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Mini Review

Canine Brachycephalic Obstructive Airway Syndrome (CBOAS) - Diagnosis and Non-Surgical Management

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Abstract

The quality of life of several popular dog breeds is negatively impacted by brachycephalic obstructive airway syndrome (BOAS), a chronic, lifelong, crippling, predominantly obstructive airway condition. BOAS occur due to abnormalities of airways, middle ear effusions, and abnormality of the gastrointestinal tract. The common clinical signs include stertor, Strider, gagging, cyanosis, inspiratory dyspnea, increased respiratory efforts, exercise intolerance, vomiting and/ or regurgitation, salivation, and hyperthermia. Clinico-pathological abnormalities include decreased arterial partial pressure of oxygen, increased arterial partial pressure of carbon dioxide, Polycythemia, and increased hematocrit. Diagnosis can be done based on the history of distress episodes and gastrointestinal issues together; physical examination for inspiratory and respiratory dyspnea; thoracic radiography used evaluation for lower airway organs condition and upper airway endoscopy for identifying abnormalities associated with BOAS. In conclusion, surgical procedure of BOAS causes recurrence of respiratory symptoms, hence medicinal management should be followed for successful treatment.

Keywords: BOAS, Brachycephalic Breeds, Management, Stertor.

Introduction

Brachycephalic obstructive airway syndrome (BOAS) commonly occurs in small animal practice specifically breeds affected. Synonyms of BOAS are brachycephalic syndrome and brachycephalic airway syndrome (BAS). BOAS comprises primary anatomic components and many secondary sequelae (Meola, 2013; Trappler and Moore, 2011). The phrase "brachycephalic syndrome" refers to the tendency of brachycephalic breeds to develop respiratory issues. Stenotic nares, larger tonsils, an extended soft palate, everted lateral laryngeal saccules, a narrower rima glottidis, and tracheal and laryngeal collapse are among the usual anatomic anomalies. Each dog exhibits these findings either singly or in different combinations and intensities. In times of excitement or heat brought on by the weather or exertion, these abnormalities limit the lumen of the upper respiratory tract, consequently restricting breathing and frequently resulting in asphyxiation and collapse (Koch *et al*., 2003; Lodato and Hedlund, 2012). Here we focus on acute emergency management and long-term conservative management of these patients.

Option of surgical correction of BOAS is available but after surgery, there will be secondary complications like inflammation may occur at the operated parts which again may result in narrowing of the upper respiratory tract and again dyspnoea can occur. Also, during anaesthetic condition of a brachycephalic dog, anaesthetic agents like diazepam cause muscle relaxation especially respiratory muscles which leads to the narrowing of the respiratory tract. So, we should avoid surgical procedures to a possible extent and manage BOAS potentially on a medicinal approach.

Hence, considering the above facts and using existing knowledge, the present review work was carried out on the diagnosis and non-surgical management of CBOAS for a better understanding and practical approach to managing CBOAS without surgery.

Brachycephalic Dog Breeds

Brachycephaly, derived from the ancient Greek words ‘brakhu’ (short) and ‘cephalos’ (head), is the terminology for a foreshortened skull (Ita and Rizvi, 2021). Pekingese, English Pugs, English Bulldogs, Boxers, Lhasa Apsos, and Shih Tzus (Hendricks, 1992). A local chondrodysplasia that develops as a result of domestication is referred to as brachycephalia. Early ankylosis causes the cartilage at the base of the skull to shorten, which shortens the skull's longitudinal axis. Breeders purposefully kept these animals with chondrodysplasia (Meola 2013; Koch *et al*., 2003).

Anatomy

The craniofacial angle between the base of the skull and the facial skull is 9 - 14 in brachycephalic dogs, 25 -26 in dolichocephalic greyhounds, and 19 -21 in mesocephalic dogs. Brachycephalic dogs have a skull width-to-length ratio of 0.81 or greater defined a brachycephalic dog (Meola 2013). The classification of a dog's head shapes by measuring its cephalic index score into dolichocephalic (CL<50; long-headed), mesocephalic (50<CL<60; medium-headed), and brachycephalic (60<CL; short-headed). The cephalic index (CI) is calculated as the maximum width of the head divided by the maximum length of the head, multiplied by 100. The higher the cephalic index, the shorter the dog's head will be (Koch *et al*., 2003; Bognar *et al*., 2021).

