Veterinary Instrumentation

Surgery Guide

Brachycephalic Obstructive Airway Syndrome (BOAS)

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There are many definitions of brachycephaly. The most common definition is shortened skull length to width (width >80% of length) which results in both nasal cavity and pharyngeal compression. According to this skull index definition, there are numerous brachycephalic breeds, including the Pug, French Bulldog, Bulldog, Boston Terrier, Cavalier King Charles Spaniel, Pekingese, Japanese Chin, Dogue de Bordeaux, Shih-tzu, Boxer, Pomeranian, Griffon, and Lhaso Apso.

Unfortunately, breeding for a particular phenotype (the wide head and flat muzzle) has resulted in accompanying diseases in many dogs which are thus essentially man-made.

These diseases include upper airway obstruction, excessive skin folds resulting in skin fold pyoderma, shallow orbits with protruding globes that have increased risk of corneal ulceration and globe prolapse, dental overcrowding and malocclusion, and hemi vertebrae which may be accompanied by spinal cord compression.

BOAS is defined as upper airway obstruction related to the restricted length of the skull, particularly the nasal cavity. The tissue proportions in the upper airway seem breed specific, which makes sense when one considers the very different types of skull morphology seen in breeds which are labelled as brachycephalic.

Contents

The prevalence of BOAS within the extreme breeds is not yet clear. In the last ten years studies have been ongoing on the extreme brachycephalic breeds with objective respiratory function testing. Although there is a perception from some veterinary professionals that all brachycephalic dogs are affected to some extent, these studies have identified dogs from the extreme brachycephalic breeds that have no upper airway noise and normal exercise tolerance. In the Cambridge study population (excluding clinical cases) approximately 40% of Bulldogs, 46% of French Bulldogs and 60% of Pugs have been classified with clinically significant disease (Liu et al 2017).

Risk factors for BOAS

BOAS is a progressive disease and dogs usually present with BOAS between 1 and 4 years of age, although severe cases may be noted when only a few months of age. If a puppy does develop signs of upper airway obstruction, it will usually get worse with age.

Risk factors.

There are some risk factors that mean a dog is more likely to develop BOAS over its life span. The main risk factors for developing BOAS are having closed nostrils and being overweight. There are some external conformational factors (shape of the head) that have a smaller effect on the risk of developing BOAS; in the pug, these are having a wider head and wider set eyes. In the bulldog it is having a wide head and a thick neck, whilst in the French bulldog it is short neck length and shorter muzzle.

Difficulties in disease recognition

A major problem with BOAS is that it is often under-recognised by both the public and veterinary professionals. A questionnaire-based study on disease recognition revealed that 60% of owners did not perceive their dogs to have airway obstruction, when clinical examination and history were compatible with the disease. (Packer et al, 2012). Even for veterinary professionals, it can be difficult to decide which dogs require surgical intervention.

Difficulties in disease recognition:stertor vs. stridor.

Auscultate the dog, listening over the thorax and also directly over the pharynx/larynx with the head in a neutral position. Listen for stertor which indicates nasopharyngeal obstruction, often palatal in origin or stridor, which indicates laryngeal involvement.

Stertor

Lower pitched – usually nasopharyngeal obstruction

Click here for an example

Stridor

Higher pitched – usually laryngeal obstruction

Click here for an example

Be aware it can be more complex: many French bulldogs will have nasal stertor; pugs may have nasal stridor and bulldogs present with both nasal and pharyngeal stertor. Stridor and stertor may present on both inspiration and expiration. Some dogs have no nasal noise due to the fact they have minimal nasal airflow, but the lack of nasal stertor does not mean these dogs have a better airway compared to others.

Observe for other signs of obstructed nasal airflow; for example, flaring of the skin just behind the nasal planum, lack of nasal wing mobility or excessive panting.

Click here for an example.

Difficulties in disease recognition: exercise testing

The clinical picture is further obscured by some dogs, particularly pugs, that appear to have reasonable respiratory function until stressed or exercised when they then show marked dyspnoea. Although this is often attributed to excitement, it would be unusual to see a healthy Collie or Labrador show signs of respiratory obstruction after a short trot. This inability to clearly define BOAS, along with clinical signs that are often described as 'normal' for the breed, makes determining the prevalence of BOAS within breeds very difficult. Often, anatomical lesions are used as a definition of disease; however, not all dogs with stenotic nares will show signs of BOAS, as Shar Pei owners will be quick to point out.

In research conducted at Cambridge University, a functional respiratory grading system for BOAS was designed that includes an exercise test. Dogs are exercised at a moderate trot (4mph) for 3 minutes. Refusals, airway noise and effort, (both pre- and post- exercise), and recovery time are all noted. The exercise test is designed to stress the upper airway, not assess cardiopulmonary fitness, which depends markedly on exercise regime, age, and body condition score. Airway noise is graded as:

- Not present.
- Mild (only audible with a stethoscope).
- Moderate (intermittent and heard without a stethoscope).
- Severe (constant and easily audible without a stethoscope).

Whilst this system is not perfect, as exercise tolerance may be affected by ambient temperature and sometimes the animal's fitness levels, it does expose those animals that are 'teetering on the edge' of obstruction when calm, and firmly tipped into 'affected' once stressed. Exercise tests also reveal clinical signs in those dogs that only have respiratory noise when mouth breathing (often the long but not particularly thickened soft palates) after switching from nasal breathing in the consult room.

Click here for an example of pre- and post-exercise testing.

The Cambridge research finds that about 40% of dogs presenting with few clinical signs in the consult room, will be classified as 'affected' after the exercise tolerance test. The dogs with grade 0 (no evidence of BOAS) or grade 1 (mild BOAS – noise only evident with a stethoscope) rarely have clinical signs associated with BOAS and are generally considered non-surgical. This RFG Scheme can be used to assess whether dogs require treatment, if they will respond to the surgical techniques available in your clinic, and to audit the surgical results. It also allows clinicians to prioritise (or refer) the severely affected dogs and order the surgical list appropriately.

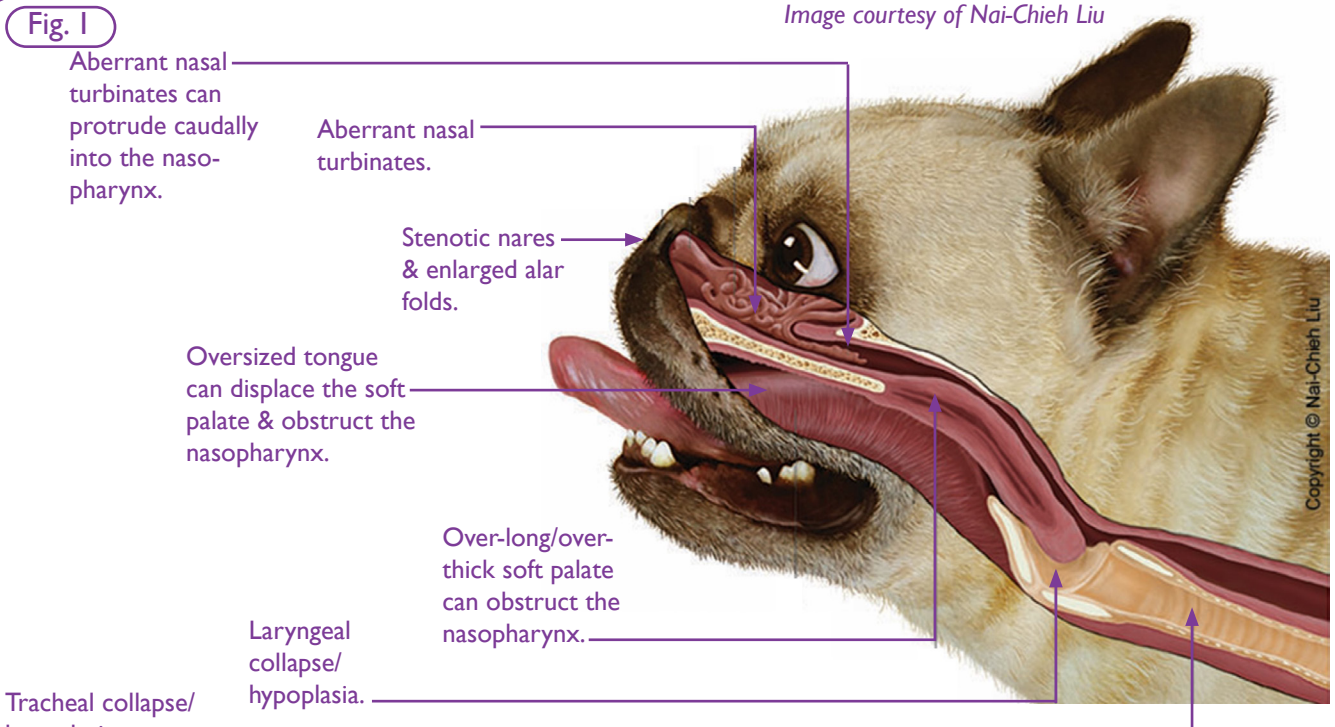
Lesion sites & clinical signs

In BOAS, there are primary congenital abnormalities that result in restriction to airflow, tissue swelling/hypertrophy, and excessive inspiratory pressures in the upper airway. This in turn leads to secondary changes. (Fig. 1).

The nasal turbinates in brachycephalic dogs are compacted inside the extremely short muzzle; this can reduce nasal airflow and can compromise thermoregulation. Narrowing of the upper airways causes dynamic collapse during inspiration as significant negative airway pressures are created in an attempt to overcome the increased resistance to flow. The increased negative pressure results in mucosal inflammation and laryngeal distortion. Palatine muscles hypertrophy in an attempt to maintain airway patency. The hyperplastic soft palate can trap the epiglottis of the larynx making it difficult to switch from nasal breathing to open mouth breathing. In addition, if the dog struggles to breathe, the soft palate and surrounding tissues can become quite swollen and oedematous, further impeding the flow air.

Fig. 1

Image courtesy of Nai-Chieh Liu



Primary Factors (hereditary/congenital)
- Stenotic nares (60%)
- Elongated Palate (90%)
- Compressed turbinates (> 20%)
- Macroglossia
- Tracheal hypoplasia

Secondary Factors (acquired)
- Thickened palate?
- Laryngeal Collapse (8-53%)
- Tonsillar hypertrophy
- Hiatal hernia
- Oesophagitis
- Pulmonary hypertension

BOAS: Clinical Signs

- Noisy breathing:
  Stertor - pharyngeal noise, snoring, snorting
  Stridor - laryngeal noise, mostly inspiratory, higher pitched
- Exercise and heat intolerance.
- Sleep apnoea/ disorders.
- Hyperthermia.
- Cyanosis and collapse.
- Regurgitation and vomiting*.
- Flatulence.

*Results from oesophagitis caused by increased gastro-oesophageal reflux.There is also an increased incidence of hiatal hernia in these dogs. Excessive ingestion of air during dyspnoeic episodes can result in gastric tympany and distention and increased gastrin secretion.

Clinical signs are exacerbated by heat and exercise.

