, snoring, nasal discharge	1	prednisolone	NP stenosis	Severe stenosis	None	81 months (Excellent)	Excellent
2	Domestic shorthair	4	Spayed female	Stertor	6	None	NP stenosis, bilateral rhinitis	n/a	None	44 months (Excellent)	Excellent
3	Birman	8	Spayed female	Snoring, nasal discharge	2	None	NP stenosis, bilateral rhinitis, retropharyngeal adenomegaly	Severe stenosis	None	Died 1 month postoperative (HBC) (Excellent)	Excellent
4	Domestic shorthair	12	Spayed female	Stertor, nasal discharge, sneezing	2	ATB, prednisolone	NP stenosis, bilateral atrophic rhinitis, unilateral sinusitis, retropharyngeal adenomegaly	n/a	None	24 months [Good (occasional sneezing)]	Excellent
5	Domestic shorthair	1	Spayed female	Snoring	1 4	ATB, NSAID	NP stenosis	n/a	None	23 months (Excellent)	Excellent
6	Domestic shorthair	12	Neutered male	Stertor, snoring	4	ATB, NSAID	NP stenosis, bilateral otitis externa, unilateral otitis media	Stenotic membrane	None	20 months (Excellent)	Excellent

ATB antibiotics, NSAID non-steroidal anti-inflammatory drugs, NP nasopharyngeal, n/a not available, HBC hit by car

recommended with recurrent stenosis in the dog and cat (Novo & Kramek 1999, Berent 2016) but numerous complications are reported.

In contrast, extended palatoplasty is a one-stage procedure and, in this series, devoid of complications or recurrence. Care was given to reduce the duration of the procedure and to limit the time with the mouth kept open. This avoided interference with maxillary artery blood flow, in order to limit the potential risk of blindness secondary to decreased oxygenated blood flow to the retina (Barton-Lamb *et al*. 2013).

CT scan was chosen to confirm the diagnosis of nasopharyngeal stenosis in these cats since it has previously been shown to provide information on the extent and location of the stenotic membrane (Allen *et al*. 1999, Hunt *et al*. 2002, Berent *et al*. 2006, 2008). Furthermore, CT allows assessment of the entire nasal cavity and nasopharynx rostral and caudal to the stenosis, an area that can be especially difficult to evaluate if there is mucus accumulation. We consider that rhinoscopy is limited in value, because it can be challenging to assess the anatomy of the stenosis. Retroflex rhinoscopy may also only allow assessment of the caudal part of the nasopharynx, and anterior rhinoscopy can fail to identify a nasopharyngeal lesion (Berent *et al*. 2006). Therefore our view is that rhinoscopy is less useful in assessing whether or not extended palatoplasty can provide the necessary relief of the stenotic membrane.

Our long-term results revealed excellent or good outcome for all cats with follow-up and none were documented to have recurrence of the stenosis. In one cat (#4), there was intermittent sneezing. The frequency of sneezing had diminished from a few times *per* day to only a few times *per* month. The cause for the continued infrequent sneezing was not determined because the owner refused to bring the cat for a repeated evaluation. We imagine that sneezing could be due to chronic rhinitis, recurrent stenosis, granuloma formation, or could be the consequence of the shortened soft palate, even if sneezing has not been described after extended palatoplasty. This cat had atrophic rhinitis on the preoperative CT scan. This condition, as a chronic rhinitis with the lysis of nasal conchae, predisposes to infections and could also explain the clinical signs. A second CT scan or retroflex rhinoscopy should have been performed to rule out recurrent stenosis or granuloma formation. One other cat (#3) was not available for long-term follow-up, because it died 1 month postoperatively (after being hit by a car).

In our series of cats, bleeding of the palatal artery during palatoplasty seems uncommon compared to what was reported in dogs when using the monopolar sealing device (Dunié-Mérigot *et al*. 2010). Nevertheless, as it has been described for resection of elongated soft palate in brachycephalic dogs, other surgical cutting devices such as CO_2 laser, diode laser or bipolar sealing device could be compared to see whether or not this may have an influence on healing and the long-term outcomes in these cases (Clark & Sinibaldi 1994, Brdecka *et al*. 2008, Dunié-Mérigot *et al*. 2010).

This study has some limitations due to its retrospective nature, small number of cases, and follow-up only based on client satisfaction. Further studies with more cases are warranted; additionally, follow-up data should, ideally, objectively document the degree of relief provided by the surgery, perhaps by using rhinoscopy or CT.

Conflict of interest

No conflicts of interest have been declared.

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Supporting Information

The following supporting information is available for this article:

Appendix S1: Questions asked to the owners during the follow-up