The medial collapse of the alae is brought on by congenitally occurring nasal cartilage deformities called stenotic nares. The dorsal lateral nasal cartilages, accessory cartilage, and the alae or wings make up the nares. The common nasal, dorsal, middle, and ventral meatuses, which house the nasal turbinate, are formed by the dorsal, ventral, and ethmoid conchae, which are housed in the nasal cavities. These meat uses lead to the caudal choana and the nasopharyngeal ducts (Lodato and Hedlund, 2012). The soft palate typically extends past the tip of the epiglottis in non-bracycephalic breeds. In Dogs with BOAS, the soft palate is enlarged and extends caudally past the tip of the epiglottis (Koch *et al*., 2003). The vocal folds and paired arytenoid cartilages dorsally form the rima glottis, which is the narrowest part of the upper airway. The arytenoids comprise two corniculate processes dorsally and two cuneiform processes ventrally, two vocal processes at the ventral aspect where the vocal folds attach, and two muscular processes dorso-laterally at the caudal aspect of these cartilages. The laryngeal saccules are located between the vocal and vestibular folds. The vestibular folds then attach to the cuneiform process (Lodato and Hedlund, 2012).

Pathophysiology

A respiratory condition connected to conformation has been developed as a result of selective breeding for excessive brachycephaly (Koch *et al*., 2003). The constricted airway in brachycephalic breeds affects airflow resistance and raises the intraluminal pressure gradient during inspiration. When this pressure is excessively higher than atmospheric pressure, the cartilaginous larynx and trachea become weakened and can collapse, reducing the tracheal luminal size and further increasing resistance to airflow. Tonsils and laryngeal saccules also evert. Inspiratory noise results from turbulent airflow, oedema, and increased resistance (Lodato and Hedlund, 2012). The eustachian tubes laterals to the nasopharyngeal meatus and enter on both sides. They bridge the gap between the pharynx and the middle ear, balancing pressure variations on either side of the tympanic membrane (Koch *et al*., 2003).

Clinical Characteristics

Abnormalities of the Airway

a. Primary Abnormalities

Stenotic nares are defined as narrowed external nostrils, and reduced diameter of nasal vestibules that lead into the nasal cavity. This varying and abnormal narrowing, classified as mild, moderate, or severe, forces dogs to breathe with an open mouth. Mucosal hypertrophy of the turbinates and mucosal contact points (MCPs) within the nasal cavity leads to reduced ventilation of sinuses, airflow resistance, nasal blockage, reduction in olfactory sense, and predisposition to chronic lymphoplasmacytic rhinitis. An elongated and thickened soft palate will frequently overlap the epiglottis and is responsible for the distinctive gagging, and retching. The progressively increased airway resistance and associated pressure changes exacerbate the thickening and elongation of the soft palate over time. An enlarged tongue (macroglossia) relative to the widened and shortened head contributes further to the dorsal displacement of the soft palate and increases the turbulent airflow in the nasopharynx. Tracheal hypoplasia is characterized by small and rigid tracheal cartilage rings and a shortened or absent dorsal tracheal membrane (Mitze *et al.*, 2022; Lodato and Hedlund, 2012).

b. Secondary Abnormalities

Enlarged or protruding palatine tonsils are a result of chronic airway pressure changes, irritation, and inflammation. Their enlargement has been linked with respiratory infection and decreased exercise tolerance. As the disease progresses due to the long-term negative pressure gradients, many brachycephalic dogs develop pharyngeal collapse. Eversion of the laryngeal saccules and laryngeal collapse during BOAS is due to cartilage fatigue and chondromalacia, both reducing the laryngeal stiffness. Brachycephaly confers an increased risk of aspiration pneumonia and pneumonitis, emphasizing the importance of thoracic imaging in the presurgical work-up of these patients (Koch *et al*., 2003; Mitze *et al*., 2022).