Diagnosis

- Clinical signs at rest and during exercise (functional grading)
- Oral examination under sedation/ GA: a light plane of anaesthesia should initially be used at induction to assess laryngeal collapse prior to induction. Once laryngeal function has been assessed, induction can proceed with intubation.
- Assess the length and thickness of the palate, position in respect to the epiglottis, thickness of tongue base, hypertrophy of the tonsils and presence of pharyngeal wall thickness or collapse.
- Head/ thoracic radiographs or CT. Thoracic imaging should be done to assess any aspiration pneumonia (in which case the surgery should be postponed unless an emergency), bronchial collapse, hiatal hernia and concomitant disease.
- Examination of the nose and nasopharynx with an endoscope. This is the most sensitive method of assessing aberrant turbinates and mucosal contact points which indicate lack of nasal airspace.

BOAS: Diagnosis

- History.
- Clinical signs (functional grading).
- Oral examination under sedation/ GA.
- Head/thoracic CT or radiographs.
- Endoscopic exam (nose and nasopharynx).

Weight

A number of studies (Liu et al, 2016, Liu et al, 2017, Packer et al, 2015) have shown a correlation between BOAS status and weight, particularly in pugs. Excessive fat around the neck, pharynx and thoracic wall increases respiratory obstruction and decreases tidal volume. Reducing an obese dog's weight is very likely to improve respiratory function, though this has not yet been proven in clinical BOAS cases.

Gastrointestinal symptoms

One study (Poncet 2005) reported 98% cases (out of 73 dogs) had chronic gastritis, 90% had lymphoplasmocytic duodenitis, and there was a positive statistical correlation between severity of respiratory and GI signs. In 80% of these cases GI signs resolved after BOAS surgery, with and without GI medication, although immediate post-op vomiting and regurgitation were reduced if the dogs were given 0.7mg/kg omeprazole, 0.2mg/kg cisapride and 1g sucralfate. The authors also believed that concurrent medical management of GI tract pathology may have helped reduce the progression of the respiratory disease (laryngeal collapse).

The author routinely gives patients omeprazole the night before surgery. If the dog is a frequent regurgitator, it is sensible to administer antacids to be given 3-5 days prior to the anaesthetic, in the knowledge that oral omeprazole (the first choice) can cause gastrointestinal side effects in up to 25% of dogs.

Preparation for surgery

BOAS: Treatment

- Diet if overweight.
- Treat intestinal signs (omeprazole, sulcralfate).
- Soft palate shortening and thinning.
- Opening of nostrils.
- Resection of laryngeal saccules.
- Resection of aryepiglottic fold.
- +/- turbinate resection.

The author advises surgery for grade 3 dogs and many grade 2 dogs, particularly the younger dogs. The older grade 2 dogs may be monitored and, particularly pugs, dieted prior to surgery.

The author treats the dogs depending on their obstructive lesions sites, confirmed via imaging and visual assessment. The minimum treatment is usually nostrils and palate though dogs are occasionally seen with only stenotic nostrils. Grade 3 dogs can be challenging surgically, and a pre-emptive tracheostomy tube is sometimes placed.

As length of anaesthesia is related to post-operative complications (with every 15 minutes of surgery increasing complications by 11%, Gruenheid et al 2018), it is preferable to operate on the airway as the sole procedure, if the owner has the resource, prior to any other elective surgeries that may be required. Future surgeries are also less likely to have complications. (Doyle et al 2020).

Anaesthesia

To safely anaesthetise extreme brachycephalic dogs requires some forward planning. Ideally assess the dogs prior to their procedure, specifically noting any airway disease and/ or regurgitation. If the dog is anxious or of a stressful temperament, then the author usually dispenses trazadone (5-10 mg/kg) and/or gabapentin (10-20 mg/kg) to be given 2 hours prior to admission and for these dogs it is advisable to admit the morning of the procedure rather than hospitalising overnight.

Fasting

The latest anaesthetic papers (Savvas et al, 2022) suggest there is no benefit to prolonged fasting of brachycephalic dogs prior to general anaesthesia and this may increase regurgitation during anaesthesia. The author fasts patients from midnight.

Premedication

The author recommends a light premedication such as methadone (0.2mg/kg) IM followed by low dose medetomidine (0.001mg/kg) slow IV (0.002mg/kg IM fractious dog). In fractious dogs the author adds 1mg/kg alfaxalone IM.

Butorphanol/methadone or acepromazine (anti-arrhythmic)/methadone are also acceptable. ACP needs 10-15 minutes in a very calm environment to be effective.

Intravenous catheter placement is achieved, and the dog is pre-oxygenated prior to induction.

Required equipment for safe induction/intubation

- Laryngoscope with a good light and suitable length blades
- Variety of ET tubes - silicone with high volume/ low pressure cuffs.
- Suction
- Q tips
- Swabs
- Cuff inflator - manometer or syringe
- Monitor - pulse oximeter, capnography and ECG
- Tracheostomy tubes
- Emergency crash kit

Induction

Pre-oxygenate for 5-10 minutes; if the dog has airway disease it is likely to decompensate when induced – it makes sense to preload with oxygen. The author tends to use IV propofol, given relatively slowly at 2-4mg/kg. Alfaxalone is also a suitable induction agent.

It is sensible to have a range of ET sizes available and, if any signs of laryngeal collapse are evident then smaller tubes such as urinary catheters or a stylet can be useful. Induction should be intravenous and to effect, the author likes to keep the dogs under a light plane of anaesthesia and assess the laryngeal movement prior to intubation. A low-pressure high volume cuffed ET tube is used to protect the airway during surgery. Use large cotton buds to remove any obstructing saliva/ foam and have suction ready in case of regurgitation (unusual).

Secure the ET tube and place the patient on oxygen at a suitable flow rate, gently inflate the ET cuff, checking for leaks or using a manometer.

Start inhalation agent. Isoflurane is usual although sevoflurane may also be used.

Check capnography and ensure patient is breathing satisfactorily. Check ECG/ pulse oximetry. Keep a check on temperature and ensure the patient does not become hyperthermic.

The author gives omeprazole (if not given previously) and metoclopramide is also given to any dogs with airway disease or with regurgitation. Also consider maropitant for BOAS cases.

Maintenance

If the anaesthetic is not stable, consider ventilation. Also consider ventilation if the ETCO2 >65, there is excessive panting or frequent arousals. Use frequent eye lubrication as brachycephalics are prone to corneal dryness; this should be continued for 24 hours post-surgery. If regurgitation occurs, perform gentle suction of the oesophagus, lavage with water and suction again.

For BOAS surgeries

The author gives intravenous dexamethasone at induction to try and avoid airway swelling. Local nerve blocks (maxillary) are effective at reducing arousal during nasoplasty. The author uses bupivacaine (up to 1ml, and not more than 2mg/kg split between each side).

Be aware of the vasovagal or trigeminal cardiac syndrome when working in the nose/ on the eyes/ changing position. Have atropine or glycopyrrolate to hand.

Tracheostomy tubes

Select a nonreactive tube that is no larger than one half the diameter of the trachea. Non-cuffed or cannulated autoclavable silicone, silver or nylon tubes are recommended. (Fig. 2). Polyvinyl chloride and red rubber tubes are irritating and should be avoided. Remove the tracheostomy tube when upper airway obstruction has resolved, or when the patient can manage with occlusion/removal of tube. Leave the site to heal by secondary intention.

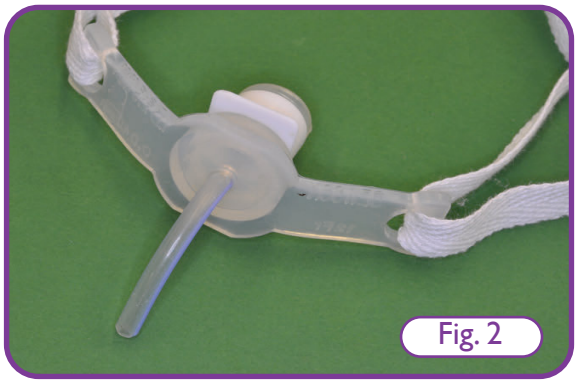


Fig. 2

Tracheostomy technique

See Figs. 3a-d overleaf.

- Ventral midline incision over trachea from caudal larynx to 7th or 8th tracheal ring. Continue through subcutaneous tissues including platysma and sphincter coli muscles.
- Separate the two sternohyoid muscles along the midline to expose ventral trachea.
- Make circumferential tracheal incision between cartilage rings 3 and 4 or 5 and 6. Incision should be around 50% of the tracheal circumference, taking care to avoid recurrent laryngeal nerves dorsolaterally.
- Place 2 or 3 metric monofilament, non-absorbable (Prolene) stay sutures around the cartilage ring above and below the tracheal incision (they may be placed around the tracheal rings before the incision is made). These will remain in place for the duration of trach tube management and are used to open the stoma during tube replacement. They should be left ~15cm long and tied at the end. Tape label can be added to the end of each stay suture.
- Withdraw the ET tube so the tip is just cranial to the tracheostomy incision and insert the trach tube through the tracheal stoma and into the trachea below the ET tube. Switch anaesthetic circuit to the trach tube and remove ET tube from mouth. Use nylon tape to tie the tube in place.
- For bulldogs with a thick neck consider suturing the sternohyoid muscles dorsal to the trachea to push it to the skin surface and make changing tubes easier.


Fig. 3a


Fig. 3b

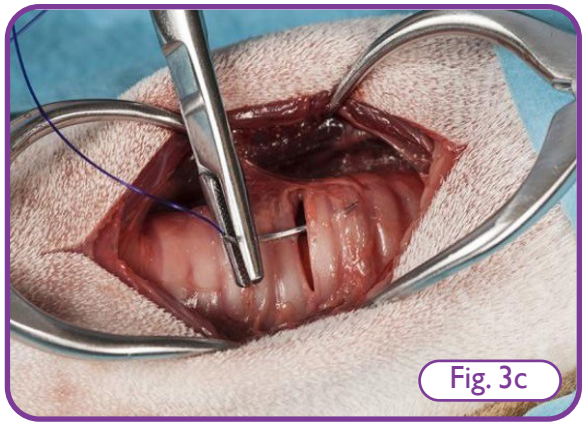


Fig. 3c


Fig. 3d

Care of tracheostomy tubes

- Intensive care - need continuous monitoring.
- Use a nebuliser every 2-4 hours (preferentially).
- Alternatively place 1-3 ml of sterile saline down the tube to break up viscous discharge every 2-4 hours.
- Clean site every 2-12 hours.
- If copious tracheal discharge is present, suction the tube. Pre-oxygenate prior to suctioning and stop if hypoxia or arrhythmias occur.
- Remove and clean every 8-12 hours depending on discharge being produced.

Within 24 hours the tube will be colonized with oropharyngeal flora.

Emergency tracheotomy

Have a tracheotomy kit made up, preferably on the crash trolley.

Use a needle to locate the trachea if tissue is swollen and distorted. Cut down onto the needle. Needle tracheotomy sets are available. Airway access can also be gained through the cricothyroid ligament (Fig.4) at the larynx and this may be easier when the neck is thick or swollen.

