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# Repeat Staphylectomy and Concomitant Episioplasty in an Aged English Bulldog Crossbred Canine

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## Abstract

Clinical signs of brachycephalic syndrome vary broadly in form, frequency, and severity. Respiratory insufficiency is often characterized by stertor or stridor, snoring, sleep apnea, open mouth breathing, apparent difficult breathing, abducted forelimb stance, exercise or stress/heat intolerance, hyperthermia, gagging or coughing, respiratory distress, cyanosis, and syncope. Digestive signs, such as vomiting, regurgitation, ptyalism, and dysphagia, may also be involved. Differential diagnoses may include foreign body obstruction of the upper respiratory tract, trauma, and neuromuscular dysfunction, specifically laryngeal paralysis. These changes in the upper airways may generate such severe negative pressure that the condition progresses to include laryngeal and pharyngeal inflammation, tonsillar eversion and epiglottic, laryngeal, or tracheal collapse. Other soft tissue structures may be affected by increased negative inspiratory pressure; macroglossia, amygdalitis and tonsillar hypertrophy, hiatal hernia, and digestive tract signs have frequent incidence in brachycephalic breeds and should be considered in clinical evaluations of these animals. Clinical signs may be exacerbated by obesity, heat, excitement, exercise, and stress.

**Keywords:** Brachycephalic syndrome; Ptyalism; Neuromuscular dysfunction; Tracheoscopy

## Introduction

Brachycephalic syndrome is a well documented combination of upper airway disorders consequential to congenital pharyngeal and nasal anatomy in predisposed brachycephalic, or “short-headed”, dog breeds the classical features are stenotic nares, elongated soft palate, and eversion of laryngeal saccules progressing to laryngeal collapse. The most common of these is the elongation of the soft palate, which may be congenital in nature or acquired due to inflammation from chronic respiratory barotrauma. Tracheal hypoplasia is also a common component, particularly in English bulldogs, the poster breed for brachycephalic syndrome.

Other breeds commonly affected include Boston Terrier, King Charles Cavalier Spaniel, boxer dogs, Pekingese, Maltese, Pug, Chinese Shar-Pei, Shih Tzu, and French bulldog (Pope and individuals of mixed breeding are rarely represented. Hendricks reported that only one mixed breed dog underwent soft palate surgery amongst 72 dogs over a 14 year span at one university veterinary hospital, whereas recent studies of 90, 62, and 51 dogs, respectively, did not include a single mixed breed dog [1].

## Pathophysiology

Brachycephalic syndrome is thought to arise from increased airway resistance. Obstruction in the cranial portions of the upper respiratory tract leads to greater inspiratory effort and exaggerated negative airway pressure, drawing the soft tissues into the lumen and resulting in chronic edematous, hyperplastic and inflammatory changes that predispose to laxity in the soft tissues. The greatest resistance is attributed to the nares and nasal passages in the dog [2]. The compressed anatomy of the endoturbinalia accounts for 76.5% of total airflow resistance, and obstruction in this area deserves evaluation when considering treatment prognosis. Although airway stenosis occurs at multiple points, the impact of negative airway pressure and barotrauma are greatest on the soft tissues of the pharynx, which are often redundant due to the brachycephalic head formation and relatively unsupported by cartilaginous and bony structures. These soft tissues include the soft palate and pharyngeal mucosa [3].

Elongation and hypertrophy of the soft palate may be primarily congenital or secondary to repeated respiratory trauma from turbulent airflow. An excessively long palate extends more than 1-3 mm caudal to the tip of the epiglottis. Respiratory forces drag the soft palate caudally during inspiration and blow the soft palate into the nasopharynx with expiration. On inspiration, the soft palate may be pulled between the corniculate processes of the arytenoid cartilages, creating an obstruction that further increases inspiratory effort, amplifies the negative pressure within the airways, and causes more turbulent airflow [4]. The caudal margin of the soft palate is usually smooth and slightly concave in normal dogs but becomes pointed or pinched in appearance in brachycephalic dogs with this dynamic motion, so much so that it may cause an audible flutter with inspiration. Eversion of the laryngeal saccules occurs secondary to increased negative airway pressures that ultimately pull the thin mucosal linings from their crypts [5]. Everted laryngeal saccules become edematous and obstruct the glottis, further adding to airflow restrictions. Laryngeal saccule eversion is the first stage of laryngeal collapse, an end stage disease process of the larynx that can be difficult to treat and worsens the prognosis in brachycephalic dogs. These changes in the upper airways may generate such severe negative pressure that the condition progresses to include laryngeal and pharyngeal inflammation, tonsillar eversion and epiglottic, laryngeal, or tracheal collapse [6]. Other soft tissue structures may be affected by increased negative inspiratory pressure; macroglossia, amygdalitis and tonsillar hypertrophy, hiatal hernia and digestive tract signs have frequent incidence in brachycephalic breeds and should be considered in clinical evaluations of these animals. Clinical signs may be exacerbated by obesity, heat, excitement, exercise, and stress [7].