Middle Ear Effusions

Middle ear effusions (MEE), which occasionally affect brachycephalic dogs, cause a greater build-up of mucus in the tympanic bulla. Typically, the discharge is sterile and thick. The mucus is continuously produced by the goblet cells of the tympanic bulla and enters the nasopharynx via the Eustachian tube. Reduced nasopharyngeal breadth in brachycephalic dogs severely impacts mucus clearance. Additionally, increased mucus production and pressure variations might possibly be involved (Mitze *et al*., 2022).

Abnormalities of Gastrointestinal Tract

The respiratory and gastrointestinal tracts share overlapping mechanisms required for breathing and swallowing and can pathologically affect each other. Prognathism malocclusion leads to traumatic contact of the mandibular incisors with the hard palate, subsequent pulpitis and focal palatitis, dental crowding, tooth rotation, unerupted teeth, prominent palatine rugae, periodontal disease, and consequent systemic bacteraemia (Meola 2013). The prevalence of gastrointestinal disease in brachycephalic dogs presenting for respiratory signs is as high as 97% (Mitze *et al*., 2022).

Congenital or acquired hiatal hernia (HH), leads to chronic regurgitation and predisposes to oesophagitis, gastric dilatation–volvulus, and aspiration pneumonia. Oesophageal motility disorders include prolonged oesophageal transit time. These variations predispose to gastroesophageal reflux disease (GERD) frequently documented in brachycephalic dogs. Signs of GERD include lip smacking, ptyalism, extension of head and neck while swallowing, retching, vomiting, regurgitation, grass ingestion, surface licking, dysphagia, nocturnal restlessness, and anorexia (Reeve *et al*., 2017; Mitze *et al*., 2022).

Clinical Signs

The common clinical signs include stertor, Strider, gagging, cyanosis, inspiratory dyspnea, increased respiratory efforts, exercise intolerance, vomiting and/ or regurgitation, salivation, and hyperthermia. In severe cases, syncope is seen in BOAS (Trappler and Moore, 2011; Lodato and Hedlund, 2012). Mild, moderate, or severe respiratory distress symptoms are possible. In mild and moderate respiratory stress, the mucous membrane is pink, and in severe respiratory stress, the mucous membrane may be cyanotic (Lodato and Hedlund 2012).

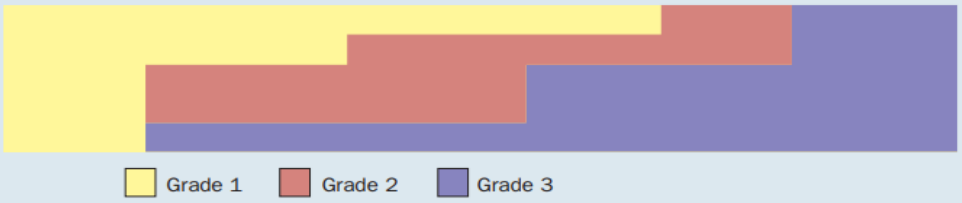
Dogs try different positions for sleep to reduce respiratory resistance. Some dog prefers to elevate their head and straighten their neck while sleeping. Some dogs fall asleep when sitting or even standing position. Some dogs wake up several times to change their position and/or to clear up their throat and seem tired all the time. Some dog holds the toy in their mouth to keep their mouth open (Liu *et al.*, 2016). Clinicopathological abnormality includes decreased arterial partial pressure of oxygen (PaO2), increased arterial partial pressure of carbon dioxide (PaCO2), polycythemia, increased hematocrit (HCT), inflammatory response resulting in the form of increased levels of C-reactive protein (CRP) and sometimes hyperglycemia and hyperlipidemia also observed. (Hendricks 1992)

Grading of BOAS

The grading system for BOAS is based on respiratory signs and digestive signs given by Poncet *et al.* (2005) as shown below in Table 1 and Table 2. A global classification of three grades was obtained: absent or minimal (grade 1), moderate (grade 2), or severe (grade 3).

