# FACTORS, DIAGNOSIS AND TREATMENT OF BOAS IN DOGS

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**CHRIS SHALES** considers the primary factors involved in this condition, as well as the secondary changes that can occur, and discusses treatment options

**BRACHYCEPHALIC obstructive airway syndrome (BOAS) is a term used to describe a raft of upper respiratory tract problems that occur in brachycephalic breeds. Clinical signs vary in severity and include stertor, stridor, exercise intolerance, collapse and cyanosis. Affected dogs are also predisposed to syncope, gastro-oesophageal reflux, vomiting and regurgitation.**

Brachycephalic breeds are popular among dog owners in the UK and it can be challenging for veterinary surgeons to determine which cases warrant detailed assessment and at what stage. Unfortunately, levels of owner tolerance of both upper respiratory noise and exercise intolerance can mean by the time a dog is presented for veterinary examination, secondary changes to the airway can be severe. This relatively late presentation can result in a poorer prognosis and the requirement for procedures that would perhaps not have been necessary had the dog been treated earlier.

This article aims to review the primary factors and secondary changes that can occur with clinically significant BOAS. Diagnosis and treatment of the airway will be discussed along with the importance of considering the effects on the gastrointestinal system and how effective gastrointestinal management can significantly benefit the animal. Treatment options will be discussed in addition to prognosis and how this is affected by the secondary changes.

## Primary condition

Anatomic features associated with increased upper airway resistance include stenotic nares (Figure 1), overcrowded ethmoturbinates, an overlong soft palate (Figure 2) and hypoplastic trachea. These anatomical features can result in significantly increased resistance to air flow when compared to mesocephalic breeds.

Animals do not have to exhibit all of the primary factors to experience breathing difficulties and significant variation is possible within breeds or family groups.

**Overlong soft palate**

Generally, it is accepted an overlong soft palate is the most common primary factor, but it is not present in all BOAS cases. Diagnosis requires examination under anaesthesia **(**Figure 2**)**, which is unfortunately not risk free in many of these animals. The caudal aspects of the tonsillar crypts are commonly used as landmarks for assessment of palate length, but, in some cases, the tonsils themselves can be abnormally positioned. Overlap with the epiglottis can also be a useful guide, but caution is required due to the variable position of the larynx depending on lingual traction or head position during the evaluation.

**Stenotic nares**

Stenotic nares are reported to occur in approximately half of canine BOAS cases, but represent the most important feature in cats suffering from the condition. Diagnosis can be made from external evaluation of the nares during inspiration. BOAS cases, including cats, are often suffering from a combination of reduced airway size and also tendency of the alar cartilage to collapse medially under the influence of the exacerbated negative inspiratory pressure.

**Overcrowded ethmoturbinates**

Overcrowded ethmoturbinates is emerging as a significant feature in some animals, but cannot be diagnosed without advanced imaging techniques or nasopharyngeal endoscopy. Its prevalence in the UK population is unknown, but is reported as approximately 21 per cent of clinically affected dogs in the US (with pugs being over-represented; Ginn et al, 2008). There are no reviewed research papers available that evaluate the effect of resection of turbinates. Laser surgery is the preferred technique due to its ability to be performed under endoscopic guidance and ability to minimise the risk of significant haemorrhage.

**Hypoplastic trachea**

Hypoplastic trachea is a congenital condition present in some brachycephalic breeds and has been associated with increased risk of respiratory tract infections. The trachea is assessed at the level of the third rib on a lateral radiographic projection. Normal diameter is considered to be approximately three times the width of the rib at the level of the trachea itself. The condition is most commonly,

but not exclusively, encountered in English bulldogs and, while it can be severe, it is often not considered as a significant negative prognostic indicator in its own right when considering the likely outcome following BOAS surgery (Riecks et al, 2007).

Many brachycephalic animals will show signs of stertor due to their head conformation, but not all are severely affected enough to require surgery. This is compounded by the high tolerance to upper respiratory noise and exercise intolerance by owners of these breeds, as discussed in news articles in *Veterinary Times* (*VT* 42.21 issue) and *Veterinary Record* following a research paper by Packer et al published in 2012. In many cases, decision-making in terms of the severity of primary factors present and whether they are clinically relevant depends on evaluating a combination of the age of the animal, presence or severity of clinical signs and, most importantly, the presence of secondary factors. The presence of secondary factors indicate a significant detrimental effect on the airway anatomy and they should be considered as a potential indication for treatment. It is often useful to consider the age of the animal along with the severity of the secondary changes when considering the appropriate level of intervention.