Transection of the tracheal rings can result in more stenosis. The presence of the tracheostomy tube results in loss of cilia, inflammation and mucosal erosion. It also results in decreased arytenoid abduction.

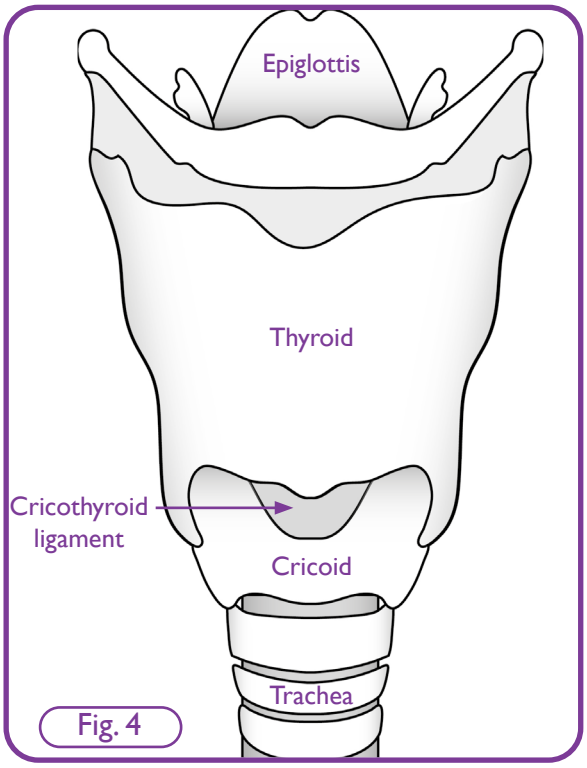


Fig. 4

Recommended surgical equipment

The Vi Premium BOAS Surgical Kit (product code BOASPREMKIT) (Fig. 5) contains the following instruments:

- Long curved Metzenbaum scissors
- Long ligature scissors
- Long DeBakey forceps
- Long needle holders with fine tip
- Fine tubular grasping forceps
- Curved micro scissors (L and R)
- Micro curved mosquito forceps
- Standard mosquito forceps
- Premium instrument box, perforated tray & silicone insert

Use of the Vi BOAS Mouth Gag (product code BOASMG - Fig. 6.) is also highly recommended.

Additional recommended equipment:

- Electrosurgery – bipolar/ monopolar (or Harmonic)
- Large cotton buds (sterilised)
- Swabs
- Tracheostomy tube – Shiley/non-cuffed 5/6

Fig. 5

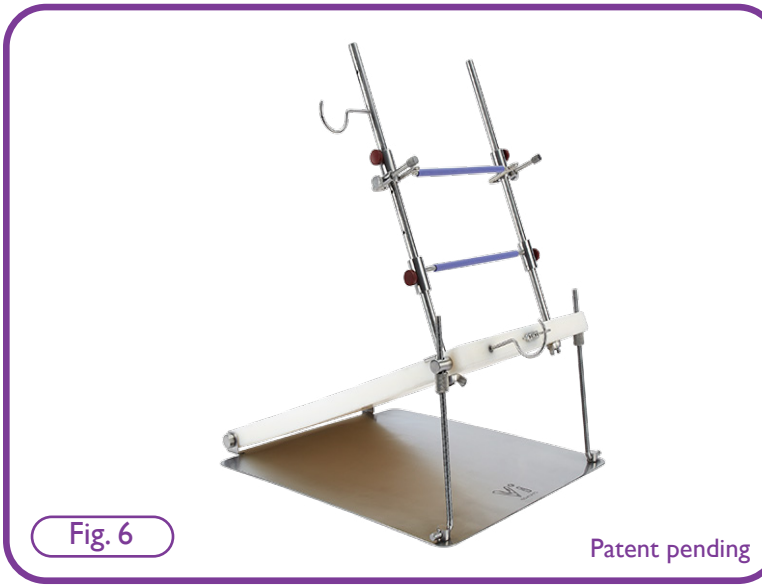


Fig. 6

Patent pending

Surgical conditions & techniques

0.2ml of xylometazoline (otrivine) is given down each nostril when scoping dogs, to reduce nasal mucosa. This is also advised during conventional surgery in dogs that have nasopharyngeal signs, to improve nasal airflow.

The author usually positions the patient in sternal recumbency with the head up. A purpose-designed stand with a tilting base and adjustable mouth bars will make positioning much easier. (For example, the Vi BOAS Mouth Gag, Figs. 7a & b - photos taken during testing of prototypes).

The tonsillectomy/ partial tonsillectomy is performed first as this then allows the palate to be sutured laterally to the tonsillar crypt. The palatoplasty is then performed, followed by ventriculectomy and other laryngeal surgery as necessary. The head is then released to perform the nostril surgery.

At the end of surgery, the nasopharynx should be carefully checked for any blood clots that could occlude the airway at extubation.


Fig. 7a

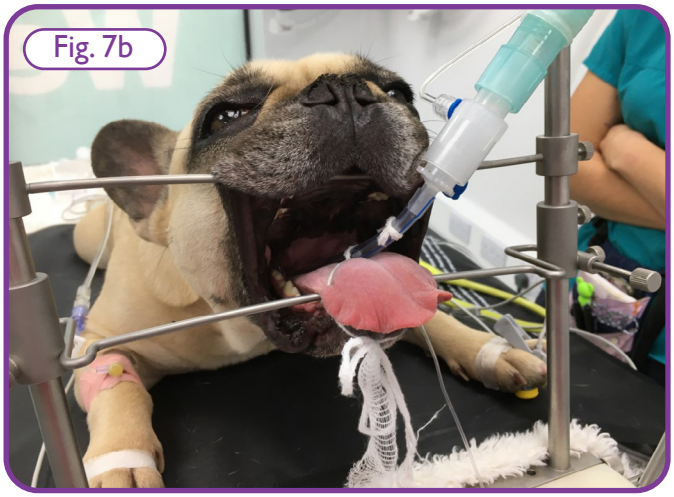


Fig. 7b

Tonsillar hypertrophy and tonsillectomy

One study reported inflammation of the tonsils (amygdalitis, Fig. 8) was diagnosed in 15/73 dogs (Poncet et al 2005). Resection was not routinely done because reports indicated that excision was unnecessary for a good improvement and may increase local inflammation post-operatively.

However, partial tonsillectomy may decrease pharyngeal pressure and was included in the surgical procedure published by the author, that showed an improvement in prognosis compared to the traditional technique with no tonsillectomy.
Remove hypertrophied part of tonsil that is everted out of the crypt. This can be a partial tonsillectomy (done with bipolar or monopolar) rather than full tonsillectomy or, if no electrosurgery is available a full tonsillectomy with a ligature can be done. The tonsillar artery comes in medially and dorsally.


Fig. 8

Soft Palate Resection/Palatoplasty

There are a variety of palatoplasties being performed, with recent developments in surgical technique to thin the palate if thickened, in addition to shortening it. The original folding flap palatoplasty (Findji and Dupre 2008) had the rostral cut 1-2 cm caudal to the palatine process. The author uses Prof. Oechetering's modified folding flap with seemingly good results, which has the rostral incision a little further caudal.

Although the surgical techniques are relatively well described, including short term complications, there is little in the literature on the effectiveness of the different palatoplasties in the longer term, presumably due to the difficulty of reliably measuring a single component of airway surgery. Complications related to cutting too short are often mentioned in the literature but not accurately reported. (The author has had two dogs (pugs) that occasionally gagged after drinking, but interestingly had no problems eating).

When shortening the soft palate, the aim is for palate to be at rostral/mid edge of tonsils, just contacting the epiglottis when the mouth is closed (extended staphylectomy).

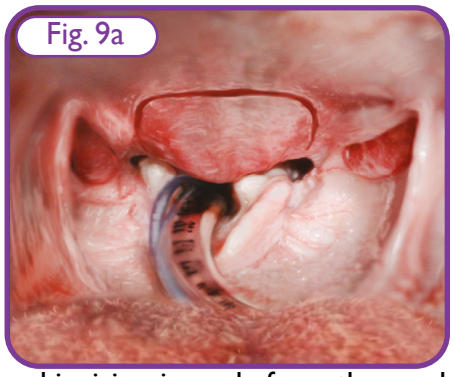
Soft palate clamps are available, but the author has not used these recently as she finds them unnecessary, and finds careful apposition of the oral and nasal mucosa a little more tricky. Carbon dioxide laser resection techniques have been reported; the results are very similar to incisional techniques.

Palatoplasty

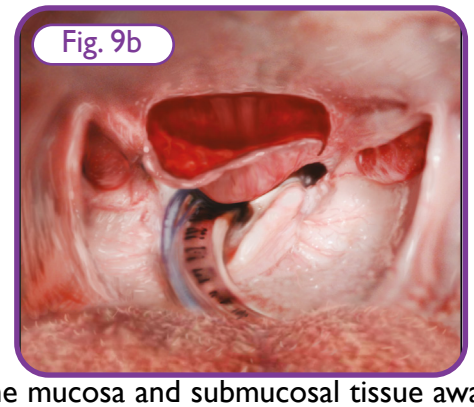
This can be a cut and sew staphylectomy. Start at the mid tonsillar crypt and curve the palate incision forward to the rostral tonsillar crypt. Suture with a 1.5M vicryl (or other 4/0 suture). Sutures can be simple interrupted or continuous suture. Cut half the palate and then suture before cutting the second half. Ensure that the nasal mucosa is sutured to the oral mucosa.

Modified Folding Flap Palatoplasty

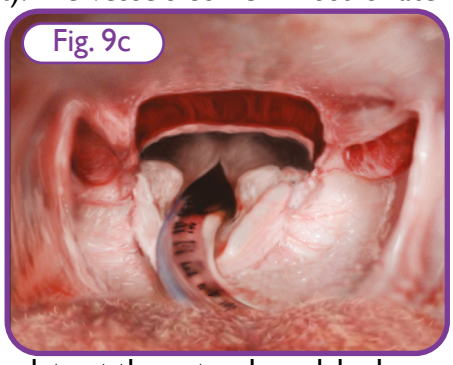
For the bulldogs, French bulldogs and many pugs with thicker soft palates, the author uses the modified folding flap palatoplasty (Fig. 9a-d); this needs electrosurgery, either bipolar, monopolar or a Harmonic (or similar) scalpel.



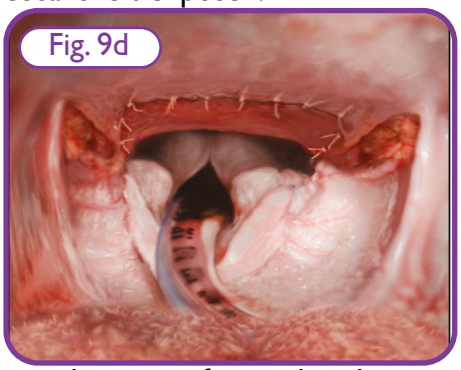
A U-shaped incision is made from the caudal aspect of palate to the level of the rostral tonsillar crypt through the oral mucosa.



Strip the mucosa and submucosal tissue away from the nasal mucosa- work initially laterally and then towards the median raphe (where the tissue is more adherent). The vessels come in rostro-laterally.



