Check for updates

Brachycephalic anaesthesia, part 1: the pre-anaesthetic period

Courtney Scales DipVN, NCert(Anaesth) RVN

Niamh J. Clancy Dip AVN (Small Animal), DipHE, CVN, Dip VN, PGCert VetEd, FHEA, RVN

Queen Mother Hospital for Animals – Anaesthesia RVN, Hawkshead Lane, Brookmans Park, Hatfield AL9 7TA, UK

ABSTRACT: This article intends to highlight the many complications that can arise during the pre-anaesthesic period with brachycephalic breeds, and address how to mitigate some of the risks. This first article will deal with the pre-anaesthetic stage discussing anatomy, admitting the brachycephalic patient and pre-anaesthetic checks, whilst a subsequent article will address the recovery period.

Keywords: anaesthesia; brachycephalic; BOAS; BAS

Courtney Scales DipVN, NCert(Anaesth) RVN

Courtney is originally from New Zealand, where she qualified as a Veterinary Nurse in 2010 and worked in a number of small animal clinics in Auckland. An anaesthesia passion took her to a large referral hospital in Australia in 2015. She has been working at the Royal Veterinary College since 2017.
Email: cscales@rvc.ac.uk

Niamh Clancy Dip AVN (Small Animal), DipHE, CVN, Dip VN, PGCert VetEd, FHEA, RVN

Niamh graduated from University College Dublin with her Diploma in Veterinary Nursing in 2011. She then moved to the UK and worked in hospitals across London while studying for her Advanced Diploma, which she obtained from Myerscough College in 2015. She currently divides her time as an anaesthesia nurse at the Queen Mother Hospital for Animals and as a Clinical Educator in Anaesthesia for the veterinary nursing school at the Royal Veterinary College. She recently obtained her Certificate in Veterinary Education.
Email: nclancy@rvc.ac.uk

DOI: 10.1080/17415349.2018.1553643

Introduction

Brachycephalic dogs are continually gaining popularity and between 2016 and 2017 there was a 25% increase in brachycephalic breeds in the top 10 registered breeds with The Kennel Club (The Kennel Club, 2018).

A study conducted by Brodbelt et al. (2008) suggests that these breeds are at an increased risk of mortality associated with anaesthesia. However, a more recent study states that it is in fact the degree of brachycephalic status that has the highest impact on mortality of these patients (Gruenheld et al., 2018). The primary reason for this increased risk is Brachycephalic Obstructive Airway Syndrome (BOAS). BOAS is described as a combination of anatomical abnormalities within the upper respiratory tract which can cause obstruction of the upper airway and dyspnea (Adshead, 2014).

Understanding brachycephalic-specific anatomy

Brachycephalic Airway Syndrome (BAS) is categorised by a number of anatomical abnormalities due to redundant soft tissue that remains when the bony structure of the skull is reduced in size (Brown & Gregory, 2005). This can result in the excess tissue obstructing the upper airway, known as Brachycephalic Obstructive Airway Syndrome (BOAS).

There are primary and secondary anatomical abnormalities (Meola, 2013) that cause stridor, exercise intolerance, respiratory distress, cyanosis and collapse (Gruenheld et al., 2018). Primary anatomical abnormalities in BAS dogs include stenotic nares, elongated soft palate, nasopharyngeal turbinates and a hypoplastic trachea (Meola, 2013). Secondary abnormalities form due to the continued trauma of the pharyngeal soft tissue being pulled into the airway as a result of the primary conditions. It causes swelling, saccule eversion and laryngeal collapse (Meola, 2013), as seen in Figure 1. The anatomical abnormalities and their effects are listed in Table 1.

Other specific brachycephalic anatomy and physiology considerations

Gastrointestinal complications include vomiting, regurgitation, ptyalism (Lodato & Hedlund, 2012), hiatal hernias (Callan et al., 1993) and pyloric stenosis (Peeters, 1991). The regurgitation may lead to aspiration pneumonia and a greater risk of respiratory fatigue (Shaver et al., 2017). Endoscopic and histologic changes were seen in 97% of a study group of brachycephalic dogs that had one or more upper respiratory tract abnormalities, where the most common finding was diffuse gastric inflammation (Poncet et al., 2005). One study showed that brachycephalic breeds of dogs have lower oesophageal pH (acidic) than non-brachycephalic dogs, and a high body condition score (BCS) significantly increases the severity of gastrointestinal findings (Aron & Crowe, 1985).

Dogs normally have three paranasal sinuses (lateral, rostral and medial frontal sinuses) which form the nasal passages; however, brachycephalic dogs are missing these (Brehm, Loeffler, & Komeyli, 1985), as shown in Figure 3.

Due to the shape of a brachycephalic skull, they may also be prone to globe proptosis because of the shallow orbit, so care should be taken during manual restraint (Severin, 1995). The skull shape should also be considered when performing an infraorbital nerve block to ensure globe penetration does not occur (Milella & Gurney, 2016).

Brachycephalic breeds may also suffer from a degree of facial nerve paralysis (Toombs & Hardy, 1981), and can have reduced palpebral reflexes due to fewer corneal sensory nerve fibres (Park et al., 2013). Constant lubrication and protection of the eyes should be performed.

