Brachycephalic Airway Syndrome in Dogs

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Summary: Brachycephalic airway syndrome results from hereditary development defects of cranium. In this breeds, normal head width decreases. As the soft tissue mass does not decrease as much as the skeleton size, the pressure of the air passing through the airway increases, which primarily leads to narrowing of stenotic nares, elongated soft palate, and secondarily to everted laryngeal saccules and laryngeal collapse. Brachycephalic dog breeds include Shih Tzu, Boxer, English and France bulldog, Pekinese, Pug, Shar Pei, Lhasa Apso and Boston Terrier. Due to high sound, body activity during breathing and increasing heat in the environment in Brachycephalic breeds leads to inspiratory difficulty in breathing. As the airway is closed during swallowing and as it will naturally make breathing more difficult, these animals may not want to swallow. If it is not treated, it can lead to respiratory and cardiovascular problems such as pulmonary vasoconstriction, pulmonary hypertension, right ventricle failure and even can lead to life loss as a result of complications like laryngeal collapse.

***Key words**: Brachycephalic airway syndrome, dog, surgical treatment*

Köpeklerde Brahisefalik Hava Yolu Sendromu

Özet: Brahisefalik hava yolu sendromu kafa tası kemiklerindeki kalıtımsal gelişim defektleri sonucu oluşur. Bu ırklarda kafa genişliği normalken uzunluğu azalmıştır. Kafadaki yumuşak doku kitlesinde, iskelet ölçülerindeki bu azalmayla doğru orantılı bir azalma oluşmadığı için üst solunum yollarından geçen havanın direncinde bir artma meydana gelir ve sonuçta burun deliklerinde daralma, yumuşak damak sarkması, primer laringeal keseciklerin eversiyonu ve laringeal kollaps durumları ise sekunder olarak ortaya çıkar. Brahisefalik köpek ırkları, Shih Tzu, Boxer, English Bulldog, French Bulldog, Pekingese, Pug, Shar Pei, Lhasa Apso ve Boston Terrier olarak sıralanabilir. Brahisefalik ırklarda soluk alıp verirken oluşan yüksek ses ile egzersiz ve ortam ısısının yükselmesiyle artış gösteren bir inspiratorik dispne mevcuttur. Köpekler yutkunma esnasında doğal olarak soluk yollarının kapanması soluk alıp vermeyi daha da güçleştireceğinden hayvanlar yutkunmak istemeyebilirler. Tedavi edilmez ise, pulmoner vazokonstruksiyon, pulmoner hipertansiyon, sağ kalp yetmezliği gibi respiratorik ve kardiovasküler rahatsızlıklara yol açabilen, laryngeal kollaps gibi komplikasyonlar sonucu hastanın yaşamını yitirmesine neden olabilen bir sendromdur.

***Anahtar Sözcükler:** Brahisefalik hava yolu sendromu, köpek, cerrahi sağaltım*

Introduction

Brachycephalic airway syndrome comes into being as result of hereditary development defects of cranium. In this breeds, normal head width decreases. As the soft tissue mass does not decrease like the skeleton size, the pressure of the air passing through the airway increases (Brown and Gregory, 2005).

Pressure on nasal passage and distortion of pharynx tissue are among the important reasons for this**.** Brachycephalic dog breeds include, Shih Tzu, Boxer, English and France 3bulldog, Pekingese, pug Shar Pei, Lhasa Apso and Boston Terrier. Brachycephalic airway syndrome is characterized with narrowing of stenotic nares (figure 1), elongated soft palate (figure 2), everted laryngeal saccules (figure 3) and laryngeal collapse (figure 4). Hypoplastic trachea is common incidence in Brachycephalic dogs because of the stress in airways (Hedlund, 2007; Monnet, 2003).