## Secondary factors

Animals suffering from clinically relevant BOAS attempt to overcome the resistance to air flow by creating exaggerated negative pressures in the thorax, lower airways, trachea, larynx and nasal cavity using the thoracic wall, diaphragm and abdominal musculature. The characteristic breathing pattern associated with trying to move air into the lungs and the resultant high negative pressures within these structures can result in a number of important secondary changes that tend to progress over time, such as:

• laryngeal collapse;

• tonsillar eversion/hypertrophy;

• (non cardiogenic pulmonary oedema); and l gastrointestinal disease:

– acid reflux;

– hiatal hernia;

– gastritis; and n duodenitis.

**Laryngeal collapse**

The cartilage framework of the larynx and larger airways is present to avoid collapse of the lumen during inspiration. The increased effort required to overcome the resistance to air flow in dogs affected by BOAS can result in negative pressures that exceed the tolerance of the laryngeal

cartilages and cause gradual collapse of the laryngeal lumen (rima glottidis). In addition, the resistance to collapse of the larynx may be reduced by abnormally soft cartilage in some individuals.

The severity of laryngeal collapse is graded from one to three (Table 1) with grade three representing almost total collapse of the rima glottidis. The rate of onset of collapse is entirely dependent on the individual case and it is worth noting that grade two or three collapse is possible, even in very young animals (Pink et al, 2006). It is also important to note many dogs demonstrating significant inspiratory stridor or other clinical signs attributed to BOAS will be suffering from at least grade one collapse regardless of their age.

**Tonsillar eversion/hypertrophy**

Increased negative pressure during inspiration can result in hypertrophy or swelling of the tonsils and associated eversion from the tonsillar crypts. Increased turbulence and further exacerbation of negative pressure during time of respiratory crisis has the potential to allow the tonsils to further enlarge and represent a significant factor in resistance to smooth airflow in brachycephalic breeds.

**Non-cardiogenic pulmonary oedema**

The balance of tissue fluid in the lung parenchyma is affected by vascular/tissue colloid osmotic pressure, blood pressure (in both the arterial and venous system) and the pressure in the airway itself. Dogs with significant upper airway resistance and increased negative pressure during inspiration can suffer from accumulation of fluid (pulmonary oedema) due to the effect of creating imbalance between the factors controlling fluid distribution.

This is a relatively uncommon manifestation among dogs undergoing assessment and treatment of BOAS, but can be significant when present. Poor progress/sudden death postoperatively can occur in a minority of cases due to the development of pulmonary oedema and while lung reexpansion or mechanical ventilation has been implicated, the definitive cause is unknown.

**Syncope**

Brachycephalic breeds can suffer bradycardia and syncopal episodes due to high vagal tone that have the potential to be confused with collapse due to airway disease. These episodes are differentiated from collapse caused by BOAS-induced hypoxia by taking a detailed history from the owner.

**Gastrointestinal disease**

Research has suggested the majority (97 per cent) of brachycephalic dogs suffering clinically significant upper airway obstruction (BOAS) are suffering from oesophageal, gastric or duodenal

inflammatory lesions (Poncet et al, 2005).

The same study demonstrated a significant correlation between the severity of the respiratory and gastrointestinal signs in French bulldogs and this trend is likely to be reflected in other breeds affected by BOAS.

Poncet et al (2005) identified evidence of chronic gastritis in brachycephalic dogs presented for investigation of upper airway disease when the owners had not observed signs attributed to gastrointestinal disease. The treatment of gastrointestinal disease in association with surgery for BOAS was reported to improve the prognosis associated with the airway surgery.

Clinical experience would agree that dogs presented with debilitating respiratory signs are also at high risk of suffering from significant gastrointestinal signs. Diagnosis usually requires detailed discussion with the owners, a significant number of which will not necessarily have perceived a problem until questioned. Due to the potential for relatively subtle signs, medical treatment of gastrointestinal disease associated with brachycephalic upper airway disease benefits many dogs, regardless of whether the owner has reported the more obvious signs of reflux or regurgitation.

Further support for the intimate relationship between the airway and gastrointestinal signs is provided by the observation that airway surgery in brachycephalic dogs can result in a durable improvement in severity of reflux or regurgitation and often allows cessation of medical management of gastro-oesophageal disease in the weeks following surgery (Poncet et al, 2005). Animals suffering from hiatal hernia with signs that do not resolve sufficiently with medical management should be considered for corrective surgery to treat the herniation.