Table 1. Frequency and nature of respiratory signs and the assigned clinical grade

Nature of the respiratory signs	Frequency					
	Never	Occasionally (< once monthly)	Regularly (once weekly)	Daily (once daily)	Often (> once daily)	Constantly
Snoring						
Inspiratory efforts						
Stress or exercise intolerance						
Syncope						



The grading of the respiratory disorders is based on the frequency of different clinical signs and is comprised of three grades. Inclusion of at least one sign in a higher grade determines the actual classification. For example, if an animal was presented with regular snoring, inspiratory difficulty, stress or exercise intolerance but occasional syncope, a grade 3 for respiratory signs was assigned

Poncet *et al.* (2005)

Diagnosis

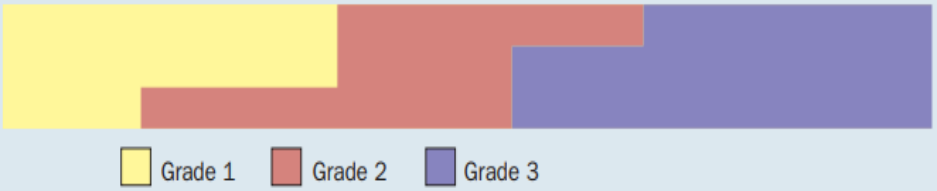
History

The history should be used to look for additional changes that could deteriorate respiratory function, such as an increase in weight, endocrine diseases (such as Cushing's syndrome or thyroid abnormalities), neuromuscular disease, heart failure, or infections. Any sedative history is important since it may lead to pulmonary oedema and evident upper airway obstruction. In almost all cases, sedation without intubation will result in blockage (Hendricks

1992). It should be emphasized that respiratory distress episodes and gastrointestinal issues frequently occur together. Because the essential blockage of the respiratory system for deglutition impairs breathing, the dogs may have difficulty swallowing (Hendricks, 1992). Ineffective swallowing can cause aspiration pneumonia. Vomiting and diarrhea may accompany extreme hyperthermia, struggle to relieve airway obstruction, or severe aerophagia.

Table 2. Frequency and nature of digestive signs and the assigned clinical grade

Nature of the digestive signs	Frequency					
	Never	Occasionally (< once monthly)	Regularly (once weekly)	Daily (once daily)	Often (> once daily)	Constantly
Ptyalism Regurgitation Vomiting						



The grading of the digestive disorders is based on the frequency of different clinical signs and is comprised of three grades. Inclusion of at least one sign in a higher grade determines the actual classification. For example, if an animal was presented with regular ptyalism and regurgitation but daily vomiting, a grade 3 for digestive signs was assigned

Poncet *et al.* (2005)

Physical Examination Findings

The respiratory rate and pattern should be noted before touching the animal. The stenotic nares also can be observed from a distance. Inspiratory dyspnea that corrects with open mouth breathing has been reported when only the nares are involved. Involvement of the soft palate and laryngeal saccules often leads to inspiratory and respiratory dyspnea (Hendricks, 1992). Mild, moderate, or severe respiratory distress symptoms are possible. In mild and moderate respiratory stress, the mucous membrane is pink, and in severe respiratory stress, the mucous membrane may be cyanotic (Lodato and Hedlund, 2012).

Radiographic Findings

Thoracic radiography used evaluation for lower airway disease, including tracheal hypoplasia, cardiac, and pulmonary abnormalities (i.e. aspiration pneumonia and noncardiogenic pulmonary edema) (Meola, 2013).On a properly positioned lateral neck and thoracic radiograph, the distance from the thoracic inlet at the ventral aspect of the vertebral column at the midpoint of the first rib to the inner surface of the manubrium at its narrowest point is the TI measurement. The diameter of the tracheal lumen perpendicular to the long axis of the trachea where the TI line intersects the mid-point of the tracheal lumen provides the tracheal diameter (TD) measurement. When the TD: TI ratio on a lateral thoracic radio-graph is <0.16, the trachea is considered to be hypoplastic (Lodato and Hedlund, 2012).