Figure 1: Stenotic nares

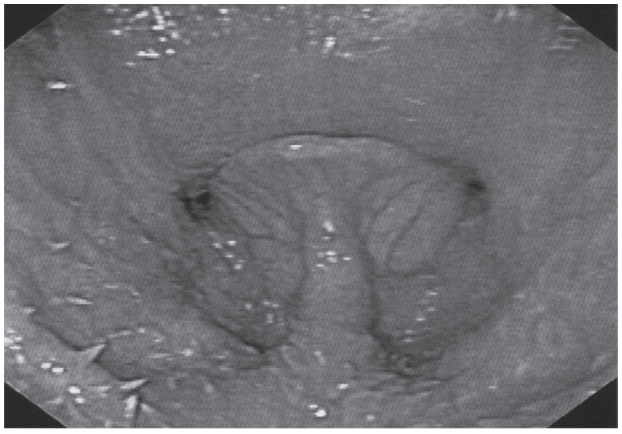

Figure 2: Elongated soft palate and the epiglottis overlap (Hedlund, 2007)

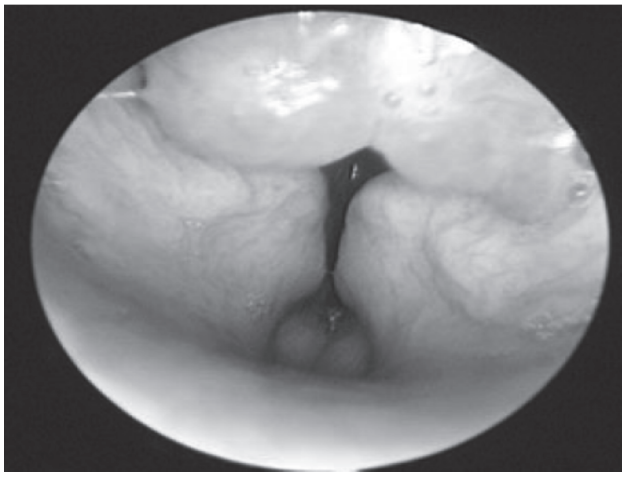

Figure 3: Everted laryngeal saccules (white arrows) (Hedlund, 2007)

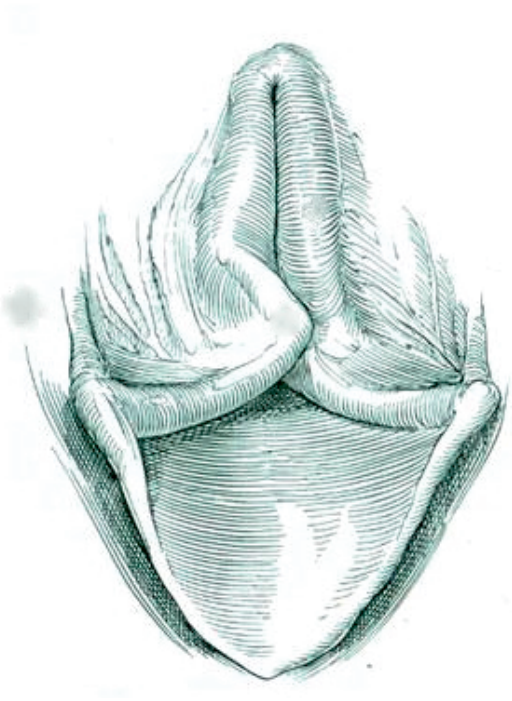

Figure 4: Laryngeal Collapse (Monnet, 2003)

Narrowing of stenotic nares and elongated soft palate are the primary constituents of this syndrome and everted laryngeal saccules and laryngeal collapse are secondary components. Excessive negative pressure resulting from narrowing nostrils and realized under inspiration leads to stretching and inflammation of soft tissues and everted laryngeal saccules and laryngeal collapse (Monnet, 2003).

The thickened epithelium outside and the cartilaginous skeleton covered with mucosa inside forms the nostrils. In brachycephalic breeds, the cartilaginous structure is short and thick and was replaced towards the medial. This case which has a frequent incidence in brachycephalic dog breeds leads to the secondary changes in the airways (everted laryngeal saccules, laryngeal collapse, tracheal collapse) (Monnet, 2003). Narrowing of nostrils is a case seen at birth. It is revealed in assessments in most of the dogs between the age of 2 and 4 (Hedlund, 2007).

