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Risk factors for complicated perioperative recovery in dogs undergoing staphylectomy or folded flap palatoplasty: Seventy-six cases (2018–2022)

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Abstract

Objective: To analyze risk factors for complicated perioperative recovery of dogs undergoing either staphylectomy or folded flap palatoplasty.

Study design: Retrospective study.

Animals: Seventy-six client-owned dogs.

Methods: Medical records of dogs that underwent either staphylectomy or folded flap palatoplasty were reviewed for signalment, brachycephalic risk (BRisk) score, history of gastrointestinal signs, laryngeal collapse grade, presence of preoperative aspiration pneumonia, intraoperative respiratory and cardiovascular complications, length of general anesthesia, number of corrected brachycephalic obstructive airway syndrome (BOAS) components, and gastrointestinal and respiratory postoperative complications. Complicated recovery was defined as requirement for prolonged oxygen treatment and/or tracheostomy or perioperative death. Penalized logistic regression was used to identify risk factors.

Results: Seventy-six dogs were enrolled in the study. Multivariate penalized logistic regression identified four risk factors for complicated recovery. These include surgery type ($p = .0002$), age ($p = .0113$), laryngeal collapse grade >2 ($p < .0001$) and length of general anesthesia ($p = .0051$).

Conclusions: In this population, dogs that had staphylectomy, increasing age, laryngeal collapse grade >2 and increasing length of general anesthesia were at increased risk for perioperative complicated recovery.

Clinical significance: The results of this study identified risk factors for perioperative complicated recovery in dogs undergoing elongated soft palate correction and may assist in surgical planning and early prediction of complications.

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1 | INTRODUCTION

Brachycephalic obstructive airway syndrome (BOAS) is a frequently encountered disease in dogs with congenitally short skull and muzzle.[1,2] One of the components of BOAS is elongated soft palate, which often contributes to respiratory signs.[3,4] Dogs that display signs of respiratory obstruction require soft palate resection alongside other corrective procedures of the upper respiratory tract such as nares resection or laryngeal sacculectomy. Several surgical techniques have been described for the correction of elongated soft palate in brachycephalic dogs. Conventional staphylectomy relieves the laryngeal obstruction by resecting the caudal portion of soft palate. A newer method, folded flap palatoplasty[5] addresses both length and thickness of the soft palate, aiming to alleviate both laryngeal and pharyngeal obstruction.[6] This technique is suggested to increase the pharyngeal lumen due to significant amount of soft tissue being removed. The suture line is located rostrally, thus advancing the caudal aspect of soft palate cranially, potentially allowing for further opening of the nasopharynx. Additionally, with the surgical site located farther from pharynx, there may be less risk for airway obstruction from postoperative inflammation and edema.[6] However, there are many factors that may affect success of the selected surgical method, including pre-, intra-, and postoperative variables.

To date, a limited number of prognostic indicators have been investigated for dogs undergoing BOAS surgery. Severity of laryngeal collapse was not associated with surgical outcomes in one study.[7] Preoperatively assessed severity of inspiratory effort or pharyngeal narrowing was not noted to negatively affect the outcome in another study.[8] Previously, preoperatively available information such as dog age, breed or presurgery respiratory sign severity was not shown to affect postsurgical outcome.[4,9] However, increasing age was a risk factor for death in a more recent study of 423 brachycephalic dogs undergoing BOAS surgery.[10] Brachycephalic dogs were reportedly four times more likely to experience postanesthetic complications compared to nonbrachycephalic dogs, and prolonged anesthesia was a risk factor for development of complications including aspiration pneumonia and need for temporary tracheostomy.[9,11] Also, young brachycephalic dogs with normal body condition and presence of laryngeal collapse undergoing traditional multilevel surgery for BOAS seemed to have less favorable postoperative prognosis.[12] However, higher body condition score (BCS) has been significantly associated with BOAS and significantly overweight dogs were at higher risk of developing signs of BOAS.[13,14]

The brachycephalic risk (BRisk) score has been suggested to predict the risk of major complications for brachycephalic dogs undergoing upper airway surgery.[15] It can be easily applied in a clinical setting by using commonly accessible preoperative data including breed, body condition score, rectal temperature, history of previous airway surgery, degree of airway obstruction on admission, and concurrent surgeries performed at the time of BOAS correction.

The variation in previously described risk factors for perioperative complications, including conflicting evidence for what constitutes a risk factor, stimulated us to design a study further evaluating risk factors for negative outcomes in our population of dogs undergoing BOAS surgery.

The objective of this study was to identify risk factors for complicated perioperative recovery in dogs undergoing either staphylectomy (S) or folded flap palatoplasty (FFP).

We hypothesized that receiving an FFP procedure would be associated with a less complicated short-term recovery compared to S.

2 | MATERIALS AND METHODS

2.1 | Animals

Medical records of client-owned dogs undergoing upper airway surgery for BOAS between January 2018 and July 2022 were retrospectively reviewed. Dogs were included in the study if they had S or FFP performed, and the medical records were deemed complete. Dogs that underwent additional surgical procedures concurrently were also included. Due to the retrospective nature of the study informed consent form from the owner was not required.

2.2 | Data collection

Preoperative data retrieved from medical reports included breed, sex, neuter status, age, weight, BCS/5, reason for presentation divided into gastrointestinal (GI), respiratory and other reasons, clinical findings, rectal temperature on admission, whether oxygen and sedation was required on admission, previous medical history, diet type, diagnostic tests, preoperative diagnoses divided into respiratory, gastrointestinal, and other diseases, presence of laryngeal collapse and its grade, and whether laryngeal paralysis and aspiration pneumonia were present and treated prior to surgery. BRisk score was calculated retrospectively for each data category.

The procedures described in this report were performed or supervised by a group of three ACVS board certified surgeons. Each dog underwent either S or FFP performed by a surgical team consisting of one ACVS diplomate assisted by one surgery resident with method selection at the discretion of the surgeon. The BOAS surgery type for each patient was not inextricably linked to the individual surgeon, and each surgeon performed both procedures during the time period that was evaluated. Collected intraoperative data included medications used for general anesthesia, anesthetic and surgery time, BOAS surgery type and number of BOAS components that were corrected, type of surgery for soft palate resection and instrument used for its correction, additional procedures performed alongside BOAS, intraoperative complications divided into those considered respiratory or cardiovascular in nature.