## Case Presentation

Clinical signs of brachycephalic syndrome vary broadly in form, frequency, and severity. Respiratory insufficiency is often characterized by stertor or stridor, snoring, sleep apnea, open mouth breathing, apparent difficult breathing, abducted forelimb stance, exercise or stress/heat intolerance, hyperthermia, gagging or coughing, respiratory distress, cyanosis, and syncope. Digestive signs, such as vomiting, regurgitation, ptyalism and dysphagia, may also be involved [8].

Differential diagnoses may include foreign body obstruction of the upper respiratory tract, trauma, and neuromuscular dysfunction, specifically laryngeal paralysis (Table 1).

| **Brachycephalic syndrome** | |
|---|---|
| **Signs specificity** | **Symptoms** |
| Respiratory signs | stridor |
| | snoring |
| | sleep apnea |
| | open mouth breathing |
| | apparent difficult breathing |
| | abducted forelimb stance |
| | exercise |
| | hyperthermia |
| | gagging |
| | coughing |
| | respiratory distress |
| | cyanosis |
| | syncope |
| Digestive signs | vomiting |
| | regurgitation |
| | ptyalism |
| | dysphagia |

**Table 1:** Signs and symptoms for brachycephalic syndrome.

## Diagnosis

In clinical practice, the diagnosis of brachycephalic syndrome is greatly subjective and influenced heavily by the owner, clinician, and patient. Observations of upper airway obstruction in a dog of brachycephalic breed influence warrant examination of the nares, pharynx, and larynx; it is during this preoperative visual inspection that the diagnosis of brachycephalic syndrome generally occurs [9]. Ideally, quantification of brachycephaly through objective means would be utilized for the diagnosis, treatment recommendations, and prognosis determination of the condition. While measurement of the angles of the skull through craniometry and computed tomography imaging of the nasal cavities have shown some promise, these modalities have not met with widespread application. Thoracic radiographs are needed to rule out concurrent diseases and to evaluate the trachea for hypoplasia. Cervical radiographs may suggest an abnormally long soft palate. Laryngoscopy, pharyngoscopy, and tracheoscopy have also been used for assessment of function and luminal collapse in these areas. As brachycephalic dogs pose many anesthetic challenges, a complete blood count and serum chemistry profile should be performed prior to surgery to ascertain the overall systemic health status of the dog. Blood gas analysis, oxygen saturation measurements, and other respiratory function testing may be pursued as well [10].

## Treatment

Conservative therapy includes corticosteroids, weight management, avoiding cervical restraints, and a quiet, cool environment, but the flagship of treatment is surgical intervention. Surgical procedures are well described and traditionally aimed at resection of the stenotic nares, shortening of the soft palate, and laryngeal sacculectomy. Arytenoid lateralization or tracheostomy may be performed in those individuals with laryngeal collapse. These techniques focus on soft tissue structures that are more amenable to visualization, access, and correction [11,12]. However, they do not alter stenosis in the nasal cavities. Addressing the obstructions caused by intranasal deformities has gained recent attention through the introduction of laser assisted turbinectomy. Several surgical measures have been used to reduce the airway obstruction caused by soft palate elongation. Staphylectomy with the freehand “cut and sew” technique described by Bright and Wheaton is the conventional method for surgical relief of elongated soft palate. Procedural variations of soft palate resection include the clamp technique, electrocautery, and electrosurgical or laser ablation. The “cut and sew” method causes less tissue trauma than the clamp technique and is preferred between the incisional staphylectomies [13]. The decision between cold steel and electrosurgical/laser ablation is based on surgeon preference and instrument availability, as the outcomes are the same. The laser has been shown to minimize hemorrhage, pain, swelling, and duration of the procedure whereas electrocautery is thought to increase postoperative pharyngeal edema [14].

The folded flap palatoplasty is a procedural newcomer that addresses the hypertrophy common with soft palate elongation in brachycephalic dogs. It subjectively may be more technically challenging with a lengthened duration of surgery and is not yet a widespread surgical intervention. However, it is efficacious for excessively thickened soft palates with low morbidity [15].