Soft palate in Brachycephalic dogs reaches beyond epiglottis and obstructs the airway. Vibrations in soft palate during breathing can lead to inflammation and swelling, this in turn obstructs airways more. In such cases, edema in pharynx mucosa and largely protruded tonsils are frequently seen (Monnet, 2003). Elongated soft palate can also be seen in dogs with no brachycephalic skull base (Cavalier King Charles Spaniel) (Hedlund, 2007).

Everted laryngeal saccules are seen in patients with sustained airway obstruction. Due to high negative pressure during inspiration, the mucosa of the laryngeal saccules is everted in the larynx. The prolapsed part of the mucosa is oedematous and forms a mass which lead to the obstruction of the ventral rirna glottis (Monnet, 2003). In dogs which do not have brachycephalic skull base, chronic barking can lead to everted laryngeal saccules (Hedlund, 2007).

When the supporting function of larynx cartilage disappears, laryngeal collapse is formed, which is regarded as an indication of progression of brachycephalic airway syndrome**.** With the effect of excessive negative pressure in inspiration cuneiform and corniculate cartilages are inclined towards the medial. Laryngeal collapse is a progressive disease whose prognosis gets worse in time. Narrowing of nostrils leads to an abnormal pressure which cause elongated soft palate and everted laryngeal saccules, gradual reshaping and eventual collapse of arytenoid cartilage in the larynx (Monnet, 2003).

Narrowed or obstructed nostrils affect on the lung's mechanism and provoke the degeneration of nasal mucosa membranes. Severe narrowing and obstruction in upper airways ways lead to lung edema due to intra-thoracic pressure. Insufficient pulmonary ventilation caused by obstruction in the upper airways results in arterial oxygen amount. Hypoxia is a very strong vasoconstrictor which cycles the blood from alveoli with poor ventilation. Pulmonary vazoconstruction and pulmonary hypertension result in hypertension 'cor pulmonale' and right ventricle failure (Monnet, 2003).

Brachycephalic breeds have inspiratory dyspnea which increases with high sound, exercise and increasing heat. Some English bulldog race dogs can have vomiting which is not related with food. Again in English bulldog race dogs with brachycephalic airway syndrome, there is an increase in the incidence of hiatus hernia (Monnet, 2003). These animals may not want to swallow as their respiratory ways are naturally obstructed during swallowing which will make breathing more difficult (Hedlund, 2007).

When the physical examination of nostrils is done for stenosis, breathing habit of the patient is to be monitored. If brachycephalic dogs have a breathing difficulty resulting only from narrowing of nostrils, it can be compensated with breathing mouth open and only inspiratory dyspnea is seen but if it is persisted for a long time, it can lead to gastro-intestinal tension resulting from aerophagia which comes into being as secondary to breathing mouth open. Constant fast breathing, increase in the distance between front legs, excessive use of abdominal muscles, collapse of intercostals cavity and thorax entrance orthopneic posture (stretching head and craning) and not wanting to lie down and hypothermia caused by interruption of cooling can be listed as other clinical symptoms of brachycephalic airways syndrome. If there is elongated soft palate or laryngeal saccules and larynx are collapsed, the difficulty in breathing is of both inspiratory and expiratory character**.** The severity of the inspiratory dyspnea varies depending on the length and obstruction of soft palate and the existence of other obstructive conditions. In brachycephalic dogs whose axis of airways did not narrow more than 50%, obstructive breathing habit is characterized with a slow inspiration phase followed by a rapid expiration phase. In non-brachycephalic breeds, breathing is required to be modified only after the axis airway is narrowed more than 50% (Hedlund, 2007; Monnet, 2003).

Besides revealing elongated soft palate protruded to rira glottis radiography examination is useful in the diagnosis of conditions like hypoplastic trachea which can worsen prognosis. In order to make hypo-plastic trachea diagnosis, the axis of trachea lumen is divided by the axis of the thoracic entrance. This rate is 0,106 in English bulldogs in which hypoplastic trachea is the most common. Besides, thorax radiography reveals the existence of lung edema and right ventricle dilatation and informs us about the need for echocardiographic and electrocardiographic examination (Monnet, 2003).

