REVIEW ARTICLE

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Brachycephalic Airway Syndrome in Dogs

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Abstract

Brachycephalic dogs are characterized by a shortened muzzle of varying sizes and a round and large head. These breeds include the Boston Terrier, English Bulldog, French Bulldog, Pug, Pekingese, Shih Tzu, and Cavalier King Charles Spaniel. Brachycephalic airway syndrome is a common finding in brachycephalic breeds. A combination of primary and secondary changes can progress to life-threatening laryngeal collapse. In this review, information will be given about narrow nostrils, elongated soft palate, and everted laryngeal saccules, which are brachycephalic primary respiratory tract pathologies.

Keywords: Brachycephaly, airway syndrome, diagnosis, anestesia, treatment.

INTRODUCTION

In the world is known that there are close to 400 types of dogs. Significant differences in morphology and especially in skull shapes were observed among these species (Schoenebeck and Ostrander, 2013). The skull sizes of these breeds are observed to vary between 7 and 28 cm (McGreevy et al., 2004). It is known that three terms as dolichocephalic, mesocephalic and brachycephalic are generally used to describe skull shapes (Roberts et al., 2010). This classification is made according to the cephalic index calculated in dogs (Helton, 2009).

Brachycephalic breeds are generally distinguished from mesocephalic and dolichocephalic races by the presence of short skulls and open orbitals. Brachycephalic dog breeds include the Boston Terrier, English Bulldog, French Bulldog, Pug, Pekingese, Shih Tzu, and Cavalier King Charles Spaniel (Dupré et al., 2012). A definitive list of the brachycephalic breeds is not available because there are differences in definitions of 'brachycephaly'. The variation within some breeds indicates that the term is most appropriate for individual consideration of dogs rather than breeds as a whole (Ekenstedt et al., 2020).

The aim of this review is to give information about the anatomy, pathophysiology, diagnosis and treatment of the brachycephalic primary respiratory tract pathologies in dogs, which are narrow nostrils, elongated soft palate and everted laryngeal saccules.

Anatomy

Brachycephalic dogs are characterized by a shortened muzzle of varying sizes and a round and large head. Compared to mesocephalic dogs, brachycephalic dogs; medio-lateral enlargement of the skull appears to be accompanied by rostro-caudal shortening of the nose (Ekenstedt et al., 2020). One of the skull changes in brachycephalic dogs is early ankylosis of the basic cranial epiphyseal cartilage of the skull. This condition leads to chondrodysplasia of the longitudinal axis of the skull. There is currently no consensus on which measurements are standard. However, it is known that the cranio-facial angle of the skull in brachycephalic dogs is 9º-14º (Meola, 2013).

Dorsal and ventral cartilago nasi lateralis join laterally to form the nostril. The nostrils are supported medially and ventrally by the septum nasi and dorsally by the dorsal cartilago nasi lateralis (Fossum, 2007). The alae nasi contains the maxillary levator labii and nasolabial levator muscle fibers and allows this region to expand (Koch et al., 2003).

The soft palate extends from the hard palate to the tip of the epiglottis, effectively separating the oropharynx from the nasopharynx. The musculus palatinus, supplied by the plexus pharyngealis, shortens the soft palate during contraction. The epiglottis is a curved triangular cartilage at the entrance to the larynx. The apex of the epiglottis is towards the oropharynx and is located immediately dorsal to the soft palate. The mucosa forms the plica aryepiglottica by attaching the sides of the epiglottis to the processus cuneiformis of the cartilago arytenoidea (Fossum, 2007).

