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CLINICAL RESEARCH

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Complications and outcome following staphylectomy and folded flap palatoplasty in dogs with brachycephalic obstructive airway syndrome

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Abstract

Objective: To compare the prevalence of pre-, intra-, and postoperative variables and complications associated with staphylectomy (S) and folded flap palatoplasty (FFP).

Study design: Retrospective study.

Sample population: Client-owned dogs ($n = 124$).

Methods: Medical records of S and FFP dogs from a veterinary teaching hospital were reviewed between July 2012 and December 2019. Signalment, clinical pre-, intra-, and postoperative data were collected and reviewed. Median (interquartile range) was reported.

Results: A total of 124 dogs among 14 breeds underwent surgical treatment for an elongated soft palate with either a S ($n = 64$) or FFP (60). FFP dogs without concurrent non-airway procedures were associated with longer duration of surgery ($p = .02$; $n = 63$; S, median = 51 min [34–85]; FFP, median = 75 min [56.25–94.5]) and anesthesia ($p = .02$; $n = 63$; S, median = 80 min [66–125]; FFP, median = 111 min [91–140.8]). Neither soft palate surgery was associated with the occurrence of anesthetic complications ($p = .30$; 99/120; S, 49; FFP, 50), postoperative regurgitation ($p = .18$; 27/124; S, 17; FFP, 10), or with hospitalization duration ($p = .94$; $n = 124$; S, median = 1 day [1]; FFP, median = 1 [1]). Postoperative aspiration pneumonia (9/124; S, 4; FFP, 5) and major complications were rare (5/124; S, 3; FFP, 2).

Conclusion: S and FFP had similar anesthetic and perioperative complications, although FFP dogs had longer anesthetic and operative times.

Clinical significance: Although FFP took longer, no other clinically significant differences were appreciated between S and FFP procedures. Because of

Abbreviations: BOAS, brachycephalic obstructive airway syndrome; CT, computed tomography; FFP, folded flap palatoplasty; FI, female intact; FS, female spayed; GI, gastrointestinal; h, hours; IQR, interquartile range; kg, kilogram; L, left; mL, millileter; min, minute (s); mm, millimeter; mmHg, millimeters of mercury; MC, male castrated; MI, male intact; PaCO2, arterial partial pressure of carbon dioxide; R, right; S, staphylectomy.

limitations inherent in study design, surgeons should continue to use clinical judgment when deciding on a procedure.

1 | INTRODUCTION

Brachycephalic obstructive airway syndrome (BOAS) is comprised of a combination of upper respiratory anatomical abnormalities, primarily including an elongated soft palate, stenotic nares, hypoplastic trachea, redundant pharyngeal tissue, and aberrant nasal conchae.[1–3] Secondary changes associated with this syndrome may also include everted laryngeal saccules, everted tonsils, laryngeal collapse, pulmonary changes, and gastrointestinal (GI) signs.[2–5] Brachycephalic breeds, most commonly English bulldogs, French bulldogs, and Pugs are predisposed to these anatomic abnormalities due to their facial conformation.[3,5,6] Common clinical signs associated with the anatomical abnormalities of this syndrome include stertorous breathing, stridor, exercise intolerance, collapse, and/or GI signs such as regurgitation and vomiting.[1,4,5] The severity of clinical signs depends on the degree of airway obstruction due to any combination of BOAS features and can vary among dogs.[7]

Elongated soft palates, which can obstruct normal respiration, have been reported as one of the more common BOAS features in multiple studies with a prevalence varying from 86% to 96% in brachycephalic breeds.[4,5,7] As a result of breeding, brachycephaly, particularly when the muzzle is less than 1/10th the cranial length with a subsequent lack of proportionate soft tissue shortening, has been suggested as a primary contributor to soft palate "elongation" and thickness.[6] Staphylectomies (S) have historically been used to address soft palate elongation by shortening the caudal aspect of the soft palate; however, this technique only addresses laryngeal obstruction.[8] Respiratory obstruction can also occur due to nasopharyngeal and oropharyngeal obstruction associated with a thicker soft palate.[8] A folded flap palatoplasty (FFP) has been theorized to address both shortening and thinning of the soft palate to provide respiratory relief within the upper respiratory tract.[8] This technique has been evaluated in 55 dogs as a safe and efficient corrective option for elongated soft palates of greater thickness.[8] However, the FFP has been reported to involve more tissue manipulation and longer surgical times.[8]

No study in veterinary medicine has compared S and FFP. Comparing S and FFP could help surgeons in case selection for each technique and determine if one technique may be superior for decreasing complications and improving outcomes. The objective of this study was to compare the prevalence of pre-, intra-, and postoperative variables and complications associated with S and FFP.