Cut the palate at the natural caudal edge so that the nasal mucosa is left exposed.



Fold the nasal mucosa forward and suture to the oral mucosa rostrally, using vertical mattress sutures (4/0 vicryl). The lateral sutures should incorporate the caudal tonsillar crypt and the palate.

Images above courtesy of Nai-Chieh Liu

Laryngeal Collapse

Increased airway resistance, increased negative intraglottic luminal pressure and increased air velocity cause displacement of the rostral laryngeal structures medially with loss of the supporting function of the laryngeal cartilage. Laryngeal collapse is further divided into three stages, as illustrated below. (Fig. 10).

a. Normal larynx.
b. Everted laryngeal ventricles (seen in 50% of cases).
c. Deviation of the cuneiform cartilage medially.
d. Medial collapse of the cuneiform and corniculate cartilage of the arytenoid obstructing the airway.

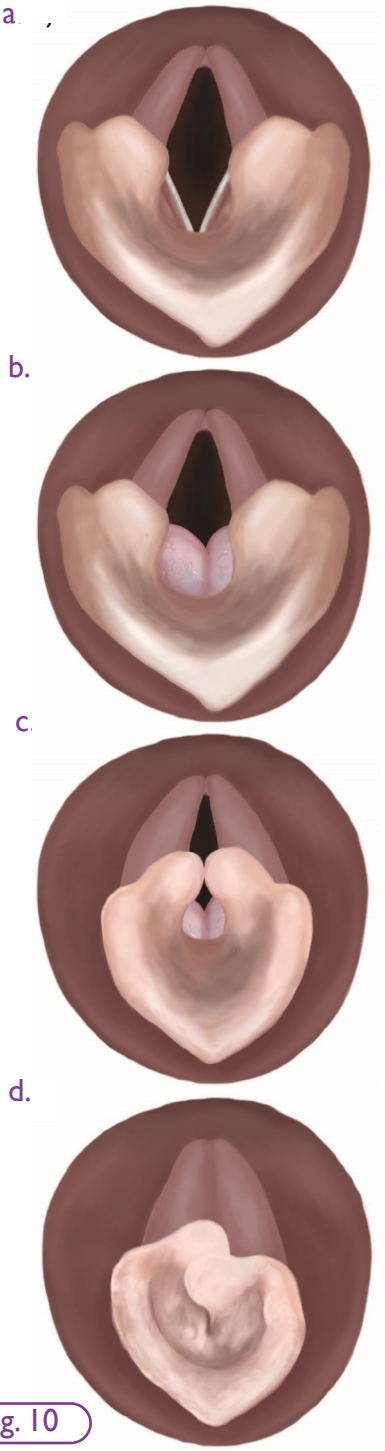


Fig. 10

Images courtesy of Nai-Chieh Liu

Everted Laryngeal Ventricles

Laryngeal ventricles (the blind ended dilation of which are known as saccules) sit in the larynx, between the vestibular and vocal folds. The ventricle lies medial to the thyroid cartilage and lateral to the vocal and vestibular folds.

This is the first stage of laryngeal collapse as the ventricles are the place of least resistance in the wall of the larynx and therefore evert under the action of negative pressure. Originally it was thought they were initially oedematous but eventually fibrose and create an obstruction to the rima glottidis ventrally. However Cantatore 2012 found no fibrotic ventricles and instead oedema and a chronic lymphoplasmacytic inflammation. The histological features were unchanged if the ventricles were resected months apart, suggesting the process is non-reversible: it is thought once a ventricle is everted and swollen, the compression at its base might interfere with lymphatic return, preventing spontaneous resolution.

Excision of ventricles has always been considered standard treatment; however, the role of ventriculectomy has recently been questioned (Ducarouge 2002, Poncet 2006, Hughes 2018). The Hughes paper had a mild increase in post-operative regurgitation risk in dogs that had undergone ventriculectomy versus not but it did not look at outcomes. Cantatore 2012 concluded that no advantage was gained by leaving the ventricles intact, that spontaneous resolution was unlikely and excision does result in an immediate enlargement of the ventral aspect of the rima glottides and this may significantly improve respiratory function in the immediate post-operative period. On presurgical laryngoscopy with no ET tube in position, everted laryngeal ventricles are sucked into the rima glottides on inspiration and can occupy the ventral 50% of the airway (http://www.vet.cam.ac.uk/boas). Immediately after surgery there is some degree of airway swelling, and it seems sensible to remove as much obstructive tissue as possible to aid recovery.

Ventriculectomy

Ventriculectomy is a simple procedure, but it can be difficult to get good visualisation as BOAS dogs often have redundant pharyngeal tissue that swells rapidly

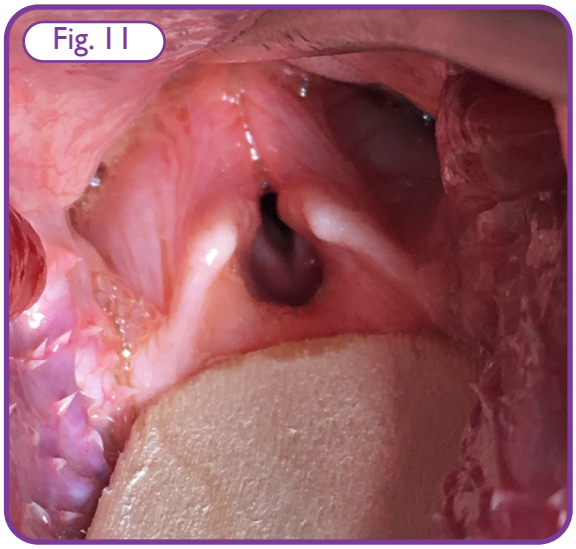
with minimal handling. The use of long handled microvascular scissors makes ventriculectomy easier. The author will often keep the ET tube in situ as the microvascular scissors allow visualisation below the ET tube. Ventricles which are everted so that they obscure the vocal folds are removed. Grasp ventricle at the dorsal aspect with a forcep and gently pull medially, cutting the base of the ventricle in front of the vocal fold.

Laryngeal Collapse

For laryngeal collapse stage 1 and 2, it is best to initially address the primary factors (favourable outcome in 13/17 dogs by Torrez and Hunt) though the author removes everted ventricles (protruding beyond the vocal folds).

The author also resects the laryngeal arytenoid cuneiform process in dogs that have a grade 2 or 3 laryngeal collapse, (Oechtering personal communication). Removal of the cuneiform results in less tissue that can be sucked into the rima glottidis on inspiration and appears to aid stabilization of the larynx. After surgery the larynx appears to heal well with no stenosis. There is a small vessel which is inclined to bleed after resection of the cuneiform but this is addressed by topical adrenaline on a swab. Fig. 11 below shows a healed bilateral cuniformectomy.

Fig. 11



For stage 3 laryngeal collapse, the larynx can be opened with a left-sided cricoarytenoid lateralisation combined with thyroarytenoid caudo-lateralisation (arytenoid laryngoplasty). With this surgery, 10/12 dogs survived on average 3 years and 6 months with no further additional surgical intervention. (RN White JSAP 2012).

Permanent tracheostomy

- Laryngeal collapse
- Permanent upper airway obstruction
- Damage to proximal trachea

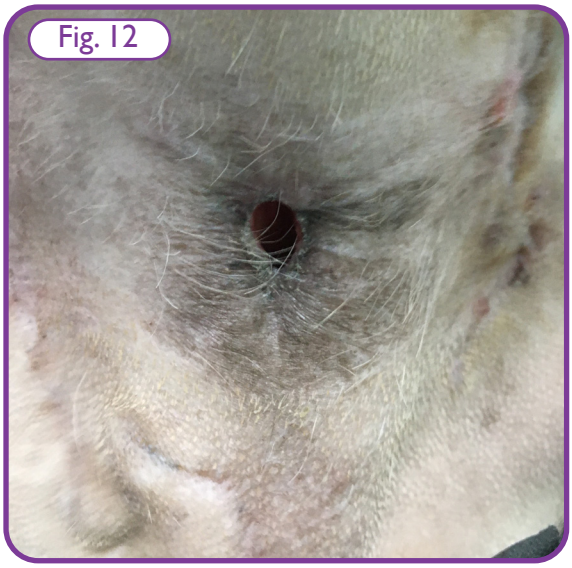
Another option is a permanent tracheostomy to bypass upper airways (requires daily cleaning, regular trimming of hair around the stoma and maintenance of a clean environment.) The outcome is uncertain in brachycephalics due to the hypoplastic trachea and thick, often fat neck with prominent skin folds. Permanent tracheostomy will alter vocalisation.

A ventral cervical incision and approach to the trachea is performed. Blunt dissection allows elevation of the trachea to the skin. The sternohyoideus muscles are sutured together dorsally to the trachea, pushing it more superficially. Ventral aspect of 1-5 rings are removed and the mucosa is incised. An oval of skin is resected, the subcutaneous tissue is sutured to the tracheal fascia and the mucosa sutured to the skin with simple interrupted sutures. The initial stoma should be made 50% larger than anticipated. Excise any skin folds that could obscure the stoma. In pugs with softer tracheal rings, the author will usually use the cricoid as the proximal ring as it is more stable (personal communication Bryden Stanley).

Long term about 30% of permanent tracheostomy cases had a good outcome in a recent retrospective study. (Gobetti et al 2018).

Fig. 12 shows a patient with a permanent tracheostomy.

Fig. 12



Click here for a short video of the same patient.

Stenotic nares and nasoplasty

BOAS dogs usually have stenotic, turned-in dorsolateral nasal cartilages with a thickened alar fold which often contacts the medial philtrum. (Fig. 13).

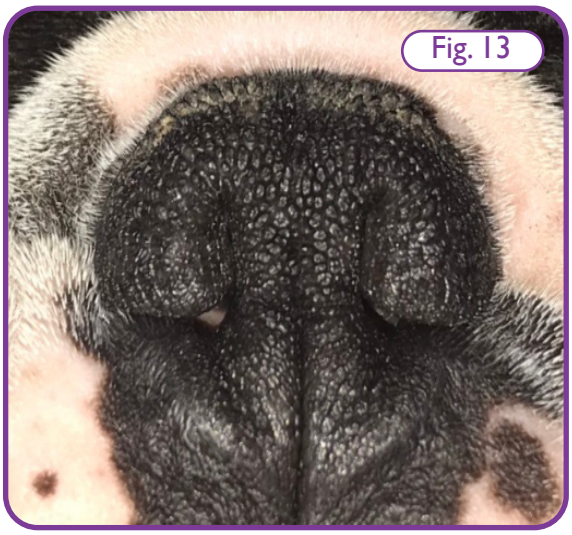


Fig. 13

The nares surgery now performed by the author, the alavestibuloplasty, involves resection of the inner alar fold within the vestibule (alar fold or second stenosis) along with resection of the wing of the nares (Oechtering personal communication). The author uses a Trader technique for the external nares and the combination of these two nares techniques results in a very much enlarged nostril. Although the nostrils can look rather raw at first, in a few weeks they pigment and appear normal.