Pathophysiology

The airflow passing through the nasal cavities constitutes 76.5% of the total airflow resistance in the respiratory tract. In normal dogs, inspiration and expiration are passive (Koch et al., 2003). However, brachycephalic dogs have difficulties due to pathological problems in the respiratory tract. Brachycephalic dogs have an increased resistance to airflow during inspiration and an increased intraluminal pressure gradient due to anatomical differences (Hobsan, 1995). Poiseuille's law states that a 50% reduction in radius results in a 16 fold increase in flow resistance. Therefore, reducing the size of the nostrils, nasal passage and laryngeal openings by half will increase the airway resistance in the brachycephalic breed by 16 fold that of a non-brachycephalic dog. The increased negative pressure created to overcome the resistance causes inflammation of the soft tissue, eversion of the

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laryngeal vesicles and many pathologies such as laryngeal and tracheal collapse (Meola, 2013).

Upper Respiratory Track Pathologies Associed With Brachycephalic Breeds

Brachycephalic airway syndrome is characterized primarily by respiratory and thermoregulatory problems, especially among pathologies involving partial or complete obstruction of the upper respiratory tract (Ekenstedt et al., 2020). Brachycephalic airway syndrome was at first thought to be caused only by narrow nostrils and a long soft palate. Recently, new endoscopic, radiological and computed tomography studies show that most airway obstruction is caused by more than one thing (Table 1) (Grand and Bureau, 2011).

Table 1. Upper airway abnormalities associated with brachycephalic breeds (Fossum, 2007).

Classic Components of Brachycephalic Syndrome
Elongated soft palate
Stenotic nares
Everted laryngeal saccules
Common Concurrent Findings
Hypoplastic trachea
Aryepiglottic collapse
Other Findings
Corniculate collapse
Tracheal collapse
Tonsil eversion
Macroglossia
Pharyngeal collapse
Epiglottic collapse

Stenotic Nares

Stenotic nostrils are congenital deformities that cause medial collapse of the nasal cartilages and partial occlusion of the external nostrils. (Fossum, 2007). The external view of the nostril opening between the nasal septum and the dorsal cartilago nasi lateralis and ventral cartilago nasi lateralis has turned into a vertical slit (Monnet, 2013). Stenotic nostrils have been recognized as the primary anatomical components of the brachycephalic syndrome, and their early correction has been advocated to minimize the increase of obstructive disease in other regions (Tobias, 2017).

Elongated Solf Palate

Elongated soft palate is one of the most common pathologies of brachycephalic syndrome. The elongated soft palate is pulled caudally during inspiration and occludes the dorsal glottis. The laryngeal mucosa is inflamed and edematous, further narrowing the airway. Affected dogs may have difficulty swallowing due to normal occlusion of the airway during swallowing. Dysfunctional swallowing can lead to aspiration pneumonia (Fossum, 2007). Although elongated soft palate has been emphasized as the primary component of brachycephalic syndrome in the literature, recent radiographic, computed tomography (CT) and histological examinations have shown an additional pathological thickening of the soft palate. Another study showed that there is a positive relationship between soft palate thickness and the severity of clinical symptoms (Dupré and Heidenreich, 2016).

Laryngeal Diseases

Laryngeal diseases associated with brachycephalic syndrome include mucosal edema, everted laryngeal vesicles and laryngeal collapse (Koch et al., 2003). Eversion of the laryngeal vesicles has been accepted as the first degree of laryngeal collapse (Leonard, 1960). Eversion of laryngeal vesicles is less commonly diagnosed than elongated soft palate or stenotic nostrils, but has been reported in 58% to 66% of dogs with brachycephalic syndrome (Fasanella et al., 2010). The increase in airflow resistance and the increase in negative pressure to push air through the occluded areas pull the diverticula through their crypts, causing them to swell. These diverticulum obstruct the ventral side of the glottis, further obstructing airflow and thus causing respiratory tract abnormality (Fossum, 2007).

Laryngeal collapse is a form of upper airway obstruction that causes medial collapse of the rostral laryngeal cartilages due to loss of cartilage rigidity. (White, 2012). It has been reported that laryngeal collapse begins in brachycephalic dogs when they are younger than 6 months old (MacPhail, 2019).