2 | MATERIALS AND METHODS

2.1 | Selection and data collection

A medical record database review for surgical cases of S and FFP between July 2012 and December 2019 was performed. Dogs were included in the study if they underwent surgical treatment for their elongated soft palate at the University of Florida Small Animal Veterinary Hospital and had either a S or FFP performed. Dogs were excluded from the study if they had incomplete medical records, laryngeal paralysis, additional airway surgery unrelated to BOAS (i.e., cleft palate surgery), and/or an endoscopically performed soft palate surgery.

Medical records were retrospectively reviewed. The data collected and analyzed were categorized into pre-, intra-, postoperative, and follow-up categories. Preoperative data collected included signalment, clinical signs (regurgitation, vomiting, stertor, exercise intolerance, and collapse), diagnostic imaging (computed tomography [CT] and/or thoracic radiographs), presence of specific preoperative imaging findings (aspiration pneumonia, hiatal hernia, and hypoplastic trachea), airway examination findings (elongated soft palate, everted tonsils, laryngeal collapse, and stenotic nares), and administration of maropitant. Clinical signs were reported as a result of client communication and clinician interpretation. Airway examination was performed using subjective visual assessment; however, soft palate thickness was not measured. An elongated soft palate was defined as extension caudal to the tip of the epiglottis or caudal to the tonsils. Grades of laryngeal collapse were defined: Grade 1 with saccule eversion, grade 2 with saccule eversion and arytenoid cartilage cuneiform process collapse, and grade 3 with arytenoid cartilage corniculate process collapse.

Intraoperative data collected included date of surgery, surgeon, concurrent BOAS surgical procedures (nares surgery, sacculectomy, and tonsillectomy), operative time, anesthetic time, other non-BOAS surgical procedures, and anesthetic complications (hypoventilation, hypoxemia, hypercapnia, hypothermia, and hypotension). Hypoventilation was minute ventilation <100 mL/kg/min or elevated arterial partial pressure of carbon dioxide (PaCO2) >50 mm of mercury (mmHg); Hypoxemia was <90% oxygen saturation as measured by pulse oximetry; Hypercapnia was PaCO2 or end-tidal carbon dioxide >55 mmHg; Hypothermia was <96 degrees Fahrenheit; Hypotension was <80 mmHg (systolic) or <60 mmHg (mean arterial pressure).

Postoperative data collected included whether oxygen was administered and for how long (hours), length of postoperative hospitalization (days), medications used in-hospital and for discharge (anti-inflammatories, prokinetics, antiemetics, and GI protectants), and incidence of regurgitation and aspiration pneumonia. Anti-inflammatories included steroids or non-steroidal anti-inflammatory drugs, prokinetics included metoclopramide and/or cisapride, antiemetics included maropitant and/or ondansetron, and GI protectants included famotidine, pantoprazole, omeprazole, lansoprazole, and/or sucralfate. Postoperative treatments were selected based on surgeon and/or anesthesiologist faculty discretion if deemed necessary or in the best interest of the dog. Follow-up data included persistence of a hiatal hernia on postoperative imaging, whether an upper airway revision surgery was needed (staphylectomy, folded flap palatoplasty, alarplasty, and/or sacculectomy), time to revision surgery, and time to first follow-up and last known date of contact with associated clinical signs (regurgitation, vomiting, stertor, exercise intolerance, and collapse).

Staphylectomies were performed using a traditional cut-and-sew technique using long-handled Metzenbaum scissors and monofilament absorbable suture in a continuous pattern without the use of a vessel-sealing device, electrocautery, or laser. FFPs were performed as described by Findji and Dupre (2008).[8] Complications were considered minor when dogs did not require additional surgical treatment and/or did not lead to death within 2 weeks of the surgery. Complications were considered major when additional surgical treatment was required and/or death occurred within 2 weeks of the surgery.

2.2 | Statistical analysis

Descriptive statistics (median, interquartile range [IQR], and frequency) for non-parametric data were used to report the characteristics of dogs undergoing either a S or FFP. Available information varied by case and sample size was adjusted to reflect the number of dogs with available data for each category. For each categorical variable per surgery type, counts and percentages were calculated using Excel Pivot Tables. For each continuous variable per surgery type, count, median, and IQR were calculated by Excel Pivot Tables and JMP Pro 16.

