Brachycephalic breeds have underdeveloped bones of the skull relative to the development of the soft tissues of the palate and pharynx. This results in an increased resistance to the flow of air in their upper airway. Stenotic nares, elongated soft palate, and hypoplastic trachea are the primary abnormalities causing partial airway obstruction. Eversion of the mucosa of the lateral ventricles (“laryngeal saccules”) and laryngeal collapse occur secondary to chronic partial airway obstruction. Affected brachycephalic dogs have inspiratory dyspnea which is exacerbated by exercise and increasing ambient temperature. As animals work harder to breathe, their excessive muscular activity may lead to cyanosis, hyperthermia and collapse. The degree of obstruction varies among animals and often increases in severity with age.

In one study of dogs with stenotic nares and overlong soft palate, concurrent airway diseases included laryngeal saccule eversion (53%), moderate laryngeal collapse (19%), severe laryngeal collapse (13%), tracheal stenosis (34%) and tracheal collapse (6%). Heart disease was found in 16%. This emphasizes the importance of a thorough pre-surgical work-up, and evaluation of the entire respiratory system. Radiographs of the chest and neck are mandatory. Fluoroscopy can be used to evaluate the trachea for collapse, although this is uncommon.

All English bulldogs should be evaluated for tracheal hypoplasia using a lateral radiograph of the thorax. The thoracic inlet (TI) diameter, the distance from the ventral aspect of T1 to the inner surface of the manubrium, is compared to the tracheal lumen diameter (TD) at the point where the thoracic inlet line crosses the tracheal lumen. The ratio of tracheal diameter to thoracic inlet (TD/TI) is calculated. The median ratio is 0.116 (ie 12%) for bulldogs, 0.157 (16%) for non-bulldog brachycephalic breeds and 0.208 (21%) for non-brachycephalic breeds. Tracheal hypoplasia, diagnosed when the TD/TI is below these figures, greatly worsens the prognosis for affected dogs.

Brachycephalic breeds may be presented for dyspnea or for excessive noise during breathing. Evaluation of the caudal pharynx and larynx requires light anesthesia. Animals should not be too deeply anesthetized because this will prevent evaluation of the normal abduction and adduction motion of the vocal folds. Because these dogs may experience airway obstruction during anesthetic recovery, appropriate surgical procedures should be performed at the time of evaluation.

Stenotic Nares

In brachycephalic breeds the cartilage plates which form the skeleton of the external nares are shortened and thickened so that the nasal vestibule is effectively obliterated. Removing the lateral wing of the dorsal lateral nasal cartilage increases the diameter of the nostril.

Surgical treatment: Under general anesthesia the animal is positioned in sternal recumbency. Grasping the lateral wing of the dorsal parietal cartilage, the obstructing mass of nasal cartilage is removed. An incision begins rostrolateral on the epithelium and ends caudomedial on the nasal mucosa. Bleeding is brisk and is temporarily controlled by pressure. Simple interrupted sutures are placed between the epithelium and mucosa for closure and control of hemorrhage.
Elongated Soft Palate

In mesocephalic animals, the soft palate extends caudal to the tonsil with its tip extending over the apex of the epiglottis. In brachycephalic dogs the soft palate extends beyond the epiglottis into the larynx. Here it blocks the passage of air and is frequently sucked into the glottis with increased inspiratory effort. This effort causes the palate to flutter or vibrate resulting in stridor. With more flutter, a turbulence is established which may traumatize the palate resulting in inflammation, edema and greater obstruction.

Surgical treatment: A short acting induction agent is used to induce anesthesia and the animal is intubated without delay. General anesthesia is maintained with inhalant. With the animal positioned in sternal recumbency, the head is elevated by a rope sling placed behind the maxillary canine teeth. The mandible is pulled ventrally by a strip of adhesive tape passed over the canine teeth and secured on either side to the surgical table. The surgical assistant pulls the tongue rostrally and depresses the endotracheal tube to provide a clear view of the soft palate for the surgeon.

Retracting the palate ventrally and rostrally, the first knot of a simple continuous suture pattern is placed in one of the free borders of the soft palate. The point of transection is between the caudal end and midpoint of the tonsil. Starting immediately distal to that suture, the palate is cut with curved scissors approximately one half way across. Bleeding is active but is controlled by a simple continuous suture pattern apposing the cut edges of oral and nasal mucosa. Once the cut section is sutured the remaining portion is transected and the suture line is completed. Swelling and edema of the soft palate is controlled by corticosteroids given immediately prior to surgery and continued for 48 hours postoperatively. Reported complications include hemorrhage, respiratory obstruction due to swelling, gagging/retching/vomiting after eating, and aspiration.