### Aspiration pneumonia

The relatively high incidence of reflux/regurgitation in these breeds, accompanied by respiratory compromise, places them at significant risk of developing aspiration pneumonia. Clinically significant aspiration pneumonia does not always cause clear respiratory signs and can be difficult to diagnose using auscultation alone. Thoracic radiography is usually included in the preoperative investigation of these cases and is indicated when a brachycephalic breed presents with signs of systemic illness or respiratory compromise.

## Diagnosis

The initial and basic diagnosis is often straightforward in affected breeds, but the extent of the primary and secondary factors and resultant severity of signs can vary widely between individuals.

As we have discussed, owners run the risk of being inappropriately tolerant of respiratory stertor, stridor and exercise intolerance, and there is a danger of a breakdown in the relationship with their vet if the vet appears too “pushy” in advising investigation or treatment. The dilemma of the

primary care clinician is compounded by the fact those suffering from clinically significant increased airway resistance experience a clear benefit following treatment that is provided before laryngeal collapse progresses to grade two or three.

The clinical history is potentially very useful to determine whether a brachycephalic breed dog warrants further investigation and treatment. Reports of excessive respiratory stertor, exercise intolerance, collapse, cyanosis, regurgitation and nocturnal restlessness would be considered consistent with, but not necessarily diagnostic for, clinically relevant BOAS. Careful questioning regarding restlessness at night, non-productive retching and lip smacking, regurgitation and excessive mucous or salivation can be indicators of gastro-oesophageal disease.

Examination of the external nares is usually possible in the conscious animal and involves assessment of both the size of the opening and the potential for collapse of the alar cartilage into the opening during inspiration (Figure 1). Detailed and meaningful examination of the palate, tonsils, aryepiglottic folds and larynx require general anaesthesia or deep sedation (Figures 2 and 3).

The significant risk associated with anaesthesia of brachycephalic breeds cannot be underestimated. The increased incidence of respiratory arrest and of reflux/ regurgitation with secondary aspiration, when compared to mesocephalic breeds, requires these cases be managed with full understanding of the pathophysiology. The risks associated with anaesthesia or sedation can be minimised by appropriate surgical treatment of the airway under the same anaesthetic used to confirm the diagnosis.

Diagnosis of oesophagitis can be confirmed using endoscopy, although this is often not necessary. The dynamic nature of hiatal hernias results in low sensitivity for conventional radiography and while conscious fluoroscopy is usually considered the most sensitive diagnostic modality, false negatives can still occur.

## Treatment protocol

### Stenotic nares

Successful widening of the nares requires a three-dimensional procedure that also excises a significant proportion of the alar fold that occupies the nare (Figure 4). Both vertical and horizontal wedge procedures have been described, along with variations such as use of a Keyes biopsy punch (Trostel and Frankel, 2010) to try to maximise the beneficial effect. A technique that aims to abduct the alar cartilage without resection of the alar fold has been described (alapexy; Ellison, 2004), but is less popular due to concerns over the long-term benefit afforded by the technique.

In the majority of dogs, treatment of stenotic nares is combined with surgical treatment of accompanying primary and secondary factors. A small minority of canine BOAS cases occur where the nares are the only significant abnormality present.

## Overlong soft palate

Most dogs that require surgery to treat BOAS undergo palate resection and there are a number of techniques described that include a more conventional full thickness resection (staphylectomy) and the more recently reported palatoplasty (Findji and Dupré, 2008).

Care must be taken not to overshorten the palate due to the risk of oronasal reflux and the extreme difficulty associated with palate reconstruction. As in all airway surgery, tissue handling and accuracy of suture placement are extremely important in achieving a successful outcome.

## Everted tonsils

There is some variability among surgeons regarding the indications for tonsillectomy in these cases and it is difficult to document the impact that everted and hypertrophied/ enlarged tonsils have on the airway. It is likely the effect of the tonsils on air flow has the potential to vary depending on the degree of turbulence and negative pressure present in the airway at that particular time, with the result that examination under controlled conditions in a calm anaesthetised animal may not be representative. Tonsillectomy is often performed to try to maximise the potential benefit of surgery in dogs that have large or prominent, everted tonsils. More work is necessary to provide more definitive information regarding the effect of this procedure on airflow.