TABLE 1 Characteristics of 124 cases of dogs undergoing either a S or FFP.

	S	FFP	Total
Total surgeries			
	64	60	124
Reproductive status			
	FI = 14; FS = 17; MI = 17; MC = 16	FI = 11; FS = 13; MI = 15; MC = 21	124
Breed			
French Bulldog	25	29	54
English Bulldog	15	19	34
Pug	11	5	16
Boston Terrier	5	4	9
Bulldog	2	0	2
Boxer	1	0	1
Affenpinscher	1	0	1
Pekingese	1	0	1
Pitbull	1	0	1
Pomeranian	1	0	1
Shih Tzu	1	0	1
Cavalier King Charles Spaniel	0	1	1
Dogue de Bordeaux	0	1	1
French Bulldog/Boston Terrier mix	0	1	1

Abbreviations: FFP, folded flap palatoplasty; FI, female intact; FS, female spayed; MC, male castrated; MI, male intact; S, staphylectomy.

TABLE 2 Preoperative clinical signs among dogs undergoing S and FFP.

	S (N/64)	FFP (N/60)	Total (N/124)
Clinical signs			
Regurgitation	3	4	7
Vomiting	3	9	12
Stertor	12	10	22
Exercise intolerance	13	21	34
Collapse	0	3	3

Abbreviations: FFP, folded flap palatoplasty; S, staphylectomy.

To test for association between procedure and categorical outcome, Pearson's chi-square test was used. In the case where one of the variables was continuous, the Wilcoxon non-parametric test was used to test for differences between procedures. Values of $p < .05$ were considered statistically significant.

3 | RESULTS

3.1 | Preoperative

The records of 128 dogs were reviewed, and four were excluded due to an endoscopic FFP (1), left lateralizing cleft soft palate surgery (1), laryngeal paralysis (1), and an incomplete medical record (1). Case characteristic information with sex and breed distribution between both soft palate surgeries (S and FFP) are summarized in Table 1. For the three most common breeds in this study, Pugs most often underwent a S (11/16; 68.75%), whereas French Bulldogs (S, 25/54, 46.3%; FFP, 29/54, 53.7%) and English bulldogs (S, 15/34, 44.12%; FFP, 19/34, 55.88%) were more evenly distributed between soft palate surgeries. Among preoperative clinical signs for dogs undergoing surgical correction for an elongated

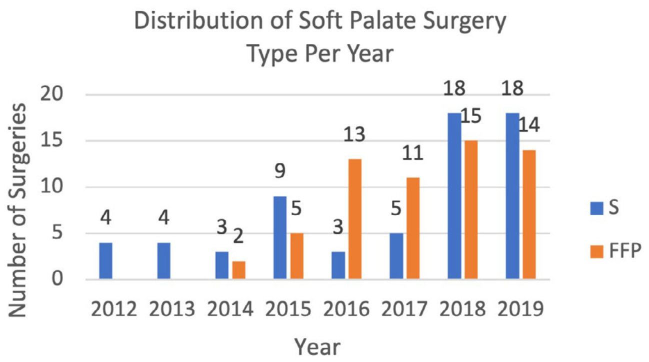

FIGURE 1 Distribution of soft palate surgery type (S and FFP) per year. FFP, folded flap palatoplasty; S, staphylectomy.

TABLE 3 Specific preoperative imaging findings from CT, thoracic radiographs, and the combination of CT and thoracic radiographs of dogs undergoing S and FFP.

	S (N/47)	FFP (N/53)	Total (N/100)
Imaging findings			
Aspiration pneumonia	2	2	4
Hiatal hernia	4	10	14
Hypoplastic trachea	5	7	12

Abbreviations: CT, computed tomography; FFP, folded flap palatoplasty; S, staphylectomy.

TABLE 4 Upper airway examination findings of dogs undergoing S and FFP.

	S (N/62)	FFP (N/58)	Total (N/120)
Upper airway examination findings			
Elongated soft palate	62	58	120
Everted tonsils	6	1	7
Stenotic nares	51	55	106
Laryngeal collapse	34	51	85
Grade 1	19	41	60
Grade 2	11	10	21
Grade 3	4	0	4

Note: Four dogs did not have documented airway examination findings.
Abbreviations: FFP, folded flap palatoplasty; S, staphylectomy.