Laryngeal sacculectomy through amputation by scissors has been described among others. However, its application is controversial. Complications of everted laryngeal resection include excessive scarring or stenosis of the larynx, bark pitch change, voice loss, persistent respiratory noise, or progressive signs of upper airway obstruction. As laryngeal saccule eversion is secondary to chronic upper airway resistance, some do not recommend sacculectomy in conjunction with other procedures [16]. The everted laryngeal saccule may not pose much solo clinical significance and thus does not require excision, provided more obtrusive soft tissue structures are being surgically addressed reported that in 22 dogs that presented with laryngeal saccule eversion, 12 did not have laryngeal saccule excision and there was reduced morbidity in these dogs [17].

## Prognosis

The prognosis following surgery of the upper airway obstruction in brachycephalic dogs is generally good to excellent with a consistently reported success rate of greater than 90 percent. However, snoring and stertor typically do not completely resolve. Furthermore, many recently published studies on long-term outcome rely on owner assessment of recovery through interviews suggest that owners of brachycephalic dogs may be more tolerant of signs of upper airway obstruction and thus may provide an assessment skewed towards a greater degree of improvement. Age, breed, body condition, and degree of laryngeal collapse have been suggested as factors affecting prognosis. Many suggest that correction of upper airway obstruction at an early age reduces the progression of changes in the upper respiratory tract, thus arresting continued tissue irritation and development [18,19].

However, these findings are not consistently reflected in studies regarding clinical outcome, likely owing to the multifactorial nature and degree of variability of the syndrome. English Bulldogs are generally considered to respond less favorably to surgical intervention with more risk of complications than other brachycephalic dogs. A comprehensive found that 55% of English Bulldogs responded poorly compared to 33% in other breeds, which is similar with other studies [20]. The post-operative mortality rate due to aspiration pneumonia in English Bulldogs was also twice that of other breeds (12.5% to 6.25%, respectively). Newer studies do not share this divergence, perhaps due to an increased awareness in managing English Bulldogs and more timely and aggressive intervention. Obesity shares a direct association with severity of clinical signs and weight reduction is an oft recommended adjunctive therapy. Laryngeal collapse is also negatively correlated with prognosis; stage 1 and 2 usually respond favorably to surgery of other components of brachycephalic syndrome, but stage 3 laryngeal collapse carries a guarded prognosis. Complications associated with shortening of the soft palate include nasal regurgitation, rhinitis, sinusitis, and predisposition for aspiration pneumonia with excessive soft palate resection; too little excision results in lack of relief of clinical signs. New reports suggest that excessive shortening of the soft palate is not as detrimental as once thought because of the possible compensatory action of the base of the tongue [21].

Aspiration pneumonia is a significant postoperative concern. Inflammation and edema of the laryngeal and pharyngeal mucosa always occur postoperatively after surgical manipulations in these regions. Gagging, coughing, vomiting, and persistent upper airway noise are common in the immediate recovery period, especially in bulldogs ascribes the two major causes of death for dogs with laryngeal dysfunction to be continued airway obstruction and aspiration pneumonia. Lorinson and colleagues reported 75 percent of the postoperative death loss in a comprehensive study of 118 dogs to occur due to aspiration pneumonia. Of the 6 that died of aspiration pneumonia, 5 were English Bulldogs. Recent studies show that survival rates following aspiration pneumonia are good, however, if supportive treatment modalities are initiated promptly [22].

The presumptive diagnosis of aspiration pneumonia is made when aspiration has been observed or acute respiratory distress develops within hours of vomiting, regurgitation, or anesthesia. Radiographic changes provide the definitive diagnosis; the most common is a predominantly alveolar pattern, usually located in the right middle or left or right cranial lung lobes. Broad-spectrum antimicrobial therapy, antiemetic therapy, adequate hydration, analgesics, and pulmonary toilet are indicated. Oxygen therapy is imperative for dyspneic animals. Additional but controversial treatments include the use of corticosteroi s, bronchodilators, or tracheobronchial lavage. This report features a unique presentation of repeat staphylectomy and concomitant episioplasty in an aged English Bulldog crossbred canine and the medical management of her post-surgical complications [23].

## Clinical report

A 9-year-old, spayed female, English bulldog crossbred canine presented to the Iowa State University Lloyd Veterinary Medical Center (ISU LVMC) Small Animal Internal Medicine Service for evaluation of progressive respiratory difficulty of approximately 3 months duration.