Hematological Findings

Routine blood testing is usually normal, although polycythemia might be expected if the hypoxia is chronic. Blood gas analysis of both arterial and venous blood gases can be useful. The arterial gas is extremely important to direct the immediate management of the animal (*i.e.*, whether supplemental oxygen is necessary). Arterial oxygen saturation (SaO_2) can be estimated by oximetry. If an arterial gas cannot be obtained, venous blood gas will still produce useful information about pH, $HC0_2$, and PCO_2 levels (Hendricks, 1992).

Upper Airway Endoscopy

Endoscopic visualization is the best means of identifying abnormalities associated with BAS. Laryngeal saccules, laryngeal collapse, everted tonsils, and nasopharyngeal turbinate (Lodato and Hedlund, 2012).

Gastrointestinal Endoscopy

Performing esophagoscopy and gastroduodenoscopy may reveal concurrent abnormalities in the GI tract, even in dogs not exhibiting clinical signs of digestive disorders. Lesions and physiologic abnormalities have been found in the esophagus as esophagitis, and esophageal deviation. In the stomach abnormalities found are cardial atony, gastroesophageal reflux, axial hiatal hernia, gastric stasis, mucosal hyperplasia of the pylorus, pyloric stenosis, and pyloric atony. In duodenum, abnormalities are found as inflammation of the corpus or antrum and diffuse inflammation of the duodenum.

Emergency Management

Emergency medical therapy of dogs in crisis focuses on the relief of dyspnea or cyanosis and reduction of stress and hyperthermia, the establishment of IV access. A rectal temperature should be taken at presentation, and active cooling should be instituted in dogs with temperatures above 103°F. Oxygen supplementation should be provided with minimal stress; options include the use of flow-by oxygen, an intranasal catheter, an oxygen cage, or endotracheal intubation. Sedation should be done with acepromazine @ 0.005 mg/kg IV (or SC), decreased the risk of acepromazine induce vasodilatory hypotension then increased dose up to 0.02 mg/kg IV or SC. Anti-inflammatory dose of short-acting corticosteroids inj. Dexamethasone @ 0.05 to 0.1 mg/kg IV should be given and avoid the large dose and repeated dose. Placement of a tracheostomy tube may be necessary to bypass upper airway swelling in severe cases (Trappler and Moore, 2011).

Medical Management

Don't allow the dog to roam outside the house in hot weather to avoid direct sunlight. Also, hot and bright colour rooms should be avoided. Take your dog for a walk early in the morning or after dusk. Maintain convection using a breeze fan or air-conditioning. Maintain conduction with the help of a cooling mat and cooling vest. Enhance panting for more air passing to moist airways and encourage water intake of dogs. Keep dog lean and balance between food intake and exercise level. Avoid excessive exercise and excitement. Give the dog a regular short walk using a harness. Care should be taken for BOAS-affected dogs with frequent regurgitation/ emesis. Feed the dog from height. Feed a small amount of food more frequently. Do not feed an hour before exercise and an hour before bedtime.

Conclusions

If diagnosed early at a young age with typical clinical signs associated with the upper respiratory tract it is easy to manage. Emergency treatment is needed to alleviate dyspnea or cyanosis and to reduce stress and hyperthermia. Because of the progressive nature of the disease, early surgical intervention is recommended to halt or delay secondary changes. Weight management and environmental modifications prove to be Long-term conservative therapy for BAS. Although the surgical and non-surgical management of BOAS patients is our duty in the clinical setting, it is indisputable that in many cases a fully successful outcome is unachievable Our biggest responsibility is to work together with all stakeholders to advise and enact policy change and guide public education and new breed standards for animals under our care.

Contribution by Authors

Equal contribution. All authors declared that 'written informed' consent was obtained from the approved parties for the publication of this article and accompanying images.

Conflict of Interests

There is no conflict of interest.

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