Postoperative data included complications divided into respiratory and GI, requirement for oxygen, use of dexmedetomidine constant rate infusion (CRI), tracheostomy, time that oxygen and dexmedetomidine CRI were administered, medications and diet given during hospitalization, duration of postoperative hospitalization, and death or euthanasia during hospitalization.

Dyspnea and need for oxygen support for more than 12 h, aspiration pneumonia, the need for a temporary tracheostomy, sedation, intubation, or death prior to discharge from hospital, were considered major complications consistent with an adapted Clavien-Dindo (aCD) postoperative complication grading of III–V,[16] and oxygen support for less than 12 h, regurgitations and nausea were considered minor complications consistent with an aCD grade of I–II.

Complicated recovery was defined as requirement for prolonged oxygen treatment, that is, >12 h, and/or the requirement of an emergency temporary tracheostomy, or death.

2.3 | Statistical analysis

A total of 23 preoperative, 11 intraoperative and 10 postoperative variables were reviewed; however, for appropriate regression analysis reasons, only 15 variables of highest interest based on previous literature were selected for further analysis. Statistical analyses were performed using commercially available statistical software (JMP Pro 15.2, JMP Statistical discovery, Cary, North Carolina). Variables were evaluated for normality with Shapiro–Wilk's test, and as age failed the normality test all continuous parameters are expressed as median and interquartile range (IQR) in the text. Categorical data are reported as percentage. Univariate regression was performed to evaluate all selected variables, with complicated recovery as the outcome variable. Parameters with p-value <.25 were included in the multivariable logistic regression model. Least absolute shrinkage and selection operator (lasso) penalized logistic regression was used to calculate CI for odds ratio (OR) to reduce potential bias from the sample size limitations and low prevalence of complicated recovery in our population. Significance was set at $p < .05$.

To ensure proper interpretation of the model in the face of multicollinearity, structure coefficients were also considered for the model.[17] Structure coefficients are calculated in logistic regression by calculating the correlations between predictors in the model and the saved predicted probability of the outcome from the model. Collinearity was assessed both by the pattern of the scatter plot and by structure coefficient. The structure coefficients were compared to the coefficient statistics (estimate andχ^2) of the multivariate model to determine if any parameter might be acting as a confounder or suppressor in the model. Structure coefficients represent how much a predictor correlates with the model by itself, so these values are not affected by potential multicollinearity, and therefore help to determine if multicollinearity has impacted the interpretation of the model.[17]

3 | RESULTS

3.1 | Dogs

A total of 76 cases met inclusion criteria. Breeds included the French Bulldog ($n = 48$; 63%), English Bulldog ($n = 13$; 17%) Pug ($n = 7$; 9%), Boston Terrier ($n = 3$; 4%), cross-breeds ($n = 2$; 3%), Shih Tzu (n =; 1%), Cavalier King Charles Spaniel ($n = 1$; 1%), and Mastiff ($n = 1$; 1%). In total there were 61 Bulldogs (80%), seven Pugs (9%) and eight other breeds (11%). There were 11 sexually intact females (14%), 21 spayed females (28%), 23 sexually intact males (30%), 20 castrated males (26%) and one hermaphrodite (1%). The median age was 25 months (13–70 months) and the median weight was 11 kg (9.15–15.25 kg). Body condition scores were available for 72 dogs; 16 dogs (22%) had a BCS below 2.5, 40 (56%) had a BCS between 2.5 and 3.5, and 16 dogs (22%) had a BCS higher than 3.5. Signalment data are presented in Table 1.

3.2 | Presenting complaint, physical examination, and diagnostic tests

Respiratory signs were the primary presenting complaint in most dogs (58/76; 76%). These included stertor, respiratory distress, dyspnea, stridor, snoring, increased

TABLE 1 Signalment, history, and clinical data collected from 39 dogs undergoing staphylectomy and 37 undergoing folded flap palatoplasty and selected for further analysis.

Variables	CO_2 laser staphylectomy *N* (%)	Folded flap palatoplasty *N* (%)
Breed		
• English Bulldogs	7 (18%)	6 (16%)
• French Bulldogs	19 (49%)	29 (78%)
• Pugs	7 (18%)	0 (0%)
• Boston Terriers	2 (5%)	1 (3%)
• Other breeds	4 (10%)	1 (3%)
Age (months) median (IQR)	25 (13.5–78)	25 (13–58)
BCS/5		
• <2.5	8 (22%)	7 (19%)
• 2.5–3.5	22 (61%)	19 (53%)
• >3.5	6 (17%)	10 (28%)
History of GI signs		
• Yes	15 (39%)	21 (57%)
• No	23 (61%)	16 (43%)
BRisk score		
• Low risk <3	12 (34%)	10 (28%)
• Medium to high risk 3–4	16 (46%)	15 (42%)
• High risk >4	7 (20%)	11 (30%)
Laryngeal collapse grade		
• ≤2	30 (94%)	27 (77%)
• >2	2 (6%)	8 (23%)
Preoperative aspiration pneumonia		
• Yes	3 (9%)	2 (6%)
• No	29 (91%)	33 (94%)
Number of BOAS components operated		
• 1 or 2	10 (26%)	5 (14%)
• 3	29 (74%)	32 (86%)
Intraoperative respiratory complications		
• Yes	5 (15%)	4 (11%)
• No	29 (85%)	33 (89%)
Intraoperative cardiovascular complications		
• Yes	12 (35%)	26 (70%)
• No	22 (65%)	11 (30%)
General anesthesia length (min) median (IQR)	112.5 (72.5–176.3)	145 (90–205)
Gastrointestinal postoperative complications		
• Yes	4 (13%)	8 (23%)
• No	27 (87%)	27 (77%)
Requirement of oxygen >12 and or tracheostomy		
• Yes	11 (28%)	5 (14%)
• No	28 (72%)	32 (86%)

Abbreviation: BOAS, brachycephalic obstructive airway syndrome; GI, gastrointestinal; IQR, interquartile range.

respiratory effort, heat and exercise intolerance, sleep apnea, coughing and nasal discharge. A large proportion of dogs (35/76; 46%) also had concurrent gastrointestinal signs, and only one dog was presented exclusively for a gastrointestinal complaint. The symptoms associated with gastrointestinal tract included regurgitation, vomiting or difficulty swallowing. Additional historical data were anal sac adenocarcinoma, neurological symptoms including paraplegia, cervical pain, urethral prolapse, rectal prolapse, mammary gland tumor, external genitourinary anomalies, splenic mass rupture and chronic urinary incontinence.