DIAGNOSIS

Clinical Appearance

Typical clinical signs in dogs with brachycephalic airway syndrome include; inspiratory stertore, inspiratory stridor, snoring, cough, exercise intolerance, increased respiratory effort, hyperthermia and collapse (Meola, 2013). Rapid breathing increases congestion with stress. Failure to provide normal thermoregulation predisposes dogs to hyperthermia, which can lead to heat stress and death. Any physiological condition can aggravate these conditions and lead to respiratory crises (Ekenstedt et al., 2020).

Physical Examination Findings

During the physical examination, care should be taken not to stress the animal and thus not to increase the respiratory problem. Because even an apparently stable brachycephalic dog can suddenly decompensate (Hendricks, 1992). Examination should first begin with inspection. The paradoxical movement of the thorax and abdomen, the exercise of the accessory respiratory muscles, the inward collapse of the intercostal spaces and the thoracic inlet and the forward extended head and neck position (orthoplenic body position) can be clearly seen (Fossum, 2007). Body temperature should be determined and if the body temperature is high, it should be brought to normal body temperature (Hendricks, 1992).

Gastrointestinal distention with air due to aerophagia is a common symptom accompanying respiratory problem. As the primary syndrome, gastric dilatation and volvulus can also occur in brachycephalics, so it should be differentiated from simple aerophagia (Hendricks, 1992).

Laboratory Findings

It provides assessment of blood gas, hypoxia and respiratory alkalosis. (Fossum, 2007). A pink coloration of the mucosa does not mean it is normal, as cyanosis is usually not detected until the oxygen saturation (SaO_2) is below 80%. Thus, an animal with a SaO_2 between 80% and 90% has pink mucous membranes, although it is at risk for clinically significant reductions. Colour of the mucous membrane; general posture should be evaluated together with the breathing pattern and the use of auxiliary muscles

(Lodato and Hedlund, 2012). However, the safest procedure is to provide oxygen with a face mask or oxygen cage until the partial arterial oxygen pressure (PaO_2) is directly measured (Hendricks, 1992). If arterial blood gas cannot be obtained, a venous sample or pulse oximetry can be used to establish pH and bicarbonate levels and partial pressure of carbon dioxide (Lodato and Hedlund, 2012).

Imaging Diagnostic Methods

Appropriate assessment of the airway; includes many imaging diagnostic methods such as radiography, computer tomography and endoscopy (Dupré et al., 2012). Radiography in brachycephalic respiratory tract pathologies; lateral head and neck X-ray allows to evaluate the degree of upper airway obstruction (Hendricks, 1992). Laterolateral neck radiography allows the evaluation of the thickness of the soft palate located between the nasopharynx and the oropharynx (Dupré and Heidenreich, 2016). Thoracic radiography taken in the laterolateral position, shows us the presence of hypoplastic trachea. The measure of the diameter of the trachea; where the thoracic inlet line cuts the trachea, is the tracheal lumen vertical to the long axis of the trachea. The trachea is considered hypoplastic when the trachea diameter/thoracic entry line ratio is <0.16 on a lateral thoracic radiograph. This measurement is not affected by the respiratory phase. In addition, the size of the trachea diameter can be evaluated by measuring the diameter of the trachea in the direction of the third costa and the diameter of the third costa. If the diameter of the trachea is three times the width of the third costa, it is considered normal (Lodato and Hedlund, 2012).