## History

The dog was diagnosed with brachycephalic syndrome 16 months previously at the ISU LVMC when she had difficulty breathing while being examined for left stifle associated lameness. Rhinoplasty, staphylectomy, bilateral laryngeal sacculectomy, left extracapsular lateral suture repair, and abrasion trochleoplasty were performed under a single anesthetic event. The dog exhibited a favorable recovery with reduced severity of respiratory signs for over a year until her worsening clinical condition prompted her return to the university veterinary medical center. The owners initially noted a change in bark. Over a few months, the dog's condition progressively deteriorated to respiratory difficulty in the few weeks prior to her readmission to the ISU LVMC. This increased respiratory effort was characterized by stertor, open mouth breathing, exercise intolerance, and expectoration. These signs were exacerbated by heat stress. The owners mentioned that the dog would vomit occasionally; this was thought to be due to indigestion from eating too quickly. Additionally, the dog exhibited a decline in energy of a month's duration. The dog also had a history of chronic urinary tract infections, ear infections, and allergies. She was being administered a number of medications for these ailments at the time of presentation, including 1.0% hydrocortisone creama for 8-9 years; neomycin sulfate/polymyxin B/bacitracin zinc ointment, 8 9 years; fexofenadine hydrochloride/pseudoephedrine hydrochloride, 1 year; amoxicillin, 1 year; trimethoprim/sulfamethoxazole, 3 months; and guaifenesin, a week, in addition to dietary supplementation with fish oil and glucosamine/chondroitin sulfate/avocado soybean unsaponifiables. Four days before presentation at the ISU LVMC, the patient's referring veterinarian diagnosed keratoconjunctivitis sicca and prescribed topical ocular administration of 0.2% cyclosporineh.

## Physical examination

On presentation at the university veterinary medical center, the dog respired sonorously with increased inspiratory and expiratory effort. The lungs were clear but auscultation of the lung field was difficult due to enhanced upper airway sounds. She exhibited mild, bilateral, non-pruritic alopecia of the shoulders and flanks, mild crusting of the nasal planum and a severely recessed vulva with markedly redundant juxtaposed skin folds and moderate thinning of the ventral perivulvular skin. She was also 10-15 percent over conditioned with a body condition score of 7/9. Other physical exam findings were unremarkable. Laryngeal paralysis, laryngeal collapse, laryngeal mass or foreign body, or elongation of the soft palate were considered primary differentials for the respiratory signs.

A complete blood count, serum chemistry profile, urinalysis, and urine aerobic and anaerobic bacterial culture were performed. The complete blood count and urine cultures were within normal limits, though the serum chemistry profile and urinalysis yielded some noteworthy results. Alkaline Phosphatase (ALP, Alanine Aminotransferase (ALT, and cholesterol were markedly elevated. Creatinine was mildly increased, and mild decreases were observed in sodium, chloride, and albumin. Glucose and potassium were in the lower and upper ranges of normal values, respectively. The dog's isosthenuria was not appropriate considering that the dog was not being diuresed, but a single isosthenuric measure is not definitive of kidney function. Combined with the dog's lethargy, bilateral alopecia and thinning of the skin, kerato conjunctivitis sicca and medicinal history, these changes were consistent with suspected iatrogenic hyperadrenocorticism from longstanding corticosteroid administration and suspected iatrogenic hypothyroidism secondary to chronic trimethoprim therapy. The increased ALP, ALT, and cholesterol and low normal glucose are indicative of reduced liver function from chronic corticosteroid administration. The trimethoprim/sulfamethoxazole may have been responsible for subclinical renal insufficiency, which was reflected in the hyponatremia, hypochloridemia, hypoalbuminemia, isosthenuria, and high normal serum potassium concentrations. These minor changes in those parameters indicative of kidney function may have been due to proximal renal tubular insult from the sulfamethoxazole; trimethoprim also may decrease glomerular filtration rate secondary to induction of hypothyroidism.

The dog was sedated with intravenous propofoli to effect for a visual laryngeal examination, and the soft palate was definitively elongated, extending beyond the tip of the epiglottis. There were no masses or foreign bodies observed. The function of the arytenoid cartilages was within normal limits and the cuneiform cartilages were not medially deviated, ruling out laryngeal paralysis and laryngeal collapse, respectively. Radiographic and ultrasonographic imaging modalities were utilized to evaluate the patient. The abdominal ultrasound study and thoracic and abdominal radiographs were within normal limits. Cervical radiographs showed evidence of an elongated, hypertrophied soft palate.