A total of 41 dogs (54%) had a prior history of medical problems, including allergies, dermatological or ocular problems, epilepsy, inflammatory bowel disease, urinary issues, and hypothyroidism. Five of the 41 dogs (12%) had prior BOAS surgery performed by referring veterinarian including one or more of the following procedures rhinoplasty (4/5), staphylectomy (3/5) and laryngeal sacculectomy (1/5). Two of 41 dogs (5%) had a history of previous aspiration pneumonia prior to evaluation at our institution.

A total of 31 dogs had been treated with medication prior to presentation including antibiotics, steroids, nonsteroidal anti-inflammatory drugs, medications for gastrointestinal issues, gabapentin, trazodone, heart medications, antiallergy medications, antiseizure medications. Out of 34 dogs that had history of regurgitations, only seven had been on one or more medications which included omeprazole (6 dogs; 19%), maropitant (2 dogs; 6%), and metoclopramide (1 dog; 3%).

On physical examination, all 76 dogs had respiratory signs and evidence of elongated soft palate. Median rectal temperature was 101.2 ° F (100.25–101.6 ° F).

Complete blood count and biochemistry were performed in 71 cases (93%) and chest radiographs were obtained prior to surgery in 72 cases (95%). Five of the 72 dogs (7%) had radiographic evidence of aspiration pneumonia, and all were treated with broad-spectrum antibiotics (ampicillin sulbactam or coamoxicillin) for 10–14 days before surgery. These five dogs included those with a history of aspiration pneumonia. Thoracic radiographs were repeated the day before BOAS surgery to confirm that the aspiration pneumonia had resolved. Nine of the 72 dogs (13%) that had thoracic radiographs were diagnosed with sliding hiatal hernia. A total of 13 of the 76 cases (17%) underwent one or more additional diagnostic tests for gastrointestinal or neurological disease, including fluoroscopic swallow study (5 dogs), esophagogram (4 dogs), echocardiogram (3 dogs), magnetic resonance imaging (MRI) scan (2 dogs) or skull computed tomography (CT) (2 dogs).

Six dogs (8%) required immediate oxygen administration on admission due to severe dyspnea, of which three were diagnosed with aspiration pneumonia and one with laryngeal paralysis, the latter arriving from the referring veterinarian with a tracheostomy tube in place. Out of these six cases that presented with severe dyspnea five (83%) required sedation. All dogs' history and physical examination data were considered adequate for calculation of BRisk score. Frequency data based on history of GI signs, BRisk score and preoperative aspiration pneumonia is presented in Table 1.

3.3 | Anesthesia and surgery

A variety of agents were used for premedication, including dexmedetomidine, methadone, acepromazine, hydromorphone, midazolam and butorphanol. Either propofol or alfaxalone were used as the induction agent, and general anesthesia was maintained using isoflurane or sevoflurane with 100% oxygen. The results of laryngeal examination under anesthesia were available in 67 dogs. Six dogs (9%) had no laryngeal collapse, 37 dogs (55%) had everted laryngeal saccules as evidence of grade 1 collapse, 14 dogs (21%) had aryepiglottic fold laxity with medial deviation of the cuneiform cartilages considered grade 2 collapse and 10 dogs (15%) had higher collapse than grade 2.

All the dogs underwent surgical management of their BOAS. All three BOAS components (stenotic nares, elongated soft palate and everted saccules) were corrected in 61 dogs (80%); 13 dogs (17%) had two components corrected (elongated soft palate and either stenotic nares or everted saccules) and two dogs (3%) only required correction of the elongated soft palate.

All 76 dogs were found to have elongated soft palate and underwent either S (39 dogs; 51%) or FFP (37 dogs; 49%). Staphylectomy procedures were completed using CO_2 laser as previously described.[18] A total of 37 dogs underwent FFP similar to a previous study.[6] However, 23 dogs (62%) had the procedure performed with CO_2 laser for palate dissection, nine dogs (24%) underwent sharp dissection using Metzenbaum scissors with hemostasis provided by bipolar electrocautery, and five dogs (14%) had a combination of sharp dissection and laser treatment. A total of 31 of the 76 dogs (41%) undergoing BOAS surgery had additional surgical (26 dogs) or nonsurgical procedures (5 dogs) performed under the same anesthesia. Additional surgical interventions included ovariohysterectomies, ovariectomies or castrations (9 dogs; 12%), hiatal hernia repairs (6 dogs; 8%), urethropexies (2 dogs; 3%), unilateral left arytenoid lateralization (2 dogs; 3%), hemilaminectomies (2 dogs; 3%), and one each of the following: anal sacculectomy, colopexy, mastectomy, mast cell tumor excision, gastropexy, penile amputation and scrotal ablation, splenectomy, liver biopsy, and ectopic ureter ablation. Nonsurgical procedures included MRI of a spine (2 of 76 dogs; 3%) and upper gastrointestinal endoscopy (1 dog; 1%), chest CT scan (1 dog; 1%), and thoracic radiographs (1 case; 1%).

Median duration of anesthesia was 120 min. A total of 36 (47%) dogs experienced intraoperative complications. The most common complications were hypotension (29 dogs), arrhythmia (10 dogs), difficult intubation (8 dogs) and bradycardia (7 dogs). Hypothermia (4 dogs), laryngeal edema (2 dogs) and regurgitation (1 dog) were less commonly seen. Hypotension, hypothermia, bradycardia, and arrythmias were considered cardiovascular in nature. Difficulties in intubation, laryngeal edema and regurgitation were considered of respiratory nature. Most of these signs resolved when animal recovered from anesthesia; however, in some dogs, laryngeal edema and difficult intubation contributed to requirement for oxygen or temporary tracheostomy. None of the dogs died intraoperatively. Frequency data including number of surgical procedures, intraoperative respiratory and cardiovascular complications, and general anesthesia length are presented in Table 1.