Alar fold resection

1. Grasp the alar fold with a delicate curved haemostat at the dorsal aspect.
2. Cut the alar fold medial to lateral to nasal wall, 1/3 from base of alar fold.
3. Pull alar fold medially.
4. Slip scalpel around alar fold and connect to the bottom cut.

Trader Technique for the nasal cartilage

Cut at an angle across the lateral nasal cartilage with the blade slightly rotated so that more pigment than submucosa is showing.

Click here for a video demonstrating the alavestibuloplasty technique.

Turbinectomy

Laser-assisted turbinectomy (LATE) has been shown to decrease nasal resistance by over 60%. In the authors' clinic, dogs are initally assessed with CT, rhinoscopy and plethysmography. In BOAS affected dogs the traditional surgeries are performed first (soft palate resection, opening of the nares, tonsillar reduction). In dogs with aberrant nasopharyngeal turbinates (Fig. 14) or excessive nasal turbinates, if the response to the first surgery is disappointing based on clinical examination, plethysmography and owner assessment, a laser turbinectomy is performed. The aim of this surgery is to produce a clear ventral passage through the nasal cavity into the nasopharynx. Response to laser turbinectomy is generally good and morbidity is low. Fig. 15 shows a patient 12 months following the LATE procedure.


Fig. 14

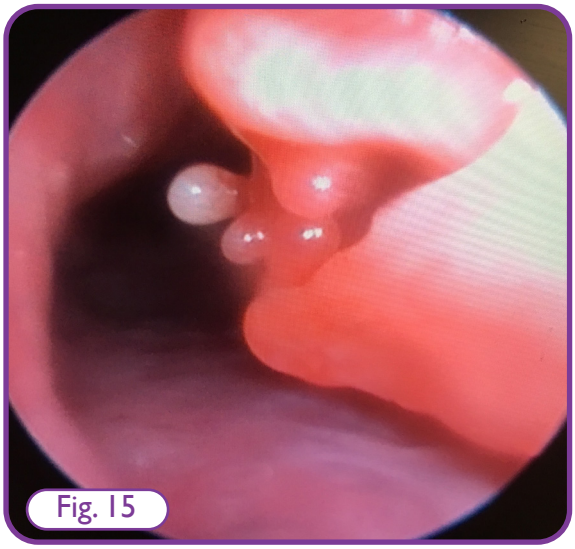


Fig. 15

Post-operative Care

• Keep the ET tube in as long as possible at the end of surgery; until the dogs can swallow.
• Use supplemental oxygen until fully recovered.
• The author nebulises patients with steam every 3-4 hours to moisten airways and prevent crusty secretions forming. If any patient shows respiratory effort after surgery, nebulizing with adrenaline will reduce some airway swelling and seems particularly effective in pugs.
• BOAS cases usually require close monitoring for the first 24 hours as post-operative swelling or haemorrhage can cause upper airway obstruction. However, with moderately affected grade 2 dogs, particularly French bulldogs, that have recovered well and are stressed in hospital, the author will send these dogs home the same day.
• Post-op tracheostomy is occasionally required.
• Advise soft food for the next couple of weeks.
• The author uses paracetamol for the first 5 days and omeprazole in any dogs that were frequent regurgitators prior to surgery.
• Ongoing monitoring.

Results

Overall, surgery is associated with a favourable outcome, with 50% of cases in various studies having a good-excellent outcome (though assessment is somewhat subjective), based on veterinary assessment or owner questionnaire. In an objective assessment of surgical results, the dogs improved after surgery but many were still clinically affected with BOAS though owner satisfaction was high (Liu et al 2017).

Dogs without laryngeal collapse generally respond well to surgery but grade II and III laryngeal collapse are associated with poorer outcomes. These dogs at the best improved so they have an adequate quality of life; they do not become unaffected.

Gastro-intestinal signs such as reflux, nausea and hypersalivation will also frequently respond to upper airway surgery, particularly in French bulldogs (Poncet et al 2006, Haimel et al 2015). If clinical signs remain after surgery and if there is marked nasal obstruction, then LATE will improve clinical cases further in most cases.

Dogs that present early (less than 6 months), are in a skinny body condition on presentation or have laryngeal collapse will generally have a worse prognosis and it is worth discussing this with owners before starting on an expensive and invasive treatment (Liu et al 2017).

Four days after nostril surgery

BOAS diagnosis and surgery: take home messages

• Assess dogs carefully prior to surgery with respiratory functional grading including an exercise test to determine which dogs are suitable surgical candidates and to audit cases.
• Surgical techniques are developing with alar fold resection, cuneiform resection of the larynx and turbinectomy procedures described.
• Using the optimal instruments and stands facilitates surgery.
• Treatment is not the best solution for BOAS. Breeding selection based on phenotypic or genotypic markers is a preferable way forward.

http://www.vet.cam.ac.uk/boas

With sincere thanks to **Jane Ladlow**
(Granta Veterinary Specialists, Linton, Cambridge)
MA VetMB, Cert VRT, Cert SAS DipECVS MRCVS
European and Royal College Specialist
in Small Animal Surgery
for her time and invaluable assistance with the creation of this Surgery Guide.

Appendix I

BOAS functional grading

Grade 0: Clinically unaffected. Free of respiratory signs; annual health check is suggested if the dog is under 2 years old.
Grade I: Clinically unaffected. Mild respiratory signs of BOAS but does not affect exercise tolerance. Annual health check is suggested if the dog is under 2 years old.
Grade II: Clinically affected. The dog has moderate/clinically relevant respiratory signs and requires management, including weight loss and/or surgical intervention.
Grade III: Clinically affected, and **should not be bred**. Severe respiratory signs of BOAS. The dog should have a thorough veterinary examination with surgical intervention.

Bulldogs and French Bulldogs

		Respiratory noise	Inspiratory effort	Dyspnoea/Cyanosis/Syncope
Grade 0	Pre-ET	Not audible	Normal	Not present
	Post-ET	Not audible	Normal	Not present
Grade I	Pre-ET	Not audible to mild stertor, and/or moderate intermittent nasal stertor when sniffing.	Normal	Not present
	Post-ET	Mild stertor and/or moderate intermittent nasal stertor when sniffing, and/or intermittent gentle stertor when panting.	Normal	Not present
Grade II	Pre-ET	Mild to moderate stertor or stridor	Normal	Not present
	Post-ET	Moderate to severe stertor	Not present to inspiratory effort. Dyspnoea not present.	Dyspnoea; cyanosis or syncope not present
Grade III	Pre-ET	Moderate to severe stertor	Inspiratory effort to dyspnoea	Dyspnoea; may or may not present cyanosis. Inability to exercise.
	Post-ET	Severe stertor	Inspiratory effort to dyspnoea	Dyspnoea; may or may not present cyanosis.

ET = exercise test

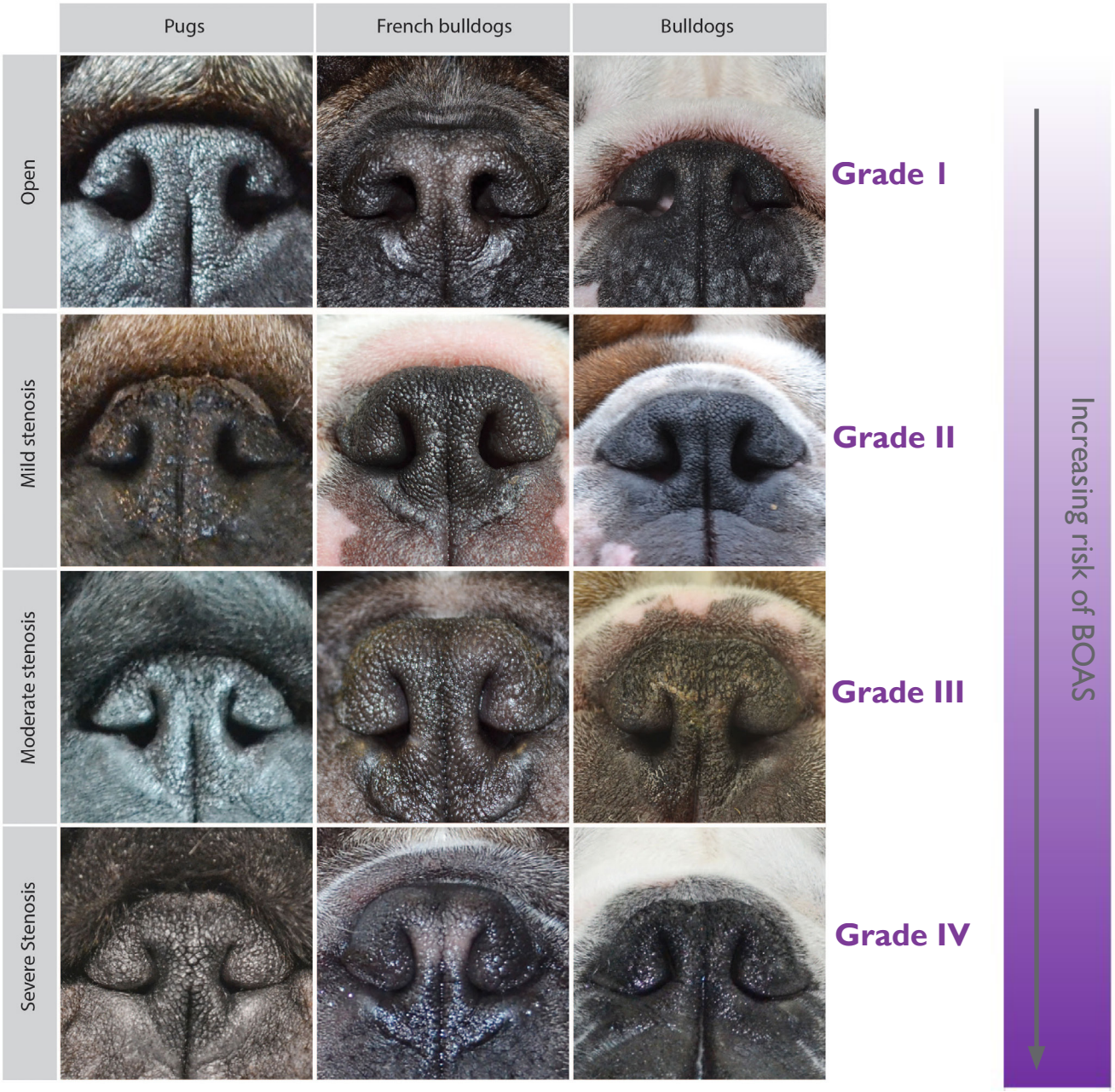
Pugs

		Respiratory noise	Respiratory pattern	Cyanosis/Syncope
Grade 0	Pre-ET	Not audible	Normal	Not present
	Post-ET	Not audible	Normal	Not present
Grade I	Pre-ET	Not audible to mild stertor, and/or moderate intermittent nasal stertor when sniffing.	Normal	Not present
	Post-ET	Mild stertor or stridor, and/or moderate intermittent nasal stertor when sniffing.	Normal	Not present
Grade II	Pre-ET	Mild to moderate stertor or stridor	Normal	Not present
	Post-ET	Moderate to severe stertor or stridor	Normal to inspiratory effort.	Not present
Grade III	Pre-ET	Moderate to severe stertor or stridor	Inspiratory effort to dyspnoea	May or may not present cyanosis or syncope. Inability to exercise.
	Post-ET	Severe stertor or stridor	Dyspnoea	May or may not present cyanosis or syncope.