## Results

To better address the dog's respiratory difficulty and chronic urinary tract infections, the dog was transferred to the ISU LVMC Small Animal Soft Tissue Surgery Service and scheduled for staphylectomy and episioplasty procedures. Food was withheld for greater than 12 hours before anesthesia. Premedication included 0.3 mg/kg intramuscular but orphanolj (10 mg and 2.0 mg/kg intravenous lidocainek (66 mg. Following induction with 2.42 mg/kg intravenous propofoli (80 mg, the dog was intubated and maintained on isofluranel in 100 percent oxygen. The dog was placed in sternal recumbency for a rostral intraoral approach for the staphylectomy. A complete oral examination of the soft palate and larynx was performed. The length in relation to the epiglottic cartilage and thickness of the soft palate were evaluated, as well as the position of the laryngeal ventricles and position and motion of the arytenoid cartilages. The soft palate was significantly elongated and hypertrophied with a more pointed caudal aspect extending beyond the epiglottic cartilage. Arytenoid cartilage abduction with inspiration was bilaterally normal. The left laryngeal saccule was everted, indicating stage 1 (stage 1/3 laryngeal collapse. The tongue was manually pulled rostrally, and gauze sponges were placed around the endotracheal tube in the retropharyngeal area. Stay sutures were placed bilaterally and mid-sagittally along the caudal edge of the soft palate using 3-0 absorbable monofilament suturem (poliglecaprone 25) to manipulate the soft palate rostrally and laterally as needed *via* traction. The soft palate was resected by cutting a short section with Metzenbaum scissors, followed by apposing the nasopharyngeal and oropharyngeal mucosa with 3-0 absorbable monofilament suturem (poliglecaprone 25) in a simple continuous pattern to close the defect. After partial resection and suturing, the soft palate was further evaluated; additional transection commenced until the entire width of the soft palate was resected. Reduction of the soft palate allowed for optimal visualization of the everted left laryngeal saccule, which was resected at its base and left to heal by second intention. Care was taken to avoid the vocal fold, vocal cord, and vestibular/ventricular fold. The oral cavity, pharynx, and larynx were gently flushed and suctioned to remove excess saliva and clotting blood, and the retropharyngeal sponges were removed.

For the episioplasty, the dog's perineal region was aseptically prepared, and the dog was moved to a clean operating theater. The vulva was manually manipulated to determine the skin resection necessary for its appropriate repositioning. Two concentric horseshoe-shaped skin incisions were made dorsal to the vulva in the perianal region, and the redundant lateral and dorsal skin and adnexa were excised. Local hemostasis was achieved through direct pressure with gauze sponges and electrocautery. Towel clamps were placed evenly along the dorsal margin of the vulvar skin section to provide traction to approximate the proper placement, and skin was resected along the outer margin as needed. The excision site was closed in two layers. Interrupted sutures with buried knots using 3-0 absorbable monofilamentn (polydioxanone) abutted the subcutaneous tissues, and the skin edges were apposed with segmented subcuticular intradermal suture patterns using 3-0 absorbable monofilament suturem (poliglecaprone 25).

The surgical procedures were completed without complications. Intraoperatively, the dog received 0.05 mg/kg intravenous dexamethasoneo (1.6 mg) to reduce inflammation, particularly in the oropharyngeal and laryngeal mucosa; 0.0025 mg/kg intravenous glycopyrrolatep (0.16 mg) for bradycardia; intravenous dopamineq and dolbutaminer (variable rate drip), 0.11 mg/kg ephedrines (7.0 mg), and intravenous 6% hetastarcht (150 mL) for hypotension; 0.15 mg/kg intravenous hydromorphoneu (5.0 mg) for pain attenuation; and 66 mg/kg intravenous cefazolinv every 2 hours as prophylactic antibiotic treatment. Intermittent positive pressure ventilation was utilized as needed for hypoventilation. The dog was smoothly and uneventfully extubated and recovered overnight in the ISU LVMC Intensive Care Unit, where careful watch was maintained for respiratory distress. Postoperative care included oxygen supplementation *via* flow by oxygen as needed, intravenous metoclopramide, transdermal and intravenous fentanyl, intravenous famotidine, and intravenous fluids. The dog did well overnight; however, in the early morning hours she was noted to be overly sedate, during which time she productively vomited several times. Despite immediate and aggressive antiemetic treatment, thoracic radiographs confirmed suspicions of aspiration pneumonitis progressing to bronchopneumonia. This was best seen as increased pulmonary opacity confined to the right middle lung lobe. The fentanyl constant rate infusiony was discontinued, and aggressive therapeutic measures were continued, including empirical antibiotic treatment with intravenous ampicillincc and enrofloxacin, subcutaneous maropitant, intravenous dolasetron, oral sucralfate, nebulization, and coupage. Naloxonehh was administered concurrently