There are a number of techniques described to perform tonsillectomy, ranging from use of a conventional scalpel with sutures to electrosurgery. Regardless of the technique selected by the surgeon, control of haemorrhage from the tonsillar vessels, along with removal of both lobes of each tonsil, represent key steps in achieving a successful outcome.

Tonsillectomy does carry a risk of postoperative haemorrhage that can cause vomiting if significant quantities of blood are swallowed or result in haematoma formation that can contribute to airway obstruction necessitating tracheostomy tube placement. Both occurrences can be prevented in the majority of cases by employment of good surgical technique.

## Laryngeal saccules

Everted laryngeal saccules are conceptually straightforward to remove, but access can be difficult, particularly in smaller breeds. Care must be taken to remove the entire saccule to minimise the risk of continued obstruction or “webbing” of scar tissue across the rima glottidis during the healing process. Work has suggested approximately 80 per cent to 90 per cent of cases undergoing resection have improvement to air flow and confirmed the supposition that everted saccules do not resolve following reduction in turbulence afforded by other procedures (Cantatore et al, 2012).

## Grades two and three laryngeal collapse

Most dogs suffering from more advanced laryngeal collapse have the potential to benefit from the techniques described above, at least for a period of time (Torrez and Hunt, 2006). Cases where signs are not alleviated sufficiently by “conventional” BOAS surgery are usually suffering from grade III laryngeal collapse, for which one option for treatment is a permanent tracheostomy to bypass the larynx entirely. The lifestyle changes required by this procedure, its challenging nature in some of the neck conformations present in these breeds and the likelihood of revision procedures being required as the stoma heals all contribute to the low popularity of this surgery among surgeons and owners alike.

There is some evidence to suggest significant improvement in airflow can be achieved using an arytenoid lateralisation procedure for cases suffering from grade three collapse (White, 2012). This procedure is significantly more technically demanding than similar surgery used to treat larger dogs suffering from laryngeal paralysis. Complications following arytenoid lateralisation occur at an acceptably low level, but can be devastating to the individual and necessitate urgent permanent tracheostomy in some cases (White, 2012).

### Gastrooesophageal reflux

Medical treatment of gastro- oesophageal reflux prior to surgery is often appropriate based on clinical signs described by the owner or observed by the clinician. In addition to this, surgery on the palate, tonsils and larynx is likely to increase the risk of reflux in cases that were not considered symptomatic prior to surgery.

### Hiatal hernia

In most cases, medical management of the hiatal hernia is effective, at least in the short term, and clinical signs have the potential to improve further following improvement in the upper airway air flow. Surgical treatment to address hiatal herniation is usually scheduled several weeks after treatment of the upper airway to minimise the cumulative impact of surgery. Unsuccessful medical management may necessitate hiatal surgery earlier than planned due to the ongoing risk of aspiration pneumonia.

## Prognosis

Approximately 47 per cent to 60 per cent of cases undergoing conventional surgical procedures for management of clinically significant BOAS are reported to be significantly improved, with a further 30 per cent to 47 per cent showing some improvement and approximately six per cent to 10 per cent failing to improve at all. Perioperative mortality rate has been reported as approximately zero per cent to three per cent (Torrez and Hunt, 2006; Rieckset al, 2007). Cases assessed as suffering from grade three laryngeal collapse are reported to be significantly improved in approximately 85 per cent of cases following conventional surgery (Torrez and Hunt, 2006).

Consideration of the gastrointestinal system has the potential to maximise success from BOAS procedures as reported by Poncet et al (2005).

## Complications

Complications of airway surgery are often life-threatening and require urgent recognition and treatment:

• haemorrhage;

• mucosal swelling/oedema;

• dyspnoea (20 per cent leading to tracheostomy seven per cent; Torrez and Hunt, 2006);

• regurgitation;

• aspiration;

• persistence of clinical signs;

• cardiorespiratory arrest; and l death (three per cent;

Riecks et al, 2007).

The acute and potentially life-threatening nature of the complications that can be associated with the diagnosis and treatment of these cases indicates that clinicians be well situated to diagnose and treat the complications when they occur.

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**Figure 1.** Stenotic nares, which are reported to occur in about half of canine BOAS cases.