3.4 | Postoperative management

Postoperative complications occurred in 30 out of 76 dogs (39%), of which 16 dogs (53%) experienced major complications and 14 dogs (47%) experienced minor complications. Of the 16 dogs with major complications, all were either requiring prolonged oxygen treatment and or needed a tracheostomy and or died during recovery. These 16 dogs comprised the group considered to have a complicated recovery. A total of 12 of the surgical cases (16%) regurgitated after surgery. Twenty-six dogs (34%) required oxygen administration on recovery due to dyspnea and/or swelling of the larynx, of which 13 dogs (50%) required more than 12 h of oxygen administration and remaining 13 (50%) less than 12 h. Dexmedetomidine CRI was required due to anxiety with or without respiratory distress in 20 dogs (26%) postoperatively, of which 19 dogs required it for more than 12 h. A temporary tracheostomy was performed in six of 76 dogs (8%) and all these dogs were either English or French Bulldogs, had various degree of laryngeal collapse and moderate to high BRisk score and all had three BOAS components corrected. Two of these dogs in addition had previously had aspiration pneumonia that was treated with antibiotics and none of them had laryngeal collapse. Five of these six dogs survived to discharge. Five dogs that required either >12 h oxygen treatment and/or tracheostomy during surgical recovery had a history of having been treated for aspiration pneumonia. Three dogs (4%) died or were euthanized prior to discharge from the hospital.

Various medications were given at postoperative period and included: steroids, trazodone, maropitant, pantoprazole or omeprazole, ondansetron, cisapride, sucralfate, gabapentin metoclopramide, butorphanol, fentanyl CRI, methadone, and tramadol.

The median duration of hospitalization postoperatively was 1.5 days (1–2 days).

Seventy-three dogs (96%) survived to discharge, and three dogs (4%) died or were euthanized for reasons including severe dyspnea, 1–2 days after airway surgery.

3.5 | Risk factors

Results of univariate analysis for the selected variables are presented in Table 2. Each variable was analyzed for association with a complicated recovery, defined as the requirement of oxygen treatment more than 12 h and/or requirement of temporary tracheostomy, and or death. Seven variables were preliminarily entered into the multivariate model with results presented in Table 3. After removal of nonsignificant or unstable variables the final model included four variables; surgery type, age, laryngeal collapse>2, and length of anesthesia (Table 3). A history of aspiration pneumonia was only present in dogs with a complicated recovery ($p < .0001$), but due to instability in the model was not included in the final multivariate model.

4 | DISCUSSION

In the investigated population of dogs, staphylectomy surgery, increasing age, high laryngeal collapse grade, and increasing length of general anesthesia were associated with a complicated recovery in dogs undergoing S or FFP. While surgery type was not associated with outcome in univariable analysis, when included in the multivariable model with age, length of anesthesia, and severity of laryngeal collapse, staphylectomy was associated with an increased risk of complicated surgery as compared to FFP. We do however advise caution when interpreting the effect size of surgery type. The OR was extremely high in our results but was at the same time associated with a wide CI. This may be a result of upward bias due to a limited sample size and low occurrence of complicated recovery. With that in mind we still noted that the surgery type was one of four variables associated with the complicated recovery and this allowed us to accept our hypothesis. There may be several possible explanations for the association between less complicated

TABLE 2 Results from univariate analysis of selected variables investigated for association with dogs experiencing complicated recovery or not.

Variable	Dogs with complicated recovery $N = 16$	Dogs without complicated recovery $N = 60$	Odds ratio (95% likelihood based CI)	p-value
Surgery type				.1233
Staphylectomy ($n = 39$)	11 (69%)	28 (47%)	2.51 (0.809–8.800)	
Palatoplasty ($n = 37$)	5 (31%)	32 (53%)	Reference	
Breed group				.3441
Bulldogs ($n = 61$)	13 (81%)	48 (80%)	n/a	
Pugs ($n = 7$)	2 (13%)	5 (8%)	n/a	
Nonbrachycephalics ($n = 8$)	1 (6%)	7 (12%)	n/a	
Age (months)				.0057
Median (IQ1-IQ3)	74 (38–83)	19 (13–60)	1.02 (1.006–1.036)[a]	
Body condition score (/5)	$n = 14$	$n = 58$		.6381
<2.5 ($n = 15$)	3 (21%)	12 (20%)	0.714 (0.142–2.835)	
2.5 < BCS≤3.5 ($n = 42$)	8 (50%)	34 (57%)	Reference	
>3.5 ($n = 16$)	2 (14%)	14 (24%)	0.476 (0.067–2.163)	
BRisk score	$n = 14$	$n = 57$		.5377
Low risk <3 ($n = 22$)	3 (21%)	19 (33%)	Reference	
Medium to high risk 3–4 ($n = 31$)	6 (42%)	25 (77%)	1.520 (0.336–6.873)	
High risk >4 ($n = 18$)	5 (36%)	13 (23%)	2.436 (0.494–12.014)	
History of gastrointestinal signs		$n = 59$		.3408
None ($n = 39$)	10 (62%)	29 (49%)	Reference	
Yes ($n = 36$)	6 (38%)	30 (51%)	0.58 (0.187–1.802)	
Laryngeal collapse grade	$n = 15$	$n = 53$		.0348
≤2 ($n = 58$)	10 (67%)	48 (91%)	Reference	
>2 ($n = 10$)	5 (33%)	5 (9%)	4.7 (1.142–19.349)	
Preoperative aspiration pneumonia				<.0001
No ($n = 71$)	11 (69%)	60 (100%)	Reference	
Yes ($n = 5$)	5 (32%)	0 (0%)	n/a	
Intraoperative respiratory complications	$n = 14$	$n = 57$		.8419
No ($n = 62$)	12 (86%)	50 (88%)	Reference	
Yes ($n = 9$)	2 (14%)	7 (12%)	1.2 (0.219–6.471)	
Intraoperative cardiovascular complications	$n = 14$	$n = 57$		.1350
No ($n = 33$)	9 (65%)	24 (42%)	Reference	
Yes ($n = 38$)	5 (35%)	33 (58%)	0.404 (0.120–1.359)	
General anesthesia length (min)	$n = 14$	$n = 57$		.0065
Median (IQ1-IQ3)	183 (123–269)	110 (80–165)	1.009 (1.002–1.016)[a]	
Number of BOAS procedures				.0926
3 ($n = 61$)	15 (94%)	46 (77%)	4.565 (0.027–1.808)	
1 or 2 ($n = 15$)	1 (6%)	14 (23%)	Reference	
Gastrointestinal postoperative complications	$n = 14$	$n = 52$		.1899
No ($n = 54$)	13 (93%)	41 (79%)	Reference	
Yes ($n = 12$)	1 (7%)	11 (21%)	0.287 (0.410–29.646)	

Note: Complicated recovery defined as >12 h of O_2 treatment and/or tracheostomy and/or death. n/a = parameter unstable.