with the removal of the fentanyl patch, and the dog's responsiveness improved, though she stayed fairly quiet. Possible pain and discomfort of the episioplasty site was managed with frequent icing. Her sonorous breathing was vastly improved from the previous night, and her lung sounds remained clear. Supplemental oxygen was provided by flow by oxygen as necessary. Food was withheld until the vomiting had ceased for greater than 24 hours, at which time the dog was started on small oral feedings of bland canned dog food. She tolerated this well and was placed on oral amoxicillin/clavulanate potassium. Levothyroxine sodium was also added to her therapeutic regimen to augment her natural thyroxine levels in the face of her suspected iatrogenic hypothyroidism. She was slowly weaned from the inject antiemetics, antibiotics, and intravenous fluids as her appetite increased. Repeat thoracic radiographs four days after aspiration revealed marked improvement of the increased pulmonary opacity with only a small focus of focal alveolar pattern present in the right middle lung lobe, consistent with resolving aspiration pneumonia. The dog was discharged from the hospital six days post-surgery on oral levothyroxine sodium, sucralfate, amoxicillin/clavulanate potassium, ii and topical ocular 0.2% cyclosporineh ointment as needed.

### Case outcome

Follow up was obtained *via* phone interview with the owner conducted 122 days after surgery. The interview included interval to improvement following surgery, the complications, current medical treatment, occurrence and frequency of observable, objective clinical signs, and subjective assessment of improvement. From the owner's perspective, the dog showed a significant improvement in clinical signs immediately at the time of discharge from the hospital following recovery from the aspiration pneumonia. She had no further complications at home. The dog's medicine cabinet had been greatly reduced to fish oil, glucosamine/chondroitin sulfate/avocado soybean unsaponifiables, fexofenadine hydrochloride/pseudoephedrine hydrochloride, and infrequent 0%.2% cyclosporineh topical ocular treatment as needed; all other medications had been discontinued. The owner noted the dog had increased brightness, activity, and energy with an associated 15 percent reduction in body weight. Overall the owner was very satisfied with the dog's recovery and regarded her improvement as excellent (resolution of nearly all clinical signs with those remaining mild and relatively infrequent in nature). The dog still exhibited some snoring, though the intensity and frequency was greatly reduced. Using the clinical grading system first implemented, the frequency of upper respiratory signs and digestive signs were recorded and a clinical grade was assigned based on this occurrence of signs in the dog's clinical history. The dog was classified as a grade 3 for respiratory signs and a grade 2 for digestive signs prior to her second staphylectomy procedure. Following surgery, her clinical signs had improved to a grade 1 for both respiratory signs and digestive signs at the time of follow up.

## Discussion

Repeat staphylectomy in the dog uncomplicated by other factors following a successful initial procedure has heretofore been unreported to this author's knowledge. Recent reports of dogs refractory to conventional staphylectomy that required additional surgical intervention were accompanied by aberrant scarring of the soft palate, repetitive aggravation of the soft palate due to vomiting, and suboptimal resolution of clinical signs due to an excessively thickened soft palate. Surgeon error in only partial resection of the necessary length with the first staphylectomy begs consideration. In its appropriate anatomic relationship, the caudal free border of the soft palate lies at the tip of the epiglottis and contacts the roof of the nasopharynx when pushed dorsally. Laterally, the proper length is the caudal border of the tonsillar crypt. This normal anatomic relationship may vary with position of the head and neck, placement of an endotracheal tube, degree of traction on the tongue, and extent of jaw traction. This variability may be minimized with consistent patient positioning. As the assessment of surgical outcome is subjectively based on clinical signs, the likelihood of surgeon error is less probable in this instance due to the dog's marked improvement in respiratory signs immediately following surgery and the 13 month interval before her clinical condition worsened. The goal of surgery is to reestablish the normal anatomic relationship of the soft palate and the epiglottis, not to excessively shorten the soft palate in anticipation of continued barotrauma. The dog's initial staphylectomy occurred when she was 8 years old after years of airway strain and its chronic effects on the structures of her upper respiratory tract. Though this dog was an English Bulldog mix, English Bulldogs also generally present at a much earlier age (median one year) than other breeds. The congenital anatomy conformation of the English Bulldog is thus thought to be more severe, which predisposes them to the detriments of brachychephalic syndrome at an earlier age with greater deleterious effects. It is thought that in this case the upper airway obstruction was greatly decreased but not eliminated by the dog's initial staphylectomy, stenotic nares resection, and bilateral laryngeal sacculectomy. The soft tissue structures in the nasal cavities, pharynx, and larynx may have endured such chronic irritation with resultant laxity secondary to barotrauma that they did not optimally reduce following surgery. The exact mechanisms of this process are unknown but the phenomenon of soft tissue hypertrophy and weakening has been previously described. While dramatically diminished, the upper airway in this dog may have remained subclinically constricted, and the soft palate was then stretched and inflamed from continued turbulent airflow. This may have eventually led to such elongation and hypertrophy that the overgrown soft palate impeded respiratory function, which was reflected by her worsening respiratory signs in the month prior to her presentation to the ISU LVMC. Conventional definitive surgery in patients with longstanding clinical signs may be more palliative than curative when considering the chronic changes along the entire upper airway tract and the uncorrected stenosis within the nasal cavities. Studies focused on long-term results of surgical correction of abnormalities associated with brachycephalic airway obstruction should perhaps incorporate clinician-based assessment of clinical signs and visualization of soft tissue structures in regards to changes over time, particularly in older dogs with a storied history of respiratory signs. This may be difficult in dogs of owners that are satisfied with the clinical status of their animal or who are opposed to additional anesthetic events given the risk for brachycephalic dogs.