Computed tomography (CT) in brachycephalic respiratory tract pathologies; It is a powerful and fast imaging method that uses the nose, paranasal sinuses, skull and trachea to create cross-sectional images (Kuehn, 2006). Endoscopy is one of the most used auxiliary diagnostic methods, although no bone can be used to define the location or dimensions of a pathological or anatomical structure (Liu et al., 2018). Endoscopic examination of the airways in brachycephalic airway syndrome includes direct and retrograde rhinoscopy, laryngoscopy and tracheo-bronchoscopy. Rhinoscopy is usually performed to detect vestibular stenosis and turbinate malformation (Dupré et al., 2012). Examination of the pharyngeal and laryngeal structures, usually by endoscopy, is best done under general anesthesia (Ekenstedt et al., 2020). Laryngoscopy is done after the dog is extubated. In this visual diagnosis method, soft palate hyperplasia can be diagnosed first (Fossum, 2007). By pressing the soft palate, everted laryngeal vesicles and vestibular folds may appear, and at the same time movements of the rima glottis can be observed during inspiration and expiration. Tracheal collapse can also be seen in some brachycephalic dogs as a result of continued negative pressure (Koch et al., 2003).

Prognosis

It is difficult to obtain an accurate prognostic perspective for dogs with brachycephalic respiratory syndrome. Most studies evaluating outcome after brachycephalic surgery are retrospective and compare results in different races with various treatment combinations and reconstructive techniques (Dupré and Heidenreich, 2016). It has been found that English Bulldogs respond worse to the operation than all other breeds and are more likely to develop aspiration pneumonia postoperatively. Its relationship with gastrointestinal diseases was investigated, and it was reported that better results were obtained in brachycephalic dogs treated simultaneously with upper respiratory tract diseases (Poncet et al., 2006).

TREATMENT

Medical Treatment

Long-term conservative medical treatment includes a weight management program and intervention in the dog's lifestyle. This is a clinically recognized issue, although one study failed to correlate increased body weight with the severity of respiratory symptoms (Trappler and Moore, 2011a). Activities that increase respiratory effort, including long walks with a collar on during the hottest hours of the day, should be avoided. Walks should be kept short and done during cool hours of the day (Trappler and Moore, 2011a; Meola 2013). Exercise restriction and elimination of triggers can eliminate these clinical symptoms when clinical symptoms are mild. Sedation, corticosteroids, supplemental oxygen and antipyretics to lower body temperature may be necessary for moderate to severe respiratory distress. Mild sedation and anti-inflammatory drugs can be effective in reducing pharyngeal swelling (Fossum, 2007; Meola, 2013).

Surgery Treatment

Early surgical intervention of brachycephalic airway syndrome pathologies is recommended to stop the progression of airway pathology (Trappler and Moore, 2011b; Dupré and Heidenreich, 2016). Surgical treatment has been found to be indicated, especially in the treatment of narrow nostrils and elongated soft palate. Recent studies have shown that in all brachiocephalic patients, clinical signs are significantly reduced in all brachiocephalic dogs of all ages and after surgery (Erjavec et al., 2021).

Preoperative Preparations

The operation should be prepared so that acute dyspnea can be followed and a tracheostomy can be performed urgently. Because the existing pathology and intraoperative intervention in the airway may cause postoperative edema in the airways in the postoperative period. (Trappler and Moore, 2011b). The patient should be carefully monitored in terms of decompensation and progressive respiratory distress, and tracheostomy should be applied when necessary. Perioperative IV corticosteroid therapy may help reduce airway swelling, but airway obstruction remains a potential complication during or after extubation (Fossum, 2007; Trappler and Moore, 2011b).

Anesthesia

In order to minimize the risks of anesthesia, it should be planned to prevent or correct complications that may occur during the perianesthetic period. There is no protocol applicable to all brachycephalics, it must be individualized and individualized for each patient according to the situation and the intervention. The purpose of premedication and induction in these breeds is to provide sedation without significant respiratory depression, reduce anxiety, reduce the required induction dose, prevent vomiting, and provide analgesia. Premedication may vary depending on the surgical intervention to be performed. It is recommended to use antiemetics (for example, maropitant and metoclopramide) especially in patients who will undergo soft palate surgery and in patients who vomit easily (Risco-López, 2015). Anticholinergics are never routinely used, only in cases of severe bradycardia during anesthesia (Bernaertsa et al., 2010).