TABLE 5 Distribution between different nares procedures of dogs undergoing S and FFP.

Nares procedure type	S (N/64)	FFP (N/60)	Total (N/124)
No nares procedure	13	5	18
Vertical wedge resection	36	26	62
Lateral wedge resection	2	1	3
Alarplasty	1	3	4
Caudal wedge resection	2	23	25
Circular incision with punch biopsy of alar fold	1	0	1
Vertical wedge resection (R) and caudal alarplasty (L)	0	1	1
Unknown nares procedure	8	1	9
Unilateral procedure	1	0	1

Abbreviations: FFP, folded flap palatoplasty; L, left; R, right; S, staphylectomy.

TABLE 6 Median and IQR (min) of operative and anesthetic times of dogs undergoing S and FFP.

Time (N)	S	FFP
Operative time without concurrent non-airway procedure ($p = .02$, 63/120; S = 31, FFP = 32)	Median = 51; IQR = 34–85	Median = 75; IQR = 56.25–94.5
Anesthetic time without concurrent non-airway procedure ($p = .02$, 63/120; S = 31, FFP = 32)	Median = 80; IQR = 66–125	Median = 111; IQR = 91–140.8

Abbreviations: FFP, folded flap palatoplasty; IQR, interquartile range; S, staphylectomy.

soft palate, exercise intolerance and inspiratory stertor were the most common (Table 2).

A majority of dogs received preoperative imaging ($n = 100$) in the form of thoracic radiographs alone (92), CT alone (1), both CT and thoracic radiographs (2), or other forms of imaging (5). Among specific imaging findings for both soft palate surgeries, hiatal hernias were more common in dogs undergoing FFP (Table 3).

Among airway examination ($n = 120$) findings (Table 4), stenotic nares and varying grades of laryngeal collapse were common concurrent findings in dogs with elongated soft palates, whereas everted tonsils were rarely noted. Laryngeal collapse was commonly absent in dogs undergoing S (S, 28/35, 80%; FFP 7/35, 20%), whereas grade 1 laryngeal collapse was commonly identified in dogs undergoing FFP (S, 19/60, 31.67%; FFP, 41/60, 68.33%).

TABLE 7 Anesthetic complications in dogs undergoing S and FFP. For some dogs, multiple anesthetic complications were recorded.

	S (N/62)	FFP (N/58)	Total (N/120)
Anesthetic complications $p = .30$	49	50	99
Hypoventilation	1	4	5
Hypoxemia	0	1	1
Hypercapnia	11	11	22
Hypothermia	20	20	40
Hypotension	25	19	44

Abbreviations: FFP, folded flap palatoplasty; S, staphylectomy.

3.2 | Intraoperative

Total numbers of soft palate surgeries increased across the timeframe of records reviewed (2012–2019), with more S occurring between 2012 and 2015, more FFP between 2016 and 2017, and a more even distribution between soft palate surgeries with slightly more staphylectomies performed between 2018 and 2019 (Figure 1). Of 16 surgeons who performed soft palate surgeries, three surgeons performed more FFPs (Surgeon A: S, 5, FFP 30; Surgeon B: S, 3, FFP 14; Surgeon C: S, 2, FFP, 4), two surgeons performed more S (Surgeon D: S, 18, FFP, 8; Surgeon E: S, 23, FFP, 1), and 11 of the remaining surgeons each performed three or less soft palate surgeries.

Dogs undergoing a nares procedure (106/124, 85.48%) were categorized by procedure type, with vertical and caudal wedge resections most commonly performed (Table 5). Dogs undergoing a concurrent laryngeal sacculectomy more frequently underwent FFP (47/74; 63.51%). The two dogs undergoing tonsillectomy underwent FFP. Of soft palate surgeries without concurrent non-airway procedures, total operative ($p = .02$) and anesthetic ($p = .02$) times were longer for FFP than S (Table 6).

The occurrence of anesthetic complications ($p = .30$; 99/120) was not different for dogs undergoing either soft palate procedure (Table 7). No intraoperative surgical complications were noted.

3.3 | Postoperative

Of 124 dogs, 64 received postoperative oxygen support. Postoperative oxygen use was similar among soft palate surgery types; however, dogs undergoing S had a slightly longer median duration of oxygen use (Table 8). Median days of hospitalization did not differ ($p = .94$) between soft palate procedures (Table 8).