English Bulldogs, Boxers and French Bulldogs have an increased occurrence of congenital cardiac abnormalities and acquired myocardial damage may also be seen in dogs with BAS (Oliveira et al., 2011). Brachycephalic breeds may have chronic hypoxia which causes hypoxic pulmonary vasoconstriction, leading to pulmonary hypertension and right-sided heart failure (Dugdale, 2011). They have high resting vagal tone making them prone to sinus bradycardia (Doxey and Boswood, 2004), sinus arrest and syncope, and second-degree atrioventricular block (Martin, 2015).

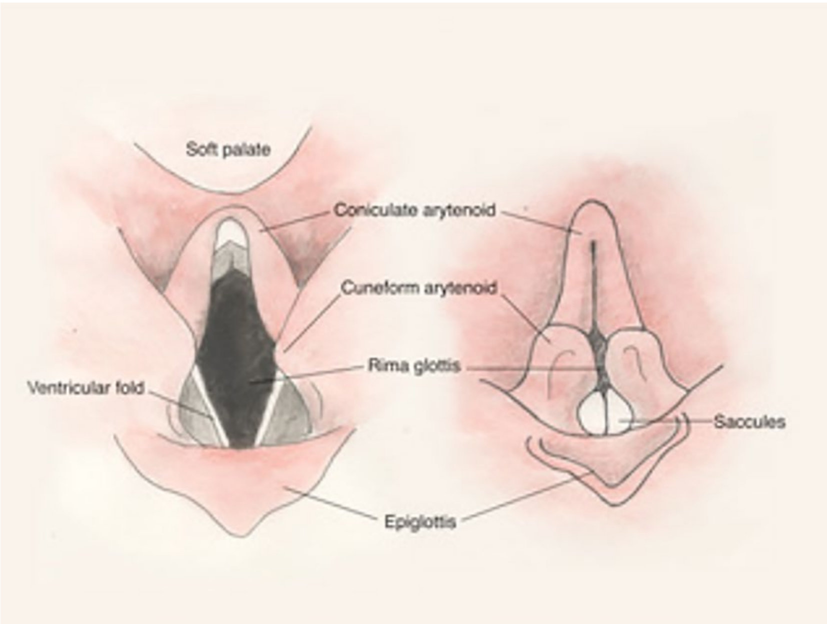

Figure 1. A normal airway compared to a collapsed airway of a BOAS dog.

The admission process

Prior to anaesthesia, a full patient history should be obtained to determine the risk for individual patients (Miller & Gannon, 2015). It should encompass the signalment, medical history and the reason for anaesthesia. The fasting status should also be confirmed as prolonged fasting (>6 hours) increases the incidence for reflux and increased gastric acidity (Galatos & Raptopoulos, 1995). Feeding a small meal of wet food 3 hours prior to anaesthesia may reduce the incidence of gastroesophageal reflux (GOR) (Savvas, Rallis & Raptopoulos, 2009). Administering 1 mg/kg omeprazole 4 hours prior to anaesthesia may also reduce the incidence of GOR (Panti et al., 2009).

The owner should be asked if there has been any recent dysphagia, vomiting, or regurgitation which may identify a loss of physiological separation of swallowing and breathing mechanisms which increases risk for aspiration pneumonia (Miller & Gannon, 2015).

Assessing sleeping habits (sleep apnoea, choking, sleeping sitting upright) and exercise intolerance can be effective in evaluating BAS and the urgency of surgical intervention (Roedler, Pohl, & Oechtering, 2013).

Table 1. Brachycephalic anatomical abnormalities.

Anatomy	Description	Physiological effects	Prevalence in BAS affected breeds
Stenotic nares	Narrow nostrils due to the collapse of the alae medially	The increase in airway resistance causes a greater pressure gradient to draw air in to lower airways resulting in the soft tissue structures being pulled caudally into the airway. Expiration is usually forced rather than being passive	46%
Elongated soft palate	The soft palate extends beyond the epiglottis	Causes obstruction and increasing airway resistance	Up to 100%
Nasopharyngeal turbinates	Abnormal turbinates extend caudally from the nasal cavities into the nasopharynx	Decrease the airflow through the nasal airway	21%, commonly seen in Pugs
Hypoplastic trachea	The tracheal cartilage is smaller and rigid. A hypoplastic trachea is defined as a tracheal diameter to tracheal inlet ratio (TD:TI) of <0.16 seen on a lateral radiograph (Thrall & Widmer, 2002) and is shown in Figure 2	A narrow larynx (due to soft tissue) can increase airway resistance by 16 times (Poiseuille's Law) that of a non-brachycephalic breed. The increased negative pressure to overcome this resistance pulls soft tissue structures into the airway (Meola, 2013)	13%, commonly seen in Bulldogs and Boston Terriers
Everted saccules and tonsils	Saccules are located between the vocal and ventricular folds	More effort is required to overcome negative pressure to pull air into the lungs and results in turbulent airflow and vibration of the soft tissues, causing oedema and inversion. It is considered the first stage of laryngeal collapse (Pink, Doyle, Hughes, Tobin, & Bellenger, 2006)	46%
Laryngeal collapse	The laryngeal cartilage is under chronic stress and progressively loses it rigidity (Brown & Gregory, 2005)	The cuneiform is pulled into the rima glottis opening causing an increase in airway resistance and obstruction. The stages of laryngeal collapse are listed in Table 2	53%