Abbreviations: BOAS, brachycephalic obstructive airway syndrome; CI, confidence interval; IQ, interquartile range.

[a]Odds ratio per additional unit increase.

TABLE 3 Multivariate analysis of risk factors associated with dogs experiencing complicated recovery.

Risk factor	Odds ratio	95% confidence interval	*p*-value	Structure coefficient
Surgery type staphylectomy	59.29	6.87–511.98	.0002	0.3548
Increasing age (per additional month)	1.04	1.01–1.07	.0113	0.5818
Laryngeal collapse > grade 2	97.13	9.90–952.50	<.0001	0.6733
Increasing anesthesia length (per additional minute)	1.01	1.00–1.02	.0051	0.4551

Note: Complicated recovery defined as >12 h of O_2 treatment and/or tracheostomy and/or death.

perioperative recovery and FFP; FFP may remove excessive redundant soft tissue which addresses both laryngeal and pharyngeal obstruction, compared to staphylectomy which relieves only a laryngeal obstruction. Additionally, FFP decreases the thickness of soft palate, which may be less susceptible to the edema development or edema may not be as clinically significant as in thick soft palates.[6] Regardless of the thinning effect and perhaps even more importantly, the FFP moves the surgical site rostrally in the oral cavity which may decrease the caudal pharyngeal-laryngeal edema as compared to a more caudal resection.[6] Our result is similar to others[12] showing that modified multilevel surgery with FFP was associated with better outcomes than traditional multilevel surgery with S. Conversely, Miller et al. showed that there was no difference in outcomes between FFP and S, and perioperative as well as anesthetic complications were similar in both surgery groups.[19] It has been suggested that chronic airflow obstruction may persist after S due to minimal soft tissue resection in the pharyngeal region.[10] However, it is important to note that our study was focusing solely on the immediate postoperative recovery, in contrast to other outcome studies.[10,12] The long-term outcome of FFP has recently been criticized for high frequency of wound healing complications.[20] Anecdotally our research team has also experienced similar complications, which was one of the inspirations for performing this study. Some surgeons at our institution started using FFP in dogs with subjectively perceived higher risk for complications, such as older English or French Bulldogs with very thick soft palates and were encouraged to keep using the procedure also in other demographics due to a likewise perceived improvement in immediate outcome. When presented with a suspicion of potential wound healing complications, it was prudent to assure that the subjective advantages were indeed true before continuing to use the FFP procedure. Our interpretation of the findings in our study population is that FFP seems to be associated with less risk for complicated immediate recovery. This effect was not immediately apparent on univariate analysis, perhaps due to case selection of more severely affected dogs initially. However, when surgery type was included with the other variables in the multivariate model, surgery type indeed seemed to have an undeniable effect on the frequency of complicated recovery. How large an effect may not be clearly demonstrated by the OR in our model. The wide CI associated with our OR makes us suspect there is an upwards bias due to limited sample size and relatively unusual occurrence of complicated outcome. It will also be imperative to determine if the long-term outcome likewise is associated with an improved outcome, as has been reported by others,[12] or if the complication rate is as high as has been suggested.[20]

While FFP may be effective in improving respiratory function when combined with other BOAS procedures,[6,7] it is not without disadvantages. Wound healing complications can occur in the postoperative period following FFP surgery and dehiscence rate is as high as 36%. However, dogs that exhibit these post-surgical complications did not show associated worsening of clinical signs.[20]

Another potential risk of the FFP is extensive soft palate resection which may lead to nasal regurgitations.[21–23] Currently, there are no clear guidelines on the ideal amount of soft palate resection and flap dimension/ margins that would balance opening the airway versus preserving palatal function. Therefore, further research is warranted to provide standardized protocol for optimal soft palate resection following FFP, which could improve surgical outcomes and minimize postoperative complications associated with overcorrection.

While staphylectomy has some benefits over FFP such as straightforward, technically easier and less challenging approach, minimal soft tissue manipulation and shorter surgical time[18] it may lead to incomplete relief of airway obstruction. The procedure addresses laryngeal obstruction only and this may not adequately open the airway, particularly in patients with severe clinical signs.[6] Consequently, residual obstruction persists requiring additional corrective surgery. Therefore, the selection of the surgical technique for soft palate correction should be tailored to the individual patient, and risk factors should not be underestimated.

Laryngeal collapse most commonly is a feature of brachycephalic dogs with chronic upper airway disease.[24] Constant negative pressure within the larynx results in permanent cartilage deformation and collapse.[21] The disease is considered progressive and demonstrated that prognoses are variable.[22,24–27] In the current study, presence of laryngeal collapse grade higher than 2 was another prognostic factor identified. Our results are in concordance with previous studies.[12,15,23,26,28] Dogs with laryngeal collapse higher than grade 2 were nearly three times more likely to have postoperative major complications such as need for oxygen supplementation for >48 h or tracheostomy, than dogs with lower laryngeal collapse grade in one study.[15] Additionally, Liu et al. reported that presence of laryngeal collapse of any grade, based on BOAS index generated from whole-body barometric plethysmography, has previously been associated with poor prognosis.[12] However, laryngeal collapse as a negative prognostic indicator is a quite controversial topic, since other studies did not show correlation between laryngeal collapse grade and postoperative prognosis,[7,25] but reported that dogs with advanced laryngeal collapse improved after BOAS surgery.[25] These differences may be explained by small number of dogs with laryngeal collapse grade 2 and 3 or inconsistencies in grading. A major challenge of laryngeal collapse grading is that it is based on subjective assessment and it may vary between observers. Grade 2 collapse was not rare in our study but found in one of five dogs which may reflect how our surgery team grade laryngeal collapse. In fact, almost one third of the dogs in this study were considered to have laryngeal collapse of grade 2 or higher. In our experience, only the highest grades of laryngeal collapse, that is, with signs of corniculate cartilage and/or severe cuneiform median deviation, are associated with the immediate outcome, which is why this group was selected for outcome analysis. Regardless, considering discrepancies on influence of laryngeal collapse grade on postoperative prognosis, further investigations with more objective or standardized grading criteria may be warranted to get consensus on this issue.