In cases with brachycephalic airway syndrome, pathology and biochemical profile are generally normal. Rarely blood gas analysis and hypoxia and respiratory alkaloses can be determined. In cases where oxygen saturation acutely decreases below 80% syncope and collapse symptoms can be seen. If hypoxia is chronic, polycythemia can develop (Hedlund, 2007).

In order to monitor soft palate, laryngeal saccules and the functions larynges slight general anesthesia is required. Normally soft palate is not to be too long to outreach the apex of epiglottis. For soft palate to be assessed robustly, in examination the tongue is to be pressed only using fingers without endotraheal tube and the head is to be in normal position. When laryngeal

saccules are everted, they seem to be white, bright dome shaped structures on cranial of the vocal cords. Laryngeal collapse is characterized with both corniculate cartilage being discharged to medial and cuneiform flattening process of arytenodi cartilage towards medial. Vocal cords cannot be seen in the case of laryngeal collapse.

Stenosis in nostrils is a case which is frequently diagnosed in young (younger than 2) brachycephalic dogs and soft palate is slightly longer than normal**.** However, in surgical interventions at this age, prognosis is rather good. As the patient gets older than 2 years old, even if surgical intervention, prognosis is to be followed carefully as other surgical disorders start to develop. However, surgical intervention is to be done immediately. As hypo-plastic trachea incidence is very high in English Bulldog, they may not respond to surgical intervention.

In anesthetic protocol which is generally preferred, each dog is sedated with glycopyrrolate (0,005 mg/kg IM) and butarphanol (0,25 mg/kg IM). Dogs are preoxyganated prior to induction to maintain adequate oxygenation during the potential stress of induction. Dogs are induced with propofol (4-6 mg/kg IV). Anesthesia is maintained with isoflurane. Capnometry, pulse oxymetry and indirect Doppler blood pressure monitoring are used throughout the procedure. At the completion of the surgery, the oropharynx is suctioned to remove any blood or mucus that could be aspirated during recovery. Dexamethasone sodium phosphate (0,25 mg/kg IV) is administred at the end of the procedure (Davidson et al, 2001). In fact there are differences between the administration time of dexamethasone in different studies. One of them dexamethasone is administred during induction (Riecks, 2007).

In the treatment of narrowed nostrils, the resistance in the airways during breathing is tried to be reduced by vertical wedge resection (figure 5), horizontal wedge resection, lateral wedge resection (Hedlund, 2007; Monnet, 2003).

The dorsal lateral and ventral lateral nose cartilages make up the canal which is called nostril. The nostrils are supported by nasal septum in the medial and by dorsal lateral cartilage in the dorsal. Lateral accessory cartilage provides ventral support to nostrils (Hedlund, 2007).

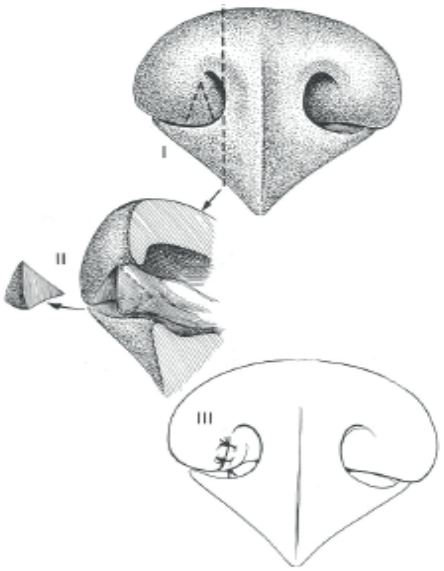

Figure 5: Treatment option for stenotic nares (vertical wedge resection) (Monnet, 2003)

In vertical wedge resection, a vertical incision to the side of the nostril is performed and this incision is deepened up to caudal alar cartilage a part like wedge is taken out. When the cavity is closed with 3 or 4 simple stitch with 3-0 or 4-0 absorbable stitch material, there will be an opening as large as the material taken out is achieved and breathing is eased. In horizontal wedge resection, an incision from the side of the nostril which goes from medial to lateral is made and deepened up to the caudal alar cartilage and the resulting cavity is stitched in the same way. Lateral wedge resection is a method carried out by the removal of a part from the caudolateral side of the nostril (Hedlund, 2007, Monnet, 2003).