TABLE 8 Presence of postoperative oxygen support, hospitalization, regurgitation, and aspiration pneumonia in dogs undergoing S and FFP.

	S	FFP
Postoperative oxygen (h) S: $n = 30$; FFP: $n = 34$	Median = 19; IQR = 7.5–22.5	Median = 11.5; IQR = 4–21
Hospitalization (days)	Median = 1; IQR = 1–1	Median = 1; IQR = 1–1
$p = .94$, S: $n = 64$; FFP: $n = 60$		
Presence of postoperative regurgitation	17	10
$p = .18$, $n = 27/124$		
Episodes of regurgitation	Median = 2; IQR = 1–3	Median = 2; IQR = 1–3.25
S: $n = 17$; FFP: $n = 10$		
Postoperative aspiration pneumonia $n = 9/124$	4	5

Abbreviations: FFP, folded flap palatoplasty; IQR, interquartile range; S, staphylectomy.

TABLE 9 Medications prescribed for use in-hospital and for discharge for dogs undergoing S and FFP.

	S (N/64)	FFP (N/60)	Total (N/124)
Medications			
Anti-inflammatories			
Administered in-hospital	32	27	59
Prescribed for discharge	27	12	39
Prokinetics			
Administered in-hospital	20	27	47
Prescribed for discharge	4	5	9
Antiemetics			
Administered in-hospital	19	40	59
Prescribed for discharge	2	4	6
GI protectants			
Administered in-hospital	27	44	71
Prescribed for discharge	18	31	49

Abbreviations: FFP, folded flap palatoplasty; GI, gastrointestinal; S, staphylectomy.

TABLE 10 Distribution of revision surgeries (S, FFP, nares, and sacculectomy) among dogs that initially underwent a S or FFP.

	Initial S (N/64)	Initial FFP (N/60)	Total (N/124)
Revision soft palate surgery	3	4	7
Revision S	1	2	3
Revision FFP	2	2	4
Revision nares	2	2	4
Revision sacculectomy	0	1	1

Abbreviations: FFP, folded flap palatoplasty; S, staphylectomy.

TABLE 11 Timing and clinical signs noted between discharge and first follow-up and discharge and last known date of contact for both soft palate procedures (S and FFP).

	S (N/64)	FFP (N/60)	Total (N/124)
Time of discharge to first follow-up (74/124; S: $n = 37$; FFP: $n = 37$)			
Number of days	Median = 12; IQR = 9.5–20	Median = 14; IQR = 12–113	74
Regurgitation	5	3	8
Vomiting	3	3	6
Stertor	2	3	5
Exercise intolerance	0	2	2
Collapse	0	0	0
Time of discharge to last known date of contact (74/124; S: $n = 37$; FFP $n = 37$)			
Number of days	Median = 124; IQR = 14–548.5	Median = 314; IQR = 41–737.5	74
Regurgitation	1	3	4
Vomiting	0	0	0
Stertor	3	2	5
Exercise intolerance	0	0	0
Collapse	0	0	0

Abbreviations: FFP, folded flap palatoplasty; IQR, interquartile range; S, staphylectomy.

Minor complications, including postoperative regurgitation and aspiration pneumonia, were reported in 36/124 (29.03%) of dogs undergoing soft palate surgery. The occurrence of postoperative regurgitation was not different ($p = .18$) between soft palate procedures (Table 8). The presence of postoperative aspiration pneumonia was rare, but similar for both soft palate surgeries (Table 8).

Major complications occurred in 5/124 (4.03%) dogs with a relatively even distribution among soft palate surgery types: Two dogs (S, 1; FFP, 1) were euthanized within 2 weeks of surgery, one dog underwent a tracheostomy postoperatively (S, 1), and two dogs (S, 1; FFP, 1) underwent a tracheostomy postoperatively and were euthanized within 2 weeks. All euthanasia was due to continued severe airway disease. Tracheostomy was performed in dogs who could not be extubated or secondary to severe respiratory effort and/or tachypnea.

Variations in medications for in-hospital and discharge were reported for both soft palate surgery types (Table 9).