In the current study, increasing age was associated with increased risk for complicated recovery. The median age of dogs with complicated recovery were 74 months, and dogs with a normal recovery only 19 months. In fact, each month of increased age increased the odds ratio of complicated recovery by 2%. Our results are similar to a previous investigation, reporting that each 1-year increase in age lead to a 30% increase in the odds ratio for temporary tracheostomy tube placement following BOAS surgery.[29] It has been suggested that with BOAS soft tissue in the oronasopharyngeal area gets constantly irritated by abnormal air flow and its pressure changes, which results in tissue inflammation and loss of elasticity over time. Therefore, dogs undergoing BOAS surgery, with such changes present, are more likely to require temporary tracheostomy tube placement due to dyspnea caused by even minor soft tissue edema in the oropharynx.[29] In addition, laryngeal collapse has been also documented as contributing factor to less favorable outcome in older dogs.[12,26,30] Conversely, other reports did not find an association between age and postoperative complications following BOAS surgery.[9,31] In fact, Liu et al., found that younger age was a risk factor for surgical treatment of BOAS in a population of dogs of similar age distribution to our study.[12] It was speculated that severely compromised BOAS dogs may be assessed at a younger age, since they develop marked respiratory problems earlier in life, which affect quality of their life. Congenital abnormalities of the upper respiratory tract in these dogs leading to severe BOAS signs also cannot be ruled out. It is possible that the immediate outcome we investigated, may be quite different from the 1 month and 6 months outcome noted by Liu et al.[12] This is another argument for following up our study with a long-term outcome analysis.

The finding that prolonged general anesthesia was associated with an increased risk for complicated recovery was not unexpected. Each additional minute in general anesthesia time increased the odds ratio of complicated recovery by 0.9%. Similar results have been obtained previously,[15] where the odds of poor outcome increased 1.22 times for each 10 min in additional procedure time. Gruenheid et al. also identified that duration of anesthesia is associated with intra-anesthetic risk of complications.[11] They reported that the odds of intra-anesthetic complications rose 1.01 times for each additional 30-min increment. Longer surgery or multiple procedures concurrently increase general anesthesia time and therefore increases the risk for slow recovery.[9,11] In contrast, one recent study suggested that duration of anesthesia and surgery were not associated with anesthetic complications in either group: S or FFP, even though FFP surgery time was longer.[19] Nevertheless, the study compared anesthesia and surgery time between only S and FFP and did not include any other concurrent, non-airway procedures, which may explain differences between their results and our findings.

Similar to our results, Ree et al. reported that prolonged surgical time in dogs undergoing BOAS surgery was associated with increased risk for temporary tracheostomy.[9] Additionally, prolonged anesthesia was recently suggested to increase the risk for postoperative anesthesia-induced pulmonary atelectasis.[32] Our results seem to support previously made suggestions that additional surgical procedure at the time of BOAS surgery should be avoided to decrease overall general anesthesia time and minimize postoperative complications.

Dogs with BOAS are at risk of developing aspiration pneumonia due to their brachycephalic conformation.[33,34]

Upper respiratory tract obstruction creates high negative intrathoracic pressure, which increases prevalence of regurgitation and gastroesophageal reflux and therefore risk of aspiration pneumonia.[4,35,36] A similar mechanism is observed in people, where reflux may lead to pharyngeal and laryngeal damage, which increases risk of aspiration.[37–39] It has been reported that other conditions such as presence of hiatal hernia, gastroesophageal reflux or pyloric stenosis also predispose brachycephalic dogs to aspiration pneumonia.[4,40] Our univariate analysis identified preoperative aspiration pneumonia as a risk factor for complicated perioperative recovery. However, the multivariate model was not able to include this variable as all dogs with previously diagnosed aspiration pneumonia experienced complicated recovery. As nominal regression is based on the chi-square test, the model considers variables with 0 in the contingency table as unstable due to inadequate data. Nonetheless, we found it interesting that all five dogs with a history of preoperative aspiration pneumonia experienced complicated recovery. This was despite the fact that these dogs had been cleared by follow-up radiographic evaluation to ensure that the pneumonia was healed prior to surgery. To our knowledge, this variable has not been previously documented as a risk factor for complicated recovery in dogs with BOAS. Aspiration pneumonia affects the lower respiratory tract and may exacerbate respiratory compromise in BOAS dogs, further complicating their recovery after surgery, especially when postoperative swelling and inflammation of the upper airways develop postoperatively. Additionally, hypoplastic trachea and presence of respiratory secretions may extend the time needed for resolution of aspiration pneumonia.[41] We speculate that dogs that have previously suffered from aspiration pneumonia may have more advanced stages of BOAS. As a result, their recovery may be more difficult and prolonged, which our study was unable to clearly demonstrate. Despite radiographic signs indicating healed aspiration pneumonia, the lungs may still be affected by the previous disease state, potentially adding to the risks of surgical recovery. Hopefully future studies will be able to elucidate the influence of previous aspiration pneumonia on the surgical outcome.

The structure coefficients for the four variables in the multivariate model indicated that the estimated effect of the variables contributed for the most part as expected. The surgery type did, however, show a larger effect in the model compared to the structure coefficient as indicated by a slightly lower than expected structure coefficient. This indicates that surgery type apart from being a direct predictor of outcome, also may act as a suppressor of variance for other predictors in the model.[42] Therefore, including surgery type in outcome predictions adds to the understanding of how other predictors relate to the outcome.