There are different methods in the surgical treatment of elongated soft palate. For resection a pair of scissors, carbon dioxide laser or electro-surgery is used. Besides, no matter what technique is used, in case of inadequate resection can cause the persistence of breathing problems and more than adequate soft palate resection can lead to nasal regurgitation, rinit and sinusitis. The aim of resection is the removal of everted soft palate which covers the apex of epiglottis. In classic technique (figure 6), the patient is laid on ventral position. The mouth cavity is opened and the part of soft palate everted to the epiglottis is determined. It is marked with sterile pencil or a small incision is made with a scalpel. The caudodorsal part of tonsils is regarded as

cranial soft palate. Soft palate is raised up to the rostral with Allis forceps. The stitch placed on the mucosa with 4-0 or 5-0 an absorbable stitch thread to the free side of soft palate is stretched towards lateral, which allows us to the excision line completely. After soft palate is excised along the line, it is stitched with simple continuous technique. In this technique, bleeding is minimal. There is no need for postoperative antibiotic use. Steroids can be used preoperatively to prevent edema (Brown and Gregory, 2005; Hedlund, 2007; Monnet, 2003).

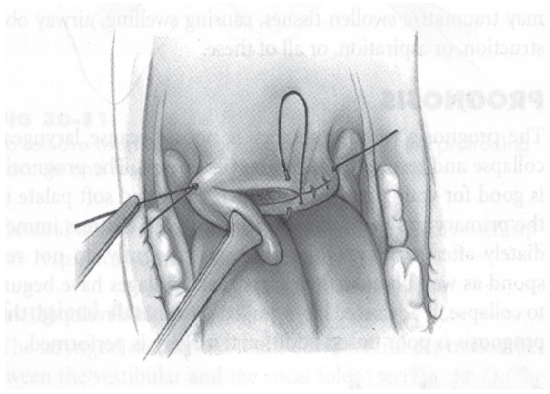

Figure 6: Classic technique for surgical treatment of elongated soft palate (Hedlund, 2007)

Another technique used in everted soft palate is 'Folded flap palatoplasty' FFP. In this technique, after the patient is laid in the position mentioned above and prepared for operation the apex of the soft palate is pulled towards the rostral with a forceps and the apex of it is touched to ventral mucosa of the soft palate and the cranial apex of the incision is marked with a electrocautery. The aim is to take a part in shape of trapezoid (figure 7). The base of this part is the hard line of soft palate, lateral sides are the medial of the tonsils. Ventral mucosa of the soft palate, palatinus muscle and a part of levator veli palatini muscle are excised and removed (figure 8). Later on the apex of the free soft palate is flattened and stitched on the cranialin of the trapezoidal cavity simple separate technique with monofilament absorbable stitch material (figure 9). After the lateral side of the soft palate is stitched in the same way, the operation is completed (Findji and Dupre, 2009).

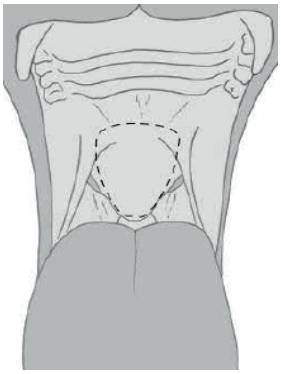

Figure 7: Trapezoid shape (Findji and Dupre, 2009)