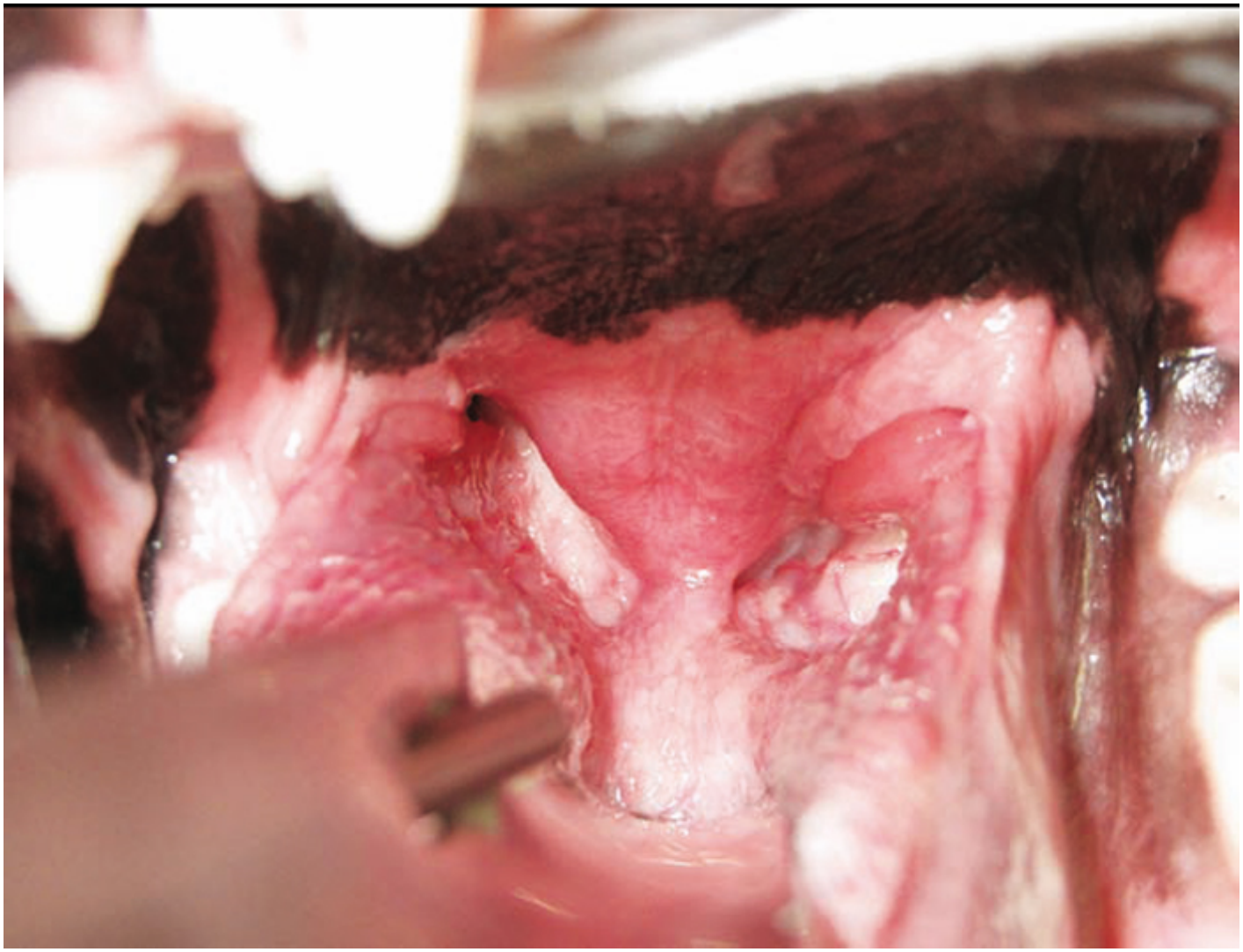

**Figure 2.** Overlong soft palate – accepted as one of the most common primary factors.

**Figure 3.** Grade one laryngeal collapse with evidence of early protrusion of the laryngeal saccules just cranial to the vocal folds into the ventral rima glottidis.

**Figure 4.** Vertical wedge rhinoplasty – the photograph was taken following completion of the procedure on the dog's left side, just before right side surgery.

| Grade of the collapse | Description |
|---|---|
| Grade one | Everted laryngeal saccules |
| Grade two | Grade I changes and medial collapse of the cuneiform processes |
| Grade three | Grade II changes and medial collapse of the corniculate process |

**Table 1.** Grades of laryngeal collapse as described by Leonard (1960)