ET = exercise test

Appendix 2

Nostril grading



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Images reproduced with permission from Cambridge BOAS Research Group

Grade I: Open nostril. Nostrils are wide open. During exercise, the nostril wings should move dorso-laterally (upwards and outwards) to open on inspiration.

Grade II: Mildly stenotic nostrils. Slightly narrowed nostrils but the lateral (outer) nostril wall does not touch the medial (inner) nostril wall. During exercise, the nostril wings should move dorso-laterally (upwards and outwards) to open on inspiration.

Grade III: Moderately stenotic nostrils. The lateral (outer) nostril wall touches the medial (inner) wall at the dorsal (upwards) part of the nostrils and the nostrils are only open at the bottom. During exercise, the nostril wings are not able to move dorso-laterally (upwards and outwards) and there may be nasal flaring (ie. muscle contraction around the nose trying to enlarge the nostrils but failing).

Grade IV: Severely stenotic nostrils. Nostrils are almost closed. The dog may switch to oral breathing from nasal breathing with stress or very gentle exercise such as playing. During exercise, the nostril wings are not able to move dorso-laterally (upwards and outwards) and always present with nasal flaring.

References/further reading

• Cantatore M, et al. Medium term endoscopic assessment of the surgical outcome following laryngeal saccule resection in brachycephalic dogs. Vet Rec. 2012 May 19;170(20):518

• Doyle CR, Aarnes TK, Ballash GA, Wendt-Hornickle EL, Baldo CF, Johnson RA, Wittum TE, McLoughlin MA. Anesthetic risk during subsequent anesthetic events in brachycephalic dogs that have undergone corrective airway surgery: 45 cases (2007-2019). J Am Vet Med Assoc. 2020 Oct 1;257(7):744-749. doi: 10.2460/javma.257.7.744. PMID: 32955391.

• Ellison G. "Alapexy: an alternative technique for repair of stenotic nares in dogs" JAAHA 2004; 40: 484-489

• Fasanella F. et al. "Brachycephalic airway obstructive syndrome in dogs: 90 cases (1991-2008)" JAVMA 2010; 237: 1048-1051

• Franklin PH, Liu NC, Ladlow JF. Nebulization of epinephrine to reduce the severity of brachycephalic obstructive airway syndrome in dogs. Vet Surg. 2021 Jan;50(1):62-70. doi: 10.1111/vsu.13523. Epub 2020 Oct 12. PMID: 33044024.

• Gobbetti M et al. Long-term outcome of permament tracheostomy in 15 dogs with severe laryngeal collapse secondary to brachycephalic obstructive airway syndrome.
Vet Surg. 2018 Jul;47(5):648-653.

• Gruenheid M, Aarnes TK, McLoughlin MA, Simpson EM, Mathys DA, Mollenkopf DF, Wittum TE. Risk of anesthesia-related complications in brachycephalic dogs. J Am Vet Med Assoc. 2018 Aug 1;253(3):301-306. doi: 10.2460/javma.253.3.301. PMID: 30020004.

• Harvey, C. E. (1982b) Upper airway obstruction surgery part IV: partial laryngectomy in brachycephalic dogs. Journal of the American Animal Hospital Association 18, 548–550

• Harvey C. "Upper airway obstruction surgery: 1, stenotic nares surgery in brachycephalic dogs" J Am Anim Hosp Assoc 1982; 18: 535-537

• Hughes et al. Complications following laryngeal sacculectomy in brachycephalic dogs. J Small Anim Pract. 2018 Jan;59(1):16-21

• Liu NC, Adams VJ, Kalmar L, Ladlow JF, Sargan DR. (2016) Whole-body barometric plethysmography characterizes upper airway obstructions in 3 brachycephalic breeds of dogs. Journal of Veterinary Internal Medicine May;30(3):853-65

• Liu NC, Oechtering GU, Adams VJ, Kalmar L, Sargan DR, Ladlow JF. Outcomes and prognostic factors of surgical treatments for brachycephalic obstructive airway syndrome in 3 breeds. Vet Surg. 2017 Feb;46(2):271-280

• Oechtering GU, Pohl S, Schlueter C, Schuenemann R. A Novel Approach to Brachycephalic Syndrome. 2. Laser-Assisted Turbinectomy (LATE). Vet Surg. 2016 Feb;45(2):173-81

• Oechtering GU, Pohl S, Schlueter C, Lippert JP, Alef M, Kiefer I, Ludewig E, Schuenemann R. A Novel Approach to Brachycephalic Syndrome. 1. Evaluation of Anatomical Intranasal Airway Obstruction. Vet Surg. 2016 Feb;45(2):165-72

• Poncet CM et al. Prevalence of gastrointestinal tract lesions in brachycephalic dogs with upper respiratory syndrome: clinical study in 73 cases (2000-2003) . J Small Anim Pract 2005

• Poncet CM et al. Long-term results of upper respiratory syndrome surgery and gastrointestinal tract medical treatment in 51 brachycephalic dogs. J Small Anim Pract 2006

• Riecks T et al. "Surgical correction of brachycephalic syndrome in dogs: 62 cases (1991-2004)" JAVMA 2007; 230: 1324-1328

• Torrez C. & Hunt G. "Results of surgical correction of abnormalities associated with brachycephalic airway obstruction syndrome in dogs in Australia" J Sm Anim Pract 2006; 47:150-154

• Savvas I et al. Factors Affecting Intraoperative Gastro-Oesophageal Reflux in Dogs and Cats. Animals (Basel). 2022 Jan 20;12(3):247. doi: 10.3390/ani12030247. PMID: 35158572; PMCID: PMC8833530.

• White RN. Surgical management of laryngeal collapse associated with brachycephalic airway obstruction syndrome in dogs. J Small Anim Pract 2012 Jan;53(1):44-50

Featured Products

Please refer to the Vi Catalogue or scan the QR code to view the relevant section of our website, and find full details of all products.

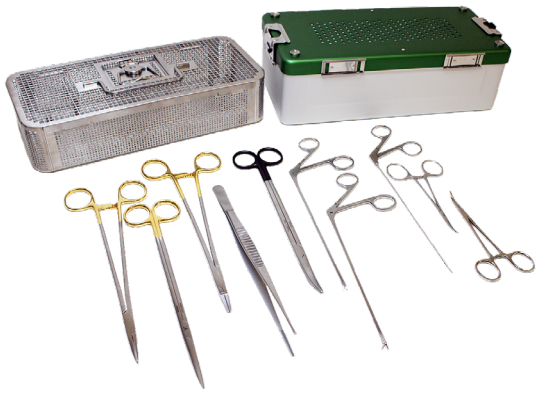
The brand new BOAS Mouth Gag (patent pending) from Vi has been developed specifically to aid surgeons performing BOAS surgery. The unique design allows vastly improved visualisation and surgical access during these procedures.

This new device is based on the design of the ever-popular table-top gag for rabbit and rodent dentistry, with several key features and adaptation specifically intended for BOAS surgery.

Special design features include:

- Fully adjustable tilting base to support the upper body of the patient at the desired angle to maximise visualisation and access.
- The tilting base is supported by sturdy upright bars to ensure excellent stability and optimal weight capacity.
- Two adjustable horizontal bars to retain the patients' mouth open in the desired position. Both bars are adjustable up/down, and the upper bar also adjusts forwards/backwards.
- Silicone bar sleeves for the horizontal bars are available to minimise potential trauma to the patient's gums.
- Front-positioned cleat hook to allow tie-down of the tongue if desired.
- Supporting hook for the ET tube or anaesthetic circuit. This is height-adjustable and can be positioned to either the front or the side of the upright.
- Interchangeable 4mm diameter horizontal bars are available separately (for use with smaller patients if necessary)

BOASMG BOAS Surgery Mouth Gag Complete
BOASST BOAS Silicone Bar Sleeve 190mm Long
BOASBARS4 4mm Bars for BOAS Mouth Gag
BOASST-SM BOAS Silicone Bar Sleeve for 4mm Bar

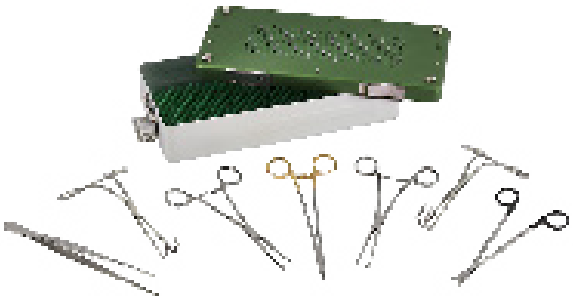


A set of instruments specifically recommended by Jane Ladlow for BOAS and upper airway surgery. The Premium BOAS Surgical Kit contains:

602030	De Bakey Needleholder TC 225mm	x1
606355	Ryder TC Needleholder Mini Profile Tip 230mm	x1
103160	Mosquito Forceps XX Micro Curved	x1
103225	Halstead Mosquito Artery Forceps 125mm Curved	x2
014057	Fine Tubular Grasping Forceps 7"	x1
342020	DeBakey Atraumatic Dissecting Forceps 205mm	x1
754040	Metzenbaum Fino TC Blunt/Blunt 9"	x1
760020	Ligature Scissors Supercut 230mm	x1
014080	Micro Scissors Left Curve 175mm	x1
014081	Micro Scissors Right Curve 175mm	x1
BX301410P-F	Premium Instrument Box 300x140x100mm	x1
PBBXINNER1	Perforated Tray with Lid	x1

Includes silicone instrument holders and holding pins

BOASPREMKIT BOAS Surgical Kit - Premium



A set of instruments suitable for BOAS and upper airway surgery. The BOAS Surgical Kit (Standard) contains:

014050	Soft Palate Clamps Internal 18x7mm	x1
014040	Soft Palate Clamps Internal 26x12mm	x1
760012	Metzenbaum Supercut Scissors 180mm Cvd	x1
801156	Allis Tissue Forceps 3/4 Teeth 180mm	x2
602010	DeBakey TC Needleholder 200mm	x1
342020	DeBakey Atraumatic Dissecting Forceps 205mm	x1
BX201470P-F	Premium Instrument Box 300x140x70mm w/ Filters	x1
PBXS270125	Fingered Silicone Mat 270x125mm Green	x1

BOASSTDKIT BOAS Surgical Kit - Standard

To place an order for any of the products featured in this Surgery Guide, please email info@vetinst.com or call 0114 258 8530.

Webinar recording and Q&A

Jane Ladlow very kindly delivered a webinar for Vi in February 2023 entitled BOAS - Recognition, Diagnosis and Surgery. A recording is available to view, please email info@vetinst.com for details. A huge number of questions were submitted by webinar attendees during the live session (too many to address them all at the time). Below are all the questions we received (some have been paraphrased) and answers provided by Jane, organised by topic/subject matter.