Confounding factors in this dog's case were the history of her change in bark prior to worsening respiratory signs and eversion of the left laryngeal saccule despite previous bilateral laryngeal sacculectomy. Change in bark is a hallmark of laryngeal dysfunction, namely laryngeal paralysis, and is not associated with soft palate elongation or pharyngeal changes. Laryngeal function and position was assessed to be within normal limits during both the pre-surgical and surgical oral examinations, though definitive evaluation of laryngeal paralysis requires either electromyography of the laryngeal musculature or evidence of neurogenic muscle atrophy *via* biopsy. The sole laryngeal abnormality noted in this dog was the everted left

laryngeal saccule. The laryngeal saccule may have reverted to its intraluminal position due to surgeon error with minimal partial resection. However, the degree of resection in this location tends to be more conservative; aggressive resection may result in unintended damage to the other laryngeal structures, including the vocal fold, vocal cord, and vestibular/ventricular fold. This may lead to excessive scarring and stenosis of the laryngeal lumen and create further airway obstruction. Laryngeal saccules are left to heal by second intention following surgical resection, and as the mucosal linings of the laryngeal ventricle they are considered to be fragile tissues. It is speculated that the continued upper airway turbulence and negative inspiratory pressures following the initial surgery and contributed to the eversion and subsequent edematous hypertrophy of the left saccule, already compromised its previous eversion. It is also a matter of conjecture that this occurred prior to the clinical elongation of the soft palate, corresponding with the change in bark. It is of note that hypothyrioidism has been indicated in laryngeal paralysis, though the exact relationship has not been elaborated, and that the change in bark also coincided with the onset of administration of trimethoprim/suflamethoxazole. Regarding the surgery in this case, the "cut and sew" staphylectomy remains the conventional method for soft palate resection and provides sound surgical management of soft palate elongation. The pharyngeal fold redundancy was not extensive enough to warrant excision, though these were assessed and implication in continued upper airway constriction was considered. Laryngeal sacculectomy is a commonly recommended procedure for laryngeal saccule eversion and was warranted as the dog was symptomatic for laryngeal dysfunction and airway obstruction. Laryngeal saccule eversion has roles in both. Temporary tracheostomy tube placement may be indicated in many forms of corrective surgery for brachycephalic syndrome, but it is not necessary if treating everted saccules or elongated soft palate when the patient presents with only mild distress.

The episioplasty is also the gold standard surgical correction for a recessed vulva and associated redundant skin folds. In this case, the dog had a history of chronic urinary tract infections refractory to medical management, which is commonly seen with excessive perivulvular skin folds and a recessed vulva. Redundant skin folds are common in brachycephalic dogs and are exaggerated with obesity, both of which were predisposing factors for this dog. When the vulva is recessed, accumulated vaginal secretions or urine may accumulate between in the perivulvular skin folds, leading to chronic moisture, frictional irritation of local skin, and predisposition to chronic urinary and perivulvular bacterial infections. Surgical correction can often make these problems more amenable to palliative therapies and result in resolution of the infections, such as with this dog, whose clinical signs resolved following surgical treatment. While performing both surgeries under the same anesthetic event lengthened the duration of anesthesia, the dog was stable on presentation and the dangers of a second anesthetic induction and recovery were eliminated.