The most commonly used alpha 2-agonists are medetomidine and dexmedetomidine. They are the best option in stable animals without cardiovascular disorders, as they provide very good sedation and analgesia as well as being reversible at low doses. Acepromazine should not be preferred because it causes relaxation of the pharynx muscles due to its peripheral vasodilator effect that increases heat loss. Benzodiazepines can be used but have little sedative power and should not be preferred as they can increase aggression. Although opioids produce bradycardia and respiratory depression at high doses, they show little adverse effect at usual doses. The choice depends on the type of intervention. The most commonly used opioid agents are methadone and fentanyl (Risco-López, 2015).

Preoxygenation is always very important before the operation in brachycephalic dogs. Because almost all drugs used in induction have a depressant effect on respiratory function (Koch et al., 2003). Propofol is the most used agent in induction because it provides rapid induction. In addition, respiratory depression that it may cause is rare. Alfaxalone causes little cardiovascular depression and may be preferred because it can be given intamuscular. Although ketamine causes little cardiovascular depression, it may support laryngospasm by not eliminating the reflex, so it may be preferred over operative intervention. Etomidate is indicated in cardiovascularly susceptible patients (Risco-López, 2015).

In brachycephalic breeds, we can use isoflurane or sevoflurane as inhalation anesthesia for the continuation of anesthesia, but care should be taken as these can suppress respiration. Injectable propofol or alfaxalone can also be used as the safest drug in these patients, but since they are breeds where oxygen supply is important, they should be intubated and given oxygen whether or not inhalation anesthesia is used for maintenance (Risco-López, 2015).

During the recovery period, the endotracheal tube should be kept in place until the swallowing reflex occurs to prevent aspiration pneumonia (Hobson, 1995). Before extubation, fluids such as mucus and blood in the upper respiratory tract should be checked. The patient should be placed in the sternal position with the head slightly elevated and the tongue extended. A material should be used to raise the chin. If sedatives are needed while waking up, low doses of alpha2-agonists, benzodiazepines or acepromazine can be used as sedatives (Risco-López, 2015).

Positioning

In operations to be performed inside the mouth, the patient is placed in a dorsoventral position with its mouth completely open. The maxilla should be suspended from a stick or two infusion carriers that are passed slightly above the operating table, and the mandible should be secured with tape ventrally. The tongue should be pulled rostrally for maximum visibility of the inside of the mouth (Trappler and Moore, 2011b). Modified apparatus made of stainless steel, consisting of a rectangular frame that opens the maxilla and mandible, can also be used (Kuraji et al., 2019).

As an alternative to the operations of the soft palate and laryngeal vesicles, the patient can be placed in the ventrodorsal lying position. In the operation performed for the stenotic nostril, the dorsoventral lying position can be performed with the mouth closed by supporting the chin. The patient's head should be taped to the table to prevent the head from turning (Fossum, 2007).

Surgical Techniques

In brachycephalic airway syndrome, different surgical techniques (eg, resection of stenotic nostrils, resection of everted laryngeal vesicles) have been described for most anatomical pathologies (Fossum, 2007; Hueber, 2008; Lippert et al., 2010).

Stenotic Nostril Resection (Rhinoplasty)

Various surgical techniques are used for resection of stenotic nostrils. All of the techniques used are used to widen the external nostrils (Fossum, 2007; Dupré and Heidenreich, 2016). Techniques such as alar amputation, wedge resection, punch alaplasty and alapexy are among the techniques that have positive results in the permanent widening of the stenotic nose (Aiken, 2021). It is recommended that the operation for stenotic nostrils, which is one of the upper respiratory tract pathologies, should be performed when the dog is 3 to 4 months old (Koch et al., 2003; Trappler and Moore, 2011b). In nostril resection, the number 11 scalpel is mostly preferred in order to make deep incisions. However, skin biopsy can also be performed with a punch tool, a fine-tipped electrosurgery or radiofrequency unit, or laser (Dupré et al., 2012).