One study suggests that dogs diagnosed and treated early (<2 years) have a better prognosis than older dogs. Results are significantly better when stenotic nares are corrected concurrently. Dogs with concurrent laryngeal surgery are less likely to be improved. This does not mean laryngeal abnormalities should not be corrected, but reflects the overall increased severity of airway disease in these patients.

Everted Mucosa of the Lateral Ventricles (“Laryngeal Saccules”)

The mucosa lining the laryngeal ventricle can become everted due to excessive negative pressure at the ventricular orifice caused by increased inspiratory effort. As the mucosa prolapses, it becomes edematous and acts as a mass obstruction to the glottal opening. The diagnosis is made by direct visualization under general anesthesia. Everted laryngeal saccules appear as small, red, fleshy pea-shaped masses just rostral to the vocal cords.

Resection of the saccules is performed through the same oral approach following placement of a tracheostomy tube (the preferred method) or during a short period of extubation. Surgery generally follows soft palate resection. The saccule can be removed using a long-handled laryngeal cup forceps. Alternatively the tissue is grasped with a forceps and slight traction is applied; the saccule is then cut with a long handled. The endotracheal tube is replaced during recovery or a tracheostomy tube is maintained for 24 hours postoperatively. In one study, 78% of dogs treated were improved, although many of them still had some cough/gaging or labored breathing.
Laryngeal Collapse

In response to chronic airway obstruction and an increased inspiratory effort, the cuneiform and corniculate cartilages are drawn into the glottal opening. The aryepiglottic fold can also be weakened and drawn into the glottis. Turbulence and vibrations irritate the laryngeal mucosa causing it to become inflamed and edematous. The net result is a gradual collapse of the laryngeal opening. In addition, all affected dogs usually have everted laryngeal saccules. Severe dyspnea and cyanosis develops. Under general anesthesia the diagnosis is made by laryngoscopy. Some of these animals may experience laryngeal spasm upon induction or may be so collapsed that routine endotracheal intubation is nearly impossible. Prior to induction, the animal and surgeon should be prepared for emergency tracheostomy.

Laryngeal collapse represents a very advanced and critical stage in the progression of brachycephalic airway syndrome. Opening the glottis by partial laryngectomy is unsuccessful. A more successful approach is permanent tracheostomy, thereby bypassing the entire upper airway. This procedure can be performed as a salvage procedure for those brachycephalic dogs not benefitted following stenotic nares, soft palate and laryngeal saccule resection or as a primary surgery in small brachycephalic breeds with laryngeal collapse.

Concurrent Gastrointestinal Disease

Many brachycephalic dogs present with clinical signs of gagging, retching, or vomiting. One study has shown that many of these brachycephalic dogs have concurrent esophageal inflammation and/or gastric ulceration. The authors suspect that the increased negative (i.e. subatmospheric) intrathoracic pressure, generated by these dogs to overcome increased upper airway resistance, causes gastroesophageal reflux. Treatment involves: 1. Correcting the upper airway abnormalities to decrease upper airway resistance, and 2. Treatment with a proton pump inhibitor (omeprazole).

Brachycephalic Dogs: A Model for Sleep Apnea

Bulldogs are used as models to study sleep apnea which is a common disorder in adult humans. Bulldogs and affected humans have excessive pharyngeal tissue which narrows the upper airway. During wakefulness, airway patency is maintained by pharyngeal dilator muscles, such as the sternohyoideus. When awake, it appears that Bulldogs recruit the sternohyoideus to dilate the pharynx with every breath, and the activity is greater than that seen in no-brachycephalic breeds. During rapid eye movement (REM) sleep in Bulldogs, apnea is associated with decreased activity of the pharyngeal dilator muscles. The apneic event is terminated by massive bursts of pharyngeal dilator muscle activity. Studies using magnetic resonance imaging, biopsy, and immunohistochemistry show that these massive bursts of activity are associated with secondary changes to the dilator muscles. Magnetic resonance studies reflect histologic findings of variable muscle edema and fibrosis. Immunohistochemical studies show increased numbers of type II myosin heavy chains. It is not clear if these muscle changes can be reversed by early surgical intervention in Bulldogs. However these findings concur with clinical studies which suggest that results of surgery are best when dogs are treated early.

References


Schotland HM, et al. Quantitative magnetic resonance imaging of upper airway musculature in an animal model of sleep apnea.