Multicollinearity of logistic regression is not quite as straightforward to elucidate as in linear regression, but several techniques, such as structure coefficients, can be utilized for both types of models.[43] The structure coefficient carries advantages in interpretation of multivariate models as it is not impacted by many of the concerns associated with suspected confounding variables.[17]

There are several limitations to the present study, and these are related to its limited sample size and retrospective nature. For example, there was no standardization of the medical records. Additionally, there is possibility that some information in the medical records might have been incomplete or very limited such as description of clinical signs, intra- or postoperative complications, and so on. Clinical examination as well as laryngeal evaluation could not be retrospectively controlled and were performed by different clinicians with different level of experience. Therefore, higher, or lower grade of laryngeal collapse in dogs could have been underreported and some vital information could have been missed during examination. Additionally, there was no protocol for immediate postoperative care and medications that dogs received after surgery and the selection was determined based on clinicians' preferences. These limitations are inherent to all retrospective studies and need to be considered when drawing conclusions. However, retrospective data is nonetheless of high value for planning of future prospective studies.

Length of oxygen treatment more than 12 h was chosen as a primary outcome variable despite the lack of prospective standardized documentation in the medical record, and the 12 h limit may be considered arbitrary. However, we chose this variable as we suspected this may be one of the more sensitive indicators of how the primary care team considered the dog's status during recovery. In the authors' experience, many dogs recovering from BOAS surgery at our institution are temporarily receiving oxygen supplementation for the first few hours of anesthesia recovery while still quite sedated. When the dog is fully alert and likely able to regain the normal auxiliary airway protective mechanisms, oxygen support tends to be discontinued unless the dog requires it, due to associated high costs for the client. Therefore, we believe administration of oxygen for 12 h or more would be a reasonable primary outcome variable indicating that the recovery was more complicated than average.

Another limitation is the low number of dogs, which could have affected statistical analysis and led to a type II error. For example, the majority of our dog population were bulldogs with a small number of pugs and other brachycephalic and nonbrachycephalic breeds which might have contributed to selecting risk factors typical of bulldogs, but not other breeds. Also, low population size means that some outcomes such as death were too few for meaningful analysis and potentially more risk factors for complicated recovery could have been identified. Importantly, the limited sample size and the rare occurrence of complicated recovery may have resulted in an upwards bias in our statistical model. The very wide CI of our OR for surgery type and laryngeal collapse>2 warrants very cautious interpretation of the OR. A further prospective study is warranted in order to determine the true association between risk factors and complicated recovery following soft palate surgery.

5 | CONCLUSIONS

The results of this study identified important risk factors for dogs undergoing elongated soft palate correction including surgery type, high-grade laryngeal collapse, increasing age and long anesthesia. These may need to be taken into consideration for planning surgery and aftercare during the immediate recovery period.

AUTHOR CONTRIBUTIONS

Fracka AB, DVM, MSc: Contributed to design of the study, performed data acquisition, data analysis and data interpretation, drafted, revised, and approved the submitted manuscript. Song MK, DVM: Compiled and analyzed data, edited, and reviewed drafts. DeJong TL, PhD: Contributed to data analysis and interpretation, reviewed and edited the manuscript. Fransson BA, DVM, MS, PhD, DACVS (Small Animal): Designed the study and contributed to the conception of the study, data analysis, and interpretation of the data, reviewed, and revised drafts of the manuscript and approved the final version for submission.

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CONFLICT OF INTEREST STATEMENT

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

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REFERENCES

1. Hedlund CS. Surgery of the upper respiratory system. In: Fossum TW, ed. *Small Animal Surgery*. 3rd ed. Mosby; 2007: 817-866.
2. Dupré G, Poncet C. Brachycephalic upper airways syndrome. In: Bojrab MJ, ed. *Mechanisms of Disease in Small Animal Surgery*. 3rd ed. Teton NewMedia; 2010:298-301.
3. Orsher RJ. Brachycephalic airway disease. In: Bojrab MJ, ed. *Disease Mechanisms in Small Animal Surgery*. Lea & Febiger; 1993:369-370.
4. Poncet CM, Dupre GP, Freiche VG, Bouvy BM. Long-term results of upper respiratory syndrome surgery and gastrointestinal tract medical treatment in 51 brachycephalic dogs. *J Small Anim Pract*. 2006;47:137-142.
5. Dupre G, Findji L, Poncet CM. *The Folded Flap Palatoplasty: a New Technique for Treatment of Elongated Soft Palate in Dogs*. European College of Veterinary Surgeons Annual Meeting; 2005:265-267.
6. Findji L, Dupré G. Folded flap palatoplasty for treatment of elongated soft palates in 55 dogs. *Wien Tierärztl Mschr*. 2008; 95:56-63.
7. Haimel G, Dupré G. Brachycephalic airway syndrome: a comparative study between pugs and French bulldogs. *J Small Anim Pract*. 2015;56(12):714-719.
8. Seneviratne M, Kaye BM, Ter Haar G. Prognostic indicators of short-term outcome in dogs undergoing surgery for brachycephalic obstructive airway syndrome. *Vet Rec*. 2020;187(10):403.
9. Ree JJ, Milovancev M, MacIntyre LA, Townsend KL. Factors associated with major complications in the short-term postoperative period in dogs undergoing surgery for brachycephalic airway syndrome. *Can Vet J*. 2016;57(9):976-980.
10. Carabalona JPR, Le Boedec K, Poncet CM. Complications, prognostic factors, and long-term outcomes for dogs with brachycephalic obstructive airway syndrome that underwent H-pharyngoplasty and ala-vestibuloplasty: 423 cases (2011-2017). *J Am Vet Med Assoc*. 2021;260(S1):S65-S73.
11. Gruenheid M, Aarnes TK, McLoughlin MA, et al. Risk of anesthesia-related complications in brachycephalic dogs. *J Am Vet Med Assoc*. 2018;253(3):301-306.
12. Liu NC, Oechtering GU, Adams VJ, Kalmar L, Sargan DR, Ladlow JF. Outcomes and prognostic factors of surgical treatments for brachycephalic obstructive airway syndrome in 3 breeds. *Vet Surg*. 2017;46(2):271-280.
13. Liu NC, Troconis EL, Kalmar L, et al. Conformational risk factors of brachycephalic obstructive airway syndrome (BOAS) in pugs, French bulldogs, and bulldogs. *PloS One*. 2017;12(8): e0181928.
14. Liu NC, Adams VJ, Kalmar L, Ladlow JF, Sargan DR. Whole-body barometric plethysmography characterizes upper airway obstruction in 3 brachycephalic breeds of dogs. *J Vet Intern Med*. 2016;30(3):853-865.
15. Tarricone J, Hayes GM, Singh A, Davis G. Development and validation of a brachycephalic risk (BRisk) score to predict the risk of complications in dogs presenting for surgical treatment of brachycephalic obstructive airway syndrome. *Vet Surg*. 2019; 48(7):1253-1261.
16. Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J. Academic network for conservational hip outcomes research group. Reliability of a complication classification system for orthopedic surgery. *Clin Orthop Relat Res*. 2012;470(8):2220-2226.
17. Henson RK. The logic and interpretation of structure coefficients in multivariate general linear model analyses. *Presented at the Annual Meeting of the American Educational Research Association*; Institute of Education Sciences; 2002. Available at https://eric.ed.gov/?id=ED467381