3.4 | Follow-up

Three FFP dogs had postoperative hiatal hernias on postoperative imaging and zero S dogs had postoperative hiatal hernias. Small numbers of dogs received a revision soft palate surgery or other revision upper airway surgery postoperatively (Table 10). Initial S dogs ($n = 3$) that received a soft palate revision surgery had the surgery 8, 1008, and 2522 days later and initial FFP dogs that received a soft palate revision surgery ($n = 4$) had the surgery 4, 231, 526, and 700 days later.

Variations in time from discharge to first follow-up, discharge to last known date of contact, and prevalence of continued regurgitation, vomiting, stertor, exercise intolerance, and/or collapse were reported for both soft palate procedures (Table 11).

4 | DISCUSSION

The results of this study indicated that S and FFP surgeries had similar anesthetic, minor, and major complications, as well as similar hospitalization duration. Variation in the prevalence of select pre-, intra-, and postoperative results existed between soft palate surgery types; however, dogs undergoing FFP were associated with longer operative and anesthetic times when evaluating time without concurrent non-airway procedures.

Fourteen different breeds underwent surgical repair for an elongated soft palate. In this study, the French Bulldog, English Bulldog, and Pug were the most common breeds undergoing soft palate surgery. Our study population was comparable to previously evaluated BOAS populations.[2–4,6,8–13]

A low prevalence of clinical signs among dogs undergoing soft palate surgery was reported, suggesting many of these procedures were performed preventatively. A previous study reports that respiratory obstruction can be further exacerbated due to nasopharyngeal and oropharyngeal obstruction as a result of thicker soft palates and not just due to elongated soft palates.[8] In addition, a two-way influential relationship between upper respiratory tract disease and gastroesophageal disease has been reported.[5,14] Furthermore, upper airway obstruction can worsen the intrathoracic pressure thereby increasing the risk of reflux and herniation.[11,15,16] Regurgitation, vomiting, and reflux can also worsen respiratory signs by negatively affecting the pharyngeal region and stimulating further inflammation.[5] Therefore, it is possible that dogs with more secondary GI signs were appreciated to have thicker soft palates and were more likely to undergo a FFP to address both the length and thickness of the soft palate; however, soft palate thickness was not noted on airway examination findings, so this was not able to be evaluated. A prospective study comparing clinical signs and soft palate imaging could provide further insight.

Over the years of this study's records, soft palate surgeries increased and may be a result of increased brachycephalic breed prevalence in the canine pet population. In addition, the distribution of soft palate surgery types changed with increasing use of FFPs in later years. This may be a result of increased popularity of a new technique or due to surgeon experience and change in procedure preference. In this study, some surgeons performed more of one soft palate surgery type; however, it cannot be determined from records if this was based on dog selection or surgeon preference. Surgeons may have used cervical radiographs to assess soft palate thickness; however, this was not documented and may not have occurred with every dog because some surgeons may prefer one procedure regardless of palate thickness.

A previous study suggests that ∼75% of total airway resistance originates within the nares and that more dogs with obstructed nasal cavities were more likely (∼70%) to also have concurrent soft palate and laryngeal saccule abnormalities.[4] Further studies evaluated the prevalence of stenotic nares ranging from 51 to 100%, with higher percentages in newer studies.[2,5,6,9,11,17–19] This is similar to our study where ∼85% of dogs undergoing soft palate surgery had evidence of stenotic nares. Among dogs also undergoing nares correction surgery, certain techniques were more commonly performed with a specific soft palate surgery. However, surgeon preference for both the type of soft palate surgery and nares surgery could have influenced this.

A previous study found that brachycephalic dogs were at a greater risk of anesthetic-related complications than non-brachycephalic dogs (1.57 times more likely), particularly with increasing anesthetic times.[1] Another study also found a 12% increased odds of complications post-anesthesia and a 11% increased odds of complications during anesthesia when anesthetic time increased by an extra 15 min.[20] In our study, FFP had longer median anesthetic and operative times than staphylectomies without concurrent non-airway procedures. However, in contrast to the aforementioned study, longer anesthetic and surgical times did not appear to cause more significant anesthetic complications in FFP dogs in this study. This may suggest that although brachycephalic dogs may be at higher risk for anesthetic complications during surgery, FFP dogs may not be more likely to have complications than S dogs. Further prospective studies evaluating this relationship are recommended.