Resection of Alae Nasi

Alar amputation involves resection of the soft tissue cranioventral wing to the dorsolateral nasal cartilage (Schlicksup, 2016). The incision line should be 15º downward and outward in the anterior view, and 40º downward and inward in the lateral view. Firm pressure is applied to the surgical site for 5 to 10 minutes to achieve hemostasis. The scar tissue formed after amputation may remain white for several months (Huck et al., 2008; Tobias, 2017).

Alaplasty

The most commonly used techniques are alaplasty techniques. It is made by removing a wedge from the ala nasi. This wedge can be vertical, horizontal or lateral (Dupré et al., 2012). Two to four simple separate sutures should be made using absorbable monofilament material for suturing. When the wound edges are sutured, it provides hemostasis (Dupré and Heidenreich, 2016).

Vertical Wedge Technique

In the vertical wedge technique, the ventral part of the alar fold of the stenotic nostril is held with Brown Adson forceps (Tobias, 2017). The first V-shaped incision should be made medially and the second incision should be made laterally with a scalpel around the forceps (Fossum, 2007). The lateral border of the wedge should be at an angle (40-70°) from the medial border. It is important that the removed tissues are deep enough and contain part of the alar fold to completely remove the obstruction. Care should be taken to achieve a symmetrical opening in both nostrils (Dupré et al., 2012).

Horizontal Wedge Technique

The horizontal wedge technique was initially described with various definitions. It was described as a right-angled wedge technique in which the tip of the wedge is positioned laterally (Harvey, 1982; Hobsan, 1995). According to the new definition, horizontal wedge resection involves creating a wedge from medial to lateral (Bofan et al., 2015).

Lateral Wedge Technique
The lateral wedge resection technique consists of excision of a vertical wedge of tissue from the caudolateral aspect of the outer nose, between the nose and the skin. The wedge may contain part of the skin (Nelson, 1993; Monnet, 2003) or not (Aron and Crowe, 1985). The wedge should be made deep to include part of the alar fold (Wykes, 1991).

Punch Resection Alaplasty
It is a technique in which a dermatological punch biopsy is used for the portion of the ala nasi to be resected (Trostel and Frankel, 2010). The diameter of the punch biopsy instrument used ranges from 2 mm for puppies to 3-6 mm for adult dogs (Dupré et al., 2012).

The alar fold is held for control and a dermatological punch tool is used to create a circular tissue symmetrical to the level of the alar fold at the ala nasi. The circular tissue is keeped using Thumb forceps and resected with tissue scissors after little traction. Bleeding is minimal at this stage. Pressure should be applied to stop bleeding or cotton swabs impregnated with epinephrine can be used (Trostel and Frankel, 2010).

Dorsal Offset Rhinoplasty
Dorsal offset rhinoplasty for use as the production of a rostral, most dorsal, wedge of each nasal planum and nasal cartilage. The width of the wedge should be approximately 3 to 5 mm, depending on the size of the animal and the severity of the stenosis. The first suture should be placed from the most rostral aspect of the axial edge to the most caudal aspect of the axial edge (Dickerson et al., 2020).

Alapexy
Alapexy is a method that can be used in dogs with excessive drooping of the ala nasi (Bofan et al., 2015). The length of the incision can vary from 0.5 to 1 cm, depending on the size of the dog, and should be about 3 mm wide. Another incision is made into the skin 3 to 5 mm lateral to the ala nasi, opposite the first incision. From the opposing incision surfaces, first the underlying incision edges and then the outer incision edges are joined with a simple separate suture with an absorbable 3-0 or 4-0 thread (Ellison, 2004).