It is debatable whether additional therapies or a different pain management approach would have prevented this dog's postoperative vomiting, as it is such a well documented occurrence in dogs recovering from anesthesia in general, brachycephalic dogs undergoing pharyngeal or laryngeal procedures in particular, and especially English Bulldogs that meet these criteria. A more thorough digestive tract lesion work up and medical management could have been pursued, as clinical signs alone cannot be relied on to diagnose digestive problems in brachycephalic dogs. Simultaneous upper gastrointestinal medical therapy is thought to help prevent vomiting and subsequent aspiration pneumonia related to upper airway surgery. In addition to dexamethasone, metaclopramide, and glycopyrrolate as needed for postoperative medications following upper airway surgery, poncet and others suggested omeprazole, cisapride, and magnesium hydroxide in those dogs with digestive tract lesions. However, the famotidine and metaclopramide initially prescribed postoperatively here have similar effects to omeprazole in reducing production of stomach acid and cisapride in promoting gastric emptying as a gastroprokinetic, respectively.

In this case, the aspiration pneumonia was promptly presumptively diagnosed and additional antiemetics were administered quickly. Radiographs were obtained to confirm the diagnosis and gauge the involvement of the pulmonary parenchyma, even though radiographic evidence lags behind clinical changes in physiological processes and is not useful in guiding initial therapy. The additional supportive therapies of broad-spectrum antimicrobial medication, nebulization, and coupage were all indicated. A recent study by Tart and colleagues did not find that a single treatment was significantly correlated with increased survival, though aggressive, multi-modal therapy was recommended.

## Conclusion

Fentanyl is commonly used for postoperative or chronic pain control in small animal patients; its sedative and analgesic properties make it a useful tool. It is well tolerated in dogs with lower incidence of vomiting, nausea, and dysphoria than other opioids. However, it can cause respiratory depression and a decrease in temperature in dogs, though these effects vary. Despite these effects, fentanyl patches and constant rate infusions are routinely used in brachycephalic dogs undergoing upper airway surgery. Using a sedative during the recovery period is recommended because it allows for a slow, smooth recovery with the endotracheal tube in place for as long as possible. Additionally, it decreases the dog's anxiety from mild hypoxia. Because fentanyl is lipophilic and may be stored intracellularly and accumulate in fat depots, repeated doses or constant rate infusion may result in increased effect and slow recovery. Fentanyl is primarily metabolized through cytochrome P450 mediated oxidative metabolism, and, like most opiods, is alter to polar compounds and eliminated in urine, though a small amount is excreted unchanged through the kidneys. Documentation about the effects of hypothyroidism on fentanyl metabolism in dogs is sparse. Hypothryoidism reduces glomerular filtration rate, which may lead to reduced elimination of fentanyl and its metabolites. Low thyroid hormone levels also reduce expression of the genes for cytochrome P450 reductase, though the metabolism of fentanyl is more dependent on hepatic blood flow than enzyme capacity. It appears in this case that fentanyl metabolism may have been decreased with accumulative sedative effects due to presumptive iatrogenic hypothyroidism, and it may be prudent to exercise caution when administering fentanyl to obese patients with significant fat depots or to dogs with suspected hypothyroidism.

In this case, iatrogenic hypothyroidism resulting from trimethoprim administration and hyperadrenocorticism secondary to prolonged corticosteroid use were suspected. Both are well described in dogs. Further diagnostic evaluation was not performed. Thyroxine levels were expected to be low and would not have differentiated between drug-induced hypothyroidism or sick euthyroid syndrome associated with the dog's respiratory ailments. The dog's respiratory difficulty was the primary health concern at that time so more definitive tests

were not pursued. Furthermore, both of these presumptive syndromes were thought to be drug induced and therefore reversible with discontinuation of the inciting pharmaceuticals; administration of both of the drugs was abandoned immediately when the dog was admitted to the ISU LVMC and clinical signs eventually resolved.

## Summary

This case report features the complex association of breed-associated congenital abnormalities with chronic pathogenesis in an aged English Bulldog treated through staphylectomy and episioplasty surgical procedures. The case was soundly medically and surgically managed through its postoperative complications. It is the first report of a repeat staphylectomy in a dog following a subjectively successful initial procedure to this author's knowledge. This is consistent with the theories of chronic soft tissue changes in the upper airways of brachycephalic dogs, the mechanisms of which have yet to be fully elucidated. It is suggested that further studies on the long term outcomes of surgery in the correction of brachycephalic syndrome incorporate imaging modalities to evaluate soft tissue changes over time, especially in dogs with a long history of persistent respiratory signs.

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