- Patient evaluation
- Anaesthesia & medications
- Laryngeal surgery
- Palate surgery
- Nostril surgery
- Tubinectomy
- Post op care
- RFG
- General queries

Vi are very grateful to Jane for her time taken providing answers to these questions for inclusion in this Surgery Guide.

Patient evaluation

Are there any clinical findings pre-surgery that would suggest a patient has nasal obstruction from stenotic nares vs stenotic nares AND aberrant turbinates?

Great question. Not definitive though I think nostrils tend to be quieter and often higher pitched. I think that the real nasal stertor is a very likely to include turbinates. Also nostrils more on inspiration, turbinates affect both inspiration and expiration. Not evidence based.

Why do dogs with hypoplastic tracheas get aspiration pneumonia?

I think some of these tracheas (particularly in the bulldog puppies) are so small that the inspiratory thoracic pressures are high, leading to gastroesophageal reflux. There are some good experimental papers linking airway obstruction to increased vomiting and reflux - including one particularly gruesome paper where they experimentally occluded tracheas in control dogs and created gastrointestinal signs in all.

Boesch RP, Shah P, Vaynblat M, et al. Relationship between upper airway obstruction and gastroesophageal reflux in a dog model. J Invest Surg. 2005;18:241-245.

Are there prognostic factors with megaoesophagus cases often identified at initial examination? Any particular points for management?

I think the megaoesophagus is often due to oesophagitis and reflux, though we know these dogs often have oesophageal dysmotility. I try and calm the reflux before surgery – low fat frequent meals, feeding from a height, omeprazole or a H2 blocker, cimetidine and sucralfate. Also warn that dogs with frequent regurgitation are the trickier dogs to treat successfully.

Do you use the Brisk score? I find it confusing.

I keep it in mind – it makes sense i.e dogs that have had previous airway surgery and are still affected are likely to be more severely affected, as are those presenting as an emergency. I totally agree that bulldogs are more tricky but don't think Frenchie's are as tricky. The one risk factor I hadn't picked up on was the hypothermia which is interesting and I definitely note this now.

Do you do any gastric endoscopy in the pre-op diagnostic?

Not usually. I will if the regurgitation is more severe than I would expect for the airway obstruction. We used to scope the oesophagus and stomach for all cases but it very rarely altered the treatment plan and took me longer. All biopsies tended to be inflammatory and hiatal hernias I will still treat initially by airway surgery if the airway obstruction is moderate/severe.

Anaesthesia & medications

How long do you starve your patients for before surgery?

From the night before, so 10 - 12 hours. I don't think there is evidence that fasting for longer than 4 hours makes any difference.

Are there any additional precautions that should be taken for intubating these types of dogs compared to dogs without this problem?

We use methadone/ medetomidine premedication and move the dog out of kennels to somewhere calm and darker. Observe constantly after premedication. Pre-oxygenate and then induce relatively quickly, if the dog is struggling raise the head, and gently bring the tongue forward. Have suction ready just in case, dry swabs for the tongue and large cotton buds to remove saliva/ fluid from the pharynx if necessary. Have a good laryngoscope and it is acceptable to use blade on epiglottis and tongue base if tricky.

Any advice re. endotracheal tubes for these dogs?

I have a bit of a debate with the anaesthetists on this. I tend to use smaller than they would like, as I don't like any catching or pressure on the larynx when I intubate. Usually soft silicone. Many times, the tracheas are smaller than you would anticipate for the size of dog. In pugs, where the trachea is larger, the larynx can be quite soft and I've seen pugs undergoing long anaesthetics for other conditions obstruct after extubation – I don't think that having pressure on the larynx for a long period of time is a good idea. I do check carefully for a seal and use capnography though. Also check the length – it's easier to accidentally do one-lung ventilation than one would like…

What is your advice re. dosage for trazodone for brachycephalic breeds with BOAS? And any reduction when combining with gabapentin?

I usually use 10mg/kg trazodone unless any contra-indications. I add gabapentin with the aggressive dogs (usually 20mg/kg) and don't tend to reduce the trazodone. It does help!

Would you pre-emptively give trazodone to be given at home before consultations in BOAS suspect dogs?

I only tend to use for aggressive or stressed dogs.

Why/when do you use omeprazole preoperatively?

I give omeprazole orally for 5-7 days if they are frequent (daily) regurgitators. Otherwise I give intravenously at induction. I use it because the most frequent post-operative complication is regurgitation, the risk of which is increased from the anaesthetic, probably not helped by the stress of hospitalisation and surgery (increased airway swelling/ blood in the gastrointestinal tract).

What about other gastroprotectants such as cimetidine or famotidine instead of omeprazole, if not well tolerated?

Absolutely. About 25% of Frenchies will develop gastrointestinal side effects on omeprazole in my experience and I tend to switch these to famotidine initially, or ranitidine.

Why use both maropitant and metoclopramide?

Maropitant acts centrally to decrease nausea, whereas metoclopramide, in addition to anti-nausea, has a prokinetic effect. I think ondansetron is meant to be the drug of choice, though, for anti-nausea effect.

Do you think that sucralfate (the liquid form) could be a useful addition to gastroprotectives?

I have used sulcralfate on many cases and think it is useful. However, you can end up with a real cocktail of drugs, so I tend to prioritise maropitant, omeprazole, paracetamol and then add in cisapride and then sulcralfate.

Do you use tranexamic acid to improve bleeding control in the post op period?
Not unless I think haemorrhage has been excessive during the surgery (rare), as usually it's not a major issue if you wake them up slowly.

Why do you not give them opiates?
We tend to use methadone as a post-operative analgesic and I worry it may increase the feeling of nausea and increase regurgitation – I really want them to eat within 6-8 hours of the surgery (unless they had a tracheostomy tube in) as I think it settles their stomach (and hunger is not a pleasant feeling). I also don't think many need additional analgesia if your local blocks are good. I also want them up and moving relatively quickly so they cough and clear the airways.

Why paracetamol? and what is the proper dose? I've found literature suggesting anything from 10-15 mg/kg to 30 mg/kg BID-TID.
Analgesic effect is reasonable (and proven in many studies). It's relatively gentle on the gastrointestinal tract and you can combine with steroids. I routinely use 15mg/kg three times daily.

NSAIDs with steroids: should we be more cautious about the side effects?
Yes, so I don't use NSAIDs in these dogs – I really don't want to cause gastrointestinal side effects.

Is the maxillary nerve block uni or bilateral?
Bilateral. Anecdotally I think I have far fewer dogs reacting/ swallowing during surgery with the blocks. Swallowing dogs breaks my flow and upsets my karma so I always use the local anaesthetic nerve blocks.

Do you prefer maintaning anaesthesia using TIVA (Total Intravenous Anaesthesia) with propofol using only oxygen in intubated patients or inhalation anaesthesia with isoflurane. Which protocol do you find safer?
I've done both, but I tend not to extubate in theatre now and remove the ventricles/ cuneiforms around a relatively small ET tube. If I need to extubate I switch to TIVA but not for the whole procedure.

Do you use antibiotic cover after surgery or during surgery? Do you send them home with antibiotics? Do you use IV antibiotics during surgery?
I don't routinely give peri or post-operative antibiotics for BOAS surgery, I use post-operative for LATE.

Do you use steroids for a few more days?
I use a single dose of intravenous dexamethasone at induction as it seems very sensible to use the most potent anti-inflammatory we can when operating on the airway. I only continue for a few days if I'm really worried or the dog has a laryngeal granuloma.

Do you use adult or paediatric otrivine? When do you put the otrivine in peri-op? Is it useful in the emergency stabilisation of some BOAS/hyperthermia cases?
Adult. I tend to scope the nose, then use otrivine and then check the response with the scope. If I don't scope, I put in after induction. In an emergency, definitely - if you can get it in and nebulise with adrenaline.

Otrivine plus is available which has ipratropium bromide which is a mucous reductant. Any contraindications?
Not that I'm aware of – but I've not used this product.

Are you routinely nebulising your cases with adrenaline in recovery ? Or in which cases do you do this? We seem to find early use is better but this is only subjective. Do you use nebulisation pre-extubation whilst still in theatre? What dose and frequency do you use for adrenaline nebulisation?
I do in nearly all my grade 3 dogs and all my bulldogs and pugs. I think it makes a big difference. We have Phil's paper to say it does make a difference objectively, particularly in pugs. I use after extubation, not pre-extubation as I'm usually aiming for the larynx. I tend to use the dose Phil gave in his paper – 0.05mg/kg made up to 5ml with saline. I use every 2-4 hours as necessary.

Laryngeal surgery

What is your opinion about correcting the everted laryngeal saccules?

I remove the everted saccules/ ventricles once they obstruct the vocal folds as I'm not sure (and there is no evidence) that they regress. I also don't see many issues removing the saccules.

I have heard that the removal of laryngeal saccules is an option but the tissue may re-evert due to the increased negative airway pressure after surgical correction. I assume this is the case maybe with the traditional BOAS surgical technique? Or is it even something that can happen? I thought once they are removed that's it?

I suspect that this happens if the ventricles are not fully excised at the base – I haven't had this occur as a problem.

Laryngeal collapse or paralysis? How do I diagnose conclusively that this is the primary cause of dyspnoea?

Any laryngeal stridor is a very strong indication that you have laryngeal collapse or paralysis. Confirmation is at induction of general anaesthesia under a very light plane of anaesthesia. In my experience, many dogs have some degree of laryngeal collapse, few have laryngeal paralysis, though they may have paradoxical movement where the arytenoids are sucked into the rima glottidis on inspiration due to excessive inspiratory pressure. Laryngeal paralysis – there is usually no movement or ineffectual flutter. It's really difficult to assess if the laryngeal collapse is the primary cause of dyspnoea as it is often secondary to other areas of airway compromise but it is likely to be at least highly significant.

How do you perform cuneiformectomy?

I steady the cuneiform process and then cut, catching the cartilage process. In pugs and French bulldogs, I stop any bleeding/ swelling with an adrenaline soaked cotton bud. With bulldogs you need bipolar for the vessel below the cuneiform process. I would then nebulise with adrenaline on recovery, almost as soon as the ET tube is out. I don't see many issues with this technique but probably wouldn't do it if I wasn't set up for tracheostomy (just in case).

Will you do cuneiformectomy rather than laryngeal tie back for a collapse?

I start with cuneiformectomy and then do a tie back if required. I've done a lot of cuneiformectomies and about six laryngeal arytenoid lateralisations for laryngeal collapse.

How do you manage grade II laryngeal collapse initially? Would you always consider doing cuneiformectomy in grade II laryngeal collapse or would you do only nostrils, palate and ventriculectomy first and consider cuneiformectomy if they are still affected? Are you concerned about aspiration pneumonia?

I've tried both ways. If I don't address the larynx I'll often end up coming back and doing cuneiformectomy. I'm also much more relaxed about laryngeal surgery now so it's rare I don't take the cuneiform processes if they are collapsing. And no, we don't seem to see any more aspiration pneumonia with this technique – they often still have a relatively small rima glottis.