Elongated Soft Palate Resection (Staphylectomy)
The purpose of resection of the elongated soft palate is to shorten the caudal part of the soft palate to prevent obstruction of the rima glottidis on inspiration (Dupré and Heidenreich, 2016). In normal animals, the caudal edge of the palate slightly overlaps the tip of the epiglottis (Tobias, 2017). Different markings along the rostrocaudal axis have been proposed for the soft palate (Monnet, 2013). In recent studies, it has been suggested that resection of the soft palate at the level of the cranial junction of the tonsillar crypts will not lead to nasal aspiration (Brdecka et al., 2008). Scalpel blade, scissors, monopolar electrocoagulation, carbon dioxide laser, diode laser or ligasure can be used for soft palate resection (Dupré and Heidenreich, 2016). The traditional technique is excision with a scalpel blade or Metzenbaum scissors and using simple, continuous suturing of the oropharyngeal, nasopharyngeal mucosa (Trappler and Moore, 2011b).

Laser Staphylectomy
The required length of the soft palate is marked by removing it from under the endotracheal tube. Fixation sutures are placed on both sides of the elongated soft palate, distal to the prescribed resection line, using a monofilament thread. The palate is pulled in the rostral direction with fixation sutures. Moist gauze is placed between the endotracheal tube and the palate and the prescribed resection line is marked from different areas. The incision is started from the lateral part of the resection line. In this way, the entire tissue is resected and the final appearance is achieved (Tobias, 2017).

Staphylectomy with the Cut and Sew Technique
Suspension sutures are placed on the edges of the soft palate with monofilament thread or hemostatic forceps. In order to view the ventral surface, the tip of the palate is pulled in the rostral direction with Allis tissue forceps or fixation sutures (Tobias, 2017). In order not to cause excessive mucosal swelling, the soft palate should be intervened as little as possible. After the proposed resection site has been marked, one-third to one-half of it is cut with curved Metzenbaum scissors or a scalpel. Starting from the border of the palate, the oropharyngeal and nasopharyngeal mucosa are sutured together with a simple continuous suture. In this way, the remaining soft palate is cut and sutured and the operation is terminated (Fossum, 2007).

Folded Flap Palatoplasty
Folded flap palatoplasty was developed to correct both excessive length and excessive thickness of the soft palate (Dupré and Heidenreich, 2016). In this technique, while the soft palate is thinned by cutting a part of the oropharyngeal mucosa and soft tissues, it is also shortened by folding it on itself (Monnet, 2013).

The caudal edge of the soft palate is grasped with forceps or fixation sutures and pulled rostrally. The intended incision area is marked with an electrocautery. The soft tissues under the cut part of the soft palate, the ventral mucosa of the soft palate, the palatinus muscles and part of the levator veli palatini muscle are excised. The caudal edge of the soft palate is retracted rostrally to the rostral edge of the trapezoidal incision (FIindjii and Dupré, 2008). A temporary permanent suture can be used to pull the soft palate rostrally. Thus, it provides a better visualization of the free edge of the soft palate before the palatopexy sutures are placed, allowing the operation to be performed easily (Sun et al., 2022). The soft palate is then terminated with a simple separate suture (FIindjii and Dupré, 2008).

Eversion of Laryngeal Saccules
Excision of everted laryngeal sacs is controversial, but eversion is known to cause rimal glottidis obstruction (Fawcett et al., 2018). Electrocautery, scissors, tonsil traps or laryngeal biopsy forceps can be used for excision of everted laryngeal saccules (Dupré and Heidenreich, 2016). While performing the operation, the least intervention should be done and unnecessary manipulations should be avoided. Unnecessary manipulations can cause local obstructive edema postoperatively (Fossum, 2007). It is recommended to use an endoscope or suitable magnification devices to perform a complete and safe resection of the operation. Removal of everted laryngeal sacculess is recommended only in cases where eversion is significantly caused by obstruction, according to recent studies (Dupré et al., 2012). Temporary tracheostomy is recommended by some investigators for easier operation in the operative field, but this can also be accomplished by temporary extubation or by pushing the endotracheal tube to one side. After the saccule is visualized, the saccule is

grasped with an Allis tissue forceps or hemostat and retracted rostrally and resected with an instrument such as a scalpel, Metzenbaum scissors, or electrocautery. Bleeding is usually minimal and is controlled with little pressure and the operation is completed (Trappler and Moore, 2011b). In one study, unilateral resection was performed, and it was observed that there was no improvement in the unresected area despite the treatment of the nostrils and soft palate (Dupré and Heidenreich, 2016).