In a previous study, upper airway surgery was reported to be commonly associated with postoperative complications.[7] Dyspnea was the most common complication reported, but others included coughing, infection/inflammation, vomiting, regurgitation, and cyanosis.[7] Furthermore, another study found that brachycephalic dogs were at much higher risk for developing postoperative complications than non-brachycephalic dogs.[1] Within the postoperative period of our study, median duration of hospitalization did not differ and minor and major complications were similar across both soft palate surgeries. Therefore, even though FFP surgeries are reportedly more technically challenging with more soft tissue dissection and longer surgical times than S surgeries, they did not require more postoperative support than S dogs.[8] Based on the possibility of additional perceived airway swelling postoperatively with FFP dogs, different clinicians may have tried to provide more postoperative support in the form of oxygen and different medications in-hospital and for discharge; however, this was found to be inconsistent among soft palate surgeries in our current study. This is likely the result of surgeon's preference of postoperative care. Duration of oxygen supplementation may also vary depending on when technical staff can discontinue it. Further prospective studies looking at the use of anti-inflammatory, prokinetic, antiemetic, and GI protectant use may provide more information on the benefit or prognosis of either soft palate surgery in the postoperative period.

The prevalence of persistent clinical signs during the postoperative and follow-up periods decreased for all signs except regurgitation, where one additional dog experienced regurgitation postoperatively compared to the preoperative period. Given the small number of dogs with persistent signs, comparison of individual clinical signs between soft palate surgeries is difficult; however, the overall decrease in clinical signs may suggest that either soft palate surgery is sufficient in improving the resolution of both GI and respiratory signs. This is similar to other studies that found either a reduction or resolution of 80–100% of GI signs[9,11] and 88.3% of respiratory signs among different brachycephalic breeds treated surgically.[9] It may also be that the appropriate surgical technique (FFP vs. S) was chosen for each dog on a case-by-case basis based on surgeon assessment and experience, such that a dog undergoing a FFP may not have recovered as well postoperatively with a staphylectomy if there was concern for palate thickness; however, this was not able to be determined.

Within the follow-up period, all dogs (3/3) with persistent hiatal hernias on preoperative and postoperative imaging underwent FFP. In contrast, two other dogs that had undergone S had evidence of a hiatal hernia on preoperative imaging, but these hiatal hernias were not noted on the dogs' postoperative imaging, which suggests resolution of the hernia or a sliding hernia. However, nine dogs who had evidence of a hiatal hernia preoperatively did not receive postoperative imaging and correlations cannot be made for these dogs. These findings related to hiatal hernias may be due to a type II error and future research evaluating resolution of GI signs is warranted. Because only seven dogs underwent a revision soft palate surgery, the need for any particular revision BOAS surgery (i.e., S, FFP, nares, or laryngeal sacculectomy revision) is difficult to assess between soft palate surgeries.

The main limitation of this study was its retrospective nature and the inability to randomize dogs in the study design. Data were obtained from medical records and operative reports, requiring dependence on accurate reporting of laryngeal examination findings and accurate representation of the intraoperative results. Soft palate thickness was not noted on pre-operative examination findings, so this variable was not evaluated; however, to objectively determine whether S or FFP should be performed, soft palate thickness on CT should be measured. Another limitation of this study was individual clinician preference for surgical procedures and selection of treatments and medications postoperatively (in-hospital and for discharge). Sample size of some individual variables such as clinical signs, specific pre- and postoperative imaging results (i.e., hiatal hernias and hypoplastic tracheas), everted tonsils, tonsillectomies, and revision surgeries was small. Small sample size can cause a type II error and may influence our findings. Also, limited follow-up time with a large range reported in the medical record was a constraining factor. Further studies with power analysis and randomization to compare pre-, intra-, and postoperative variables in a prospective nature are recommended to provide better recommendations for soft palate surgery selection.

In conclusion, S and FFP had similar anesthetic and perioperative complications, suggesting that both S and FFP may be considered for treatment of an elongated soft palate as part of the BOAS, although FFP dogs had longer anesthetic and operative times.

AUTHOR CONTRIBUTIONS

Miller AK, DVM, MPH: Substantial contribution to the conception and design of this study, data acquisition, data analysis, data interpretation, drafting and revision of work, in-line specific manuscript editing, and final approval of manuscript. Regier PJ, DVM, MS, DACVS-SA: Substantial contribution to the conception and design of this study, data interpretation, revision of work, in-line specific manuscript editing, and final approval of manuscript. Colee JC, MS: Statistician with substantial contribution to data analysis, data interpretation, in-line specific manuscript editing regarding statistical data, and final approval of manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest related to this report.

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