Any merit to doing vocalcordectomy in severely affected BOAS dogs?

This is an interesting question. I would worry about taking the vocal folds as I had a dog with an extensive granuloma which got laryngeal webbing after involving the vocal folds. I also understand it's not uncommon after debarking (vocalcordectomy) in the US when they are dealing with bigger dogs. So potentially, although I don't think you'd gain much airway space and the potential complications are difficult to resolve.

Palate surgery

What are your thoughts on using diathermy during the surgery vs scalpel? Do you use monopolar or scissors for the folded flap palatoplasty? What instruments do you use for your folded flaps? Scissors and bipolar? Does the use of Harmonic scalpel have advantages over monopolar for folded palatoplasty?

I use bipolar coagulation during the folding flap palatoplasty and then scissors. I don't use monopolar but I know lots of good surgeons that do, so it's personal choice. The Harmonic in theory should be better than monopolar. I tend to split the tissues from the palate edges though, and blunt dissect to the median raphe. I'm not sure I could do this with a blade.

What do you think about just doing a more aggressive traditional soft palate resection to the level of mid-tonsil as an option?

According to the literature, there is no reason why you can't do an extended traditional technique. I like the folding flap though, I think it does help to strip the thickness and I like the fact that I'm addressing any haemorrhage at the time of surgery.

Modified FFP: what is the difference in comparison to the traditional technique? Do you have some reference?

It's Prof Oechtering's technique, it's less extensive, as above. I have had very few issues with breakdown/ dehiscence (that I know about) so I suspect it's a little gentler than the original FFP.

What to do if breakdown of palatoplasty site occurs?

I very rarely see this. I would resuture or resect depending on the residual length of the palate and the severity.

How would you thin a palate that's already had a staphylectomy?

I do an inverted T incision, split the palate and strip out the stroma. I've tried the T incision in both directions and think it's easier to have the horizontal incision closest to the hard palate.

If a patient has an elongated and thickened soft palate but referral isn't an option, is it still helpful to shorten the palate, even if you don't have the skills to make it thinner? If later down the track the referral becomes an option and the patient needs revision surgery can the soft palate be made thinner after doing a standard resection?

As above and yes, if revision surgery is needed we can absolutely revise the palate and thin it.

How short is too short for staphylectomy? Is it possible to cut out too much of the soft palate?

Good question. I have cut some Frenchies pretty short (ie. shorter than the rostral edge of the tonsillar crypt) to address maximum area of nasopharyngeal compression on the CT, and it seems to be tolerated. I do worry sometimes though that reverse sneezing may be due to increased nasopharyngeal reflux if they are regurgitating. In pugs, I go to the front of the tonsillar crypt but no further, as I think they have less of a macroglossia and thus less laryngeal protection on swallowing. I've also had 2 pugs gag occasionally after drinking (no problems on eating) which made me think I'd gone a little short.

Nostril surgery

Have you got any resources for learning more about Liepzig alar resection technique? Is there a documented lateral alar fold wedge technique?

Not really, as Prof Oechtering devised the technique from Leipzig – in my mind, he owns it. There should be a paper coming out on it though, as Franklin presented a very good abstract at ECVS '22 on the alavestibuloplasty versus the wedge resection (alar fold and Traders - alavestibuloplasty) was better at increasing nostril airspace. Since I've been removing the internal alar folds and excising the alar wings completely (mainly FBD), the difference has been a game changer. However, I have some owners reluctant to have the wings removed completely, and would prefer a standard wedge resection.

Any tips on how to remove the internal folds without performing a Traders, as access is a tad tricky?
I think do the alar fold first and then the wedge resection. I would worry though that you may get nares collapse due to lack of support behind the wing. I think I would just revert to a deep wedge in this case. I don't give owners the choice and no-one has ever complained.

Alar fold removal - are there any tips about how to start doing this surgery? Any advice on how to avoid the nasolacrimal duct?
See practice with an experienced surgeon. Then try on a few cadavers first. If you go a third of the way up the alar fold you should avoid the nasolacrimal duct.

Can you remove the alar fold with a cautery pen instead of a scalpel?
I haven't, as I've seen some cases of nostril scarring after surgery and the use of energy devices seems to increase the risk.

Trader's technique: do you usually repair the defect or just cut with the blade? Do you use adrenaline after the alaplasty to reduce bleeding?
Cut with a blade and then pack with a large cotton bud infused with adrenaline for 5-10 minutes.

Do you have tips for nasal valve surgery in Persian cats?
I still do the alavestibuloplasty. I tried the ventral flap which was pretty but I'm not sure it made a huge difference to the nostril airspace. There is also a new technique described which removes some cartilage from the dorsal aspect of the nasal planum. https://doi.org/10.2460/javma.23.01.0054

Turbinectomy

Can you explain LATE again please? When to do? Only possible with laser?
It's removal of the ventral nasal conchae (maxillary turbinate) and sometimes part of the middle turbinates to create a clear airway through the ventral nasal meatus to the choanae. In dogs the laser assisted is described as the space is confined so the tubinectomy is done via a rhinoscope. In people they also cold cut with scissors and bipolar scissors.

How often do you have to re-perform laser turbinectomy?
In less than 10% of cases. It tends to be the same dogs – you can see their breathing function deteriorating over time (we have documented this in some dogs) and the LATE improves it. I assume these dogs have got very severe nasopharyngeal obstruction in addition to the turbinates, so that even moderate regrowth compromises them.

Is laser turbinectomy still a surgery to be done after the initial nares/palate/saccules if they haven't improved, or are there any situations where you would do this primarily?
I usually use the LATE after the initial BOAS surgery. However if I see a young dog with obvious stertor and a thin relatively palate (usually Frenchie) then I have done nostrils and LATE as the initial surgery to good effect.

Post-Operative Care

Do you recommend feeding them from a raised platform to help reduce regurgitation post op?
Not usually initially – I like to see how they settle after surgery. However if they are still regurgitating 2-3 weeks after surgery it's worth trying.

If the patient is stressy before and/or after the surgery, would you keep it in to monitor? Or send home where it could be less stressed?
I send most French bulldogs and some pugs home the same day (particularly the stressy dogs). I keep the severely affected (grade 3) dogs, all bulldogs, and dogs that have had laryngeal surgery, in overnight.

RFG Grading

Can Staffordshire Bull Terriers be considered for BOAS grading moving forward, as there are some cases becoming apparent?

We are currently (in 2023) two years through a PhD Study to look at 14 other Brachycephalic breeds with regard to the prevalence and incidence of BOAS in these breeds (along with general health). The breeds that require the RFG Scheme will be provided with a breed specific scheme.

How can I become a BOAS grading assessor?

If you contact the Kennel Club they will add you to a course, there are two a year. They are free of charge but there is a charge currently (in 2023) of £250 for access to the resources and forms (now online) that they expect you to pass on to clients. https://www.thekennelclub.org.uk/health-and-dog-care/health/getting-started-with-health-testing-and-screening/respiratory-function-grading-scheme/

Can we put the nostril chart on display in our hospital?

The nostril chart is attached to this surgery guide as an appendix, and can also be found at the Cambridge website: https://www.vet.cam.ac.uk/boas/about-boas/recognition-diagnosis

General queries

Should we do more BOAS surgeries preventatively (like rhinoplasty and soft palate resection) before those dogs become symptomatic? As puppies alongside castration/spay?

At the moment, the only breed we have evidence for prophylactic surgery is the Shih Tzu where, if you have a young puppy with severely stenotic nostrils, particularly if they have nasal discharge and bubbles, then rhinoplasty is beneficial and can relieve the clinical signs. With other breeds, I prefer to wait until clinical signs appear. Some dogs will not require the surgery and it does have morbidity and a low risk of mortality. It also gives the idea that BOAS is not a major issue and that it can be tweaked at neutering and I think this is the wrong message.

Do you ever do any other procedure alongside, such as castration or small mass removal?

It depends on the severity of the BOAS. With grade 3 (severely affected) dogs I tend to try just do the airways. With grade 2 (moderately affected) I discuss with owners. I explain there is an increased risk of complications with longer anaesthetics - but if there is minimal pre-operative regurgitation I'm less worried.

How do you feel about first opinion practices that don't have on-site out-of-hours facilities assessing and operating on BOAS cases?

I think operating on the right cases is important. I would choose the moderately affected dogs (grade 2) and be careful about bulldogs (I don't send these home the same day, having lost a couple). I would choose moderately affected French bulldogs and pugs, operate early and watch for a few hours before sending home. Make the local OOHs service aware and give the owner very clear discharge instructions. I would try and send on the severely affected cases that would benefit from overnight hospitalisation. Realistically not all owners can afford referral and there are hundreds of thousands of dogs in the UK alone that will benefit from surgery and not enough referral centres to see them all. I am very happy to see your tricky cases at Granta Veterinary Specialists in Cambs from January 2024.

What do you do in a dog that has had 5/5 BOAS but is still dyspnoeic eg investigation?

We tend to CT and scope the dogs prior to surgery so we have a pretty solid idea of the lesion sites before we operate. If it is laryngeal collapse (it usually is, with dyspnoea) then you are back to Rob White's modified arytenoid lateralisation or, if you think swelling is contributing, then temporary tracheostomy.

Do you always remove the tonsils if they are everted even if they are not occluding the airway enough to cause obstruction? Is there a dynamic obstruction due to them?

I do, as I want to suture the palate edges over to the tonsillar crypts. I also find in most French bulldogs and bulldogs that the tonsils are hypertrophied. They don't look so exciting when the mouth is open but on CT with the mouth closed, you can see them in the pharynx.

How do you feel BOAS affects the dogs ability to sniff and scent in comparison to a healthy dog? Asking from a behavioural point of view and with how important scent is to dogs.

Interesting question. There was a paper a few years back that described pugs as having the same olfactory ability as a GSD. However many owners note that the dogs sniff much more after surgery and I have observed this, so I think the nostril stenosis does affect sense of smell.

Is there any connection with this type of anatomy and certain infections? bacteria/virus,.. and if so, which?

I am not aware that this has been documented.

Do you run a blood clotting profile before operating?

Not if the dog appears healthy and the owner/ history confirms a good worming regime. If in doubt, we snap test for angiostrongylus or check clotting but it's not routine.

What do you think about cutting the root of the tongue when you have macroglossia by using co2 laser?

Interesting. I've tried RFA (radiofrequency ablation) and thought it had some effect but it's difficult to quantify.

Would you put a tracheostomy tube in a stressy dog pre-emptively?

I usually only use pre-emptive tracheostomies in severely affected dogs (and less than I used to as we've got better).

What are the advantages of laser surgery?

The carbon dioxide laser seems to have good results with relatively low swelling and inflammation. I don't have experience with it though. I use a diode laser for turbinectomy as it has a flexible fibre that will go through the endoscope.

Do you clean the palate somehow before surgery?

We wipe very gently with saline.

Might some pugs teeth be too short for the stand and slip off?

If this happened, I would tape the head onto the bars to secure the patient.

Using the BOAS stand, the tongue is underneath the lower bar?

Yes, it helps to clear space around the larynx and should keep it out the way

BOASMG: Patent pending

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