Laryngeal Collapse

Partial laryngectomy in the surgical treatment of laryngeal collapse has a very high (50%) mortality rate. Therefore, it is not recommended. Laser-assisted partial arytenoidectomy recommended for the treatment of laryngeal paralysis may provide some relief, but is not routinely used and more research is needed. Alternatively, arytenoid lateralization is a viable option for dogs with adequate mineralization of their laryngeal cartilage. In cases where these surgical methods are not sufficient, tracheostomy can be performed (Dupré and Heidenreich, 2016).

As a result of the researches, it was understood that when the primary diseases (stenosis of the nostrils, long soft palate and eversion of the laryngeal vesicles) were corrected, there was improvement in laryngeal collapsed brachycephalic dogs. This situation has made laryngeal collapse surgery insignificant, especially (Dupré et al., 2012).

Postoperative Care and Complications

Postoperative care should be in the form of delayed extubation, analgesic protocol, nasal oxygen supplementation for up to 24 hours, and respiratory respiration monitoring (Koch et al., 2003). The endotracheal tube should not be removed during recovery as long as the patient tolerates it. Edema of structures in the airway, decreased pharyngeal reflexes, hyperthermia, and increased risk of aspiration are present for at least 24 to 48 hours after surgery. Therefore, the patient should be followed closely (Trappler and Moore, 2011b). Optimally, the animal should lie dorsoventrally as it awakens, with its front legs extended forward and outward. In addition, the head and neck should be extended and the tongue should be pulled forward to help open the airway (Fossum, 2007). Prednisone (0.5 to 1.0 mg/kg IV for 24 to 48 hours postoperatively) can be used to help reduce airway inflammation. Dogs should not be fed for 12 to 24 hours after the operation (Trappler and Moore, 2011b). Ice chips can be given when fully awakened from anesthesia, but no food should be given. Water must be given first; If tolerated well, small amounts of soft food can be offered (Fossum, 2007). The diet should consist of only soft foods for 10 to 14 days to minimize irritation of the upper respiratory tract. During this period, patients should be kept in a cool environment, moderately active, and kept the pet in poor body condition. To relieve the stress on the upper respiratory tract of dogs, a body collar should be used, not a neck collar. These lifestyle changes must be sustained throughout the patient's life to maximize successful outcomes (Trappler and Moore, 2011b).

Serious postoperative complications include airway swelling, vomiting, and aspiration (Trappler and Moore, 2011b). The mortality rate after staphylectomy is below 5%. If palate resection is inadequate, clinical signs will likely reappear. If the resection is excessive, the animal will reflux water and food through its nose and may develop cough and rhinitis (Tobias, 2017). If the patient frequently licks or rubs her nose, a pink scar may remain (Fossum, 2007).

CONCLUSION

Brachycephalic dog breeds have been around for over 2000 years. Recently, as a result of the increase in brachycephalic dog breeds and population, the diseases in this breed have been brought to the agenda more. It is known that especially primary upper airway diseases seen in brachycephalic dogs adversely affect the quality of life of these dogs. In addition to many visual diagnosis methods used in the diagnosis of primary upper airway diseases, clinical appearance, physical examination findings and laboratory findings are also important. In the treatment of brachycephalic upper airway syndrome, especially surgical treatments are of great importance following medical treatments.

Conflict of Interest

The authors declared that there is no conflict of interest.

Authorship contributions

Concept: G.D., R.Y., Design: G.D., R.Y., Literature Search: G.D., R.Y., Writing: G.D., R.Y.

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