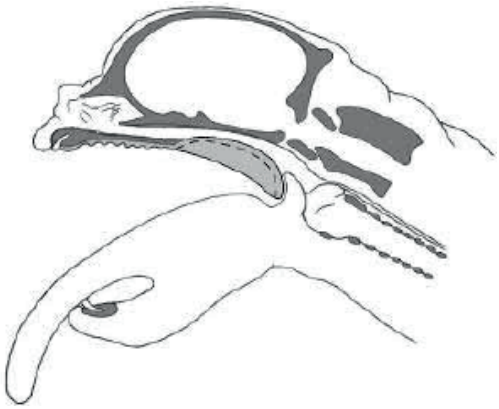

Figure 8: Ventral mucosa of the soft palate, palatinus muscle and a part of levator veli palatini muscle are excised and removed. (Findji and Dupre, 2009)

Figure 9: Free soft palate is sutured in trapezoidal cavity (Findji and Dupre, 2009)

Treatment of everted laryngeal saccules with surgical method is difficult as the study filed is limited with brachycephalic breeds, the prevention of pharynx

tissue and as the tissue worked on can easily become edematous due to a small manipulation. Therefore, temporary tracheostomy tube is to be inserted. Everted laryngeal saccule or saccules are held with forceps and excised and it is pressured with gauze bandage for a while to prevent bleeding. As resection of laryngeal saccules will cause larynx edema, steroids are to be used postoperatively and temporary tarchestomy tube is to be left there for 24 hours after operation (Hedlund, 2007; Monnet, 2003)

If symptoms do not disappear even after everted soft palate and narrowing in nostrils are resolved, partial arytenoidectomy may be necessary to enlarge laryngeal opening. In some cases of severe tracheal collapse, permanent tracheotomy tube may also be necessary (Monnet, 2003).

Conclusion

Most of the modifications in the surgical treatment of brachycephalic airway syndrome are related with elongated soft palate. Surgical techniques used in the treatment of narrowing in stenotic nares and laryngeal everted laryngeal saccules have hardly changed.

Resection of everted soft palate can be performed using various devices and equipments. These are conventional incisional technique, carbon dioxide laser and electro-surgery. It is known that electro-surgery can increase swelling (Monnet, 2003).

In study in which carbon dioxide laser and conventional incisional technique were compared on 20 adult brachycephalic, it was reported that postoperative clinic recovery periods are similar, operation period and easy application gave laser a competitive edge and besides, it was also reported that no complication was seen during operation and patients with no reanimation problem did not need to be performed tracheotomy (Davidson et al, 2001).

For the treatment of everted soft palate brachycephalic dogs was defined with different technique other than resection. In study on 55 dogs using Folded Flap Palatoplasty, it was reported that no intra-operative complication was seen and only 6 of the postoperative cases (10,9%) temporary tracheotomy was needed. Forty of the cases could be followed postoperatively (379±142 days) and 39 (97,5%) clinic symptoms related with breathing recovered after surgical intervention and in 85% recovery was within 15 days after operation (Findji and Dupre 2009). However, in this method everted soft palate is shortened more than recommended and this can be attributed to pharyngonasal regurgitation (Monnet, 2003). After Folded Flap Palatoplasty surgery such a complication was not seen, which was attributed to the fact that airway obstruction due to the edema resulting from the rostral positioning of everted soft palate being flapped on itself (Findji and Dupre, 2009).

Compared to traditional techniques, folded flap palatoplasty is harder to apply and lasts longer. In order to shorten the period of operation in operative treatment of everted soft palate resection, electro- surgery can be used but it is reported that edema can lead to life threatening airway obstructions (Bright and Wheaton, 1983). Folded flap palatoplasty seems to be the most appropriate technique to be used to eradicate the negative effects of soft palate thickened as a result of chronic inflammation on breathing (Findji and Dupre, 2009).

In a study carried out in Australia in 2006 on brachycephalic airway syndrome, it was reported there is no gender predisposition (Torrez and Hunt, 2006). However, in another study again Australia, 43 of the 61 dogs examined were males and in a study in Ireland, it was reported that out of 7 brachycephalic puppies brought to the clinics with laryngeal collapse complaints were males (Findji and Dupre, 2009; Pink et al, 2006). A study in America on 62 dogs reveals that brachycephalic airway syndrome is seen more frequently in males compared to females (rate 2:1) (Riecks, 2007).

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