18. Davidson EB, Davis MS, Campbell GA, et al. Evaluation of carbon dioxide laser and conventional incisional techniques for resection of soft palates in brachycephalic dogs. *J Am Vet Med Assoc*. 2001;219(6):776-781.
19. Miller AK, Regier PJ, Colee JC. Complications and outcome following staphylectomy and folded flap palatoplasty in dogs with brachycephalic obstructive airway syndrome. *Vet Surg*. 2023;53:29-37. doi:10.1111/vsu.13994
20. Khoo TX, Yates G, Chambers B. Wound healing complications following folded flap palatoplasty in brachycephalic dogs. *Aust Vet J*. 2022;100(12):571-578.
21. Wykes PM. Canine laryngeal diseases part I: anatomy and disease syndromes. *Compend Contin Educ Vet*. 1983;5:8-13.
22. Riecks TW, Birchard SJ, Stephens JA. Surgical correction of brachycephalic syndrome in dogs; 62 cases (1991-2004). *J Am Vet Med Assoc*. 2007;230(9):1324-1328.
23. Harvey C. Upper airway obstruction surgery. 4. Partial laryngeotomy in brachycephalic dogs. *J Am Anim Hosp Assoc*. 1982; 18:548-550.
24. Fingland RB. Obstructive upper airway disorders. In: Birchard SJ, Sherding RG, eds. *Saunders Manual of Small Animal Practice*. 3rd ed. Saunders; 2006:1651-1664.
25. Torrez CV, Hunt GB. Results of surgical correction of abnormalities associated with brachycephalic airway obstruction syndrome in dogs in Australia. *J Small Anim Pract*. 2006;47:150-154.
26. Monnet E. Brachycephalic airway syndrome. In: Slatter D, ed. *Textbook of Small Animal Surgery*. 3rd ed. Saunders; 2003: 808-813.
27. Pink JJ, Doyle RS, Hughes JML, Tobin E, Bellenger CR. Laryngeal collapse in seven brachycephalic puppies. *J Small Anim Pract*. 2006;47:131-135.
28. Koch D, Arnold S, Hubler M, et al. Brachycephalic syndrome in dogs. *Vet. Focus*. 2003;25:4-10.
29. Worth DB, Grimes JA, Jiménez DA, Koenig A, Schmiedt CW. Risk factors for temporary tracheostomy tube placement following surgery to alleviate signs of brachycephalic obstructive airway syndrome in dogs. *J Am Vet Med Assoc*. 2018;253(9): 1158-1163.
30. Leonard HC. Collapse of the larynx and adjacent structures in the dog. *J Am Vet Med Assoc*. 1960;137:360-363.
31. Fasanella FJ, Shivley JM, Wardlaw JL, Givaruangsawat S. Brachycephalic airway obstructive syndrome in dogs: 90 cases (1991-2008). *J Am Vet Med Assoc*. 2010;237(9):1048-1051.
32. Martin-Flores M, Araos JD, Daniels ZS, Newman A, Nugen SA, Campoy L. Effects of intraoperative positive end-expiratory pressure and fraction of inspired oxygen on postoperative oxygenation in dogs undergoing stifle surgery. *Vet Anaesth Analg*. 2022;49(3):275-281.
33. Packer RMA, Tivers MS. Strategies for the management and prevention of conformation-related respiratory disorders in brachycephalic dogs. *Vet Med Res Rep*. 2015;6:219-232.
34. Boveri S, Ryan TM. Successful short-term mechanical ventilation in a brachycephalic dog following aspiration pneumonia. *Vet Rec Case Rep*. 2016;4:e000256.
35. Darcy HP, Humm K, Ter Haar G. Retrospective analysis of incidence, clinical features, potential risk factors, and prognostic indicators for aspiration pneumonia in three brachycephalic dog breeds. *J Am Vet Med Assoc*. 2018;253(7):869-876.
36. Boesch RP, Shah P, Vaynblat M, et al. Relationship between upper airway obstruction and gastroesophageal reflux in a dog model. *J Invest Surg*. 2005;18:241-245.
37. Cardasis JJ, MacMahon H, Husain AN. The spectrum of lung disease due to chronic occult aspiration. *Ann Am Thorac Soc*. 2014;11(6):865-873.
38. Demeter P, Pap A. The relationship between gastroesophageal reflux disease and obstructive sleep apnea. *J Gastroenterol*. 2004;39(9):815-820.
39. Davies RJ, Stradling JR. The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnea syndrome. *Eur Respir J*. 1990;3(5):509-514.
40. Ovbey DH, Wilson DV, Bednarski RM, et al. Prevalence and risk factors for canine post-anesthetic aspiration pneumonia (1999-2009): a multicenter study. *Vet Anaesth Analg*. 2014; 41(2):127-136.
41. Hoareau GL, Mellema MS, Silverstein DC. Indication, management, and outcome of brachycephalic dogs requiring mechanical ventilation. *J Vet Emerg Crit Care*. 2011;21(3):226-235.
42. MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding and suppression effect. *Prev Sci*. 2000; 1(4):173-181.
43. Ray-Mukherjee J, Nimon K, Mukherjee S, Morris DW, Slotow R, Hamer M. Using commonality analysis in multiple regressions: a tool to decompose regression effects in the face of multicollinearity. *Methods Ecol Evol*. 2014;5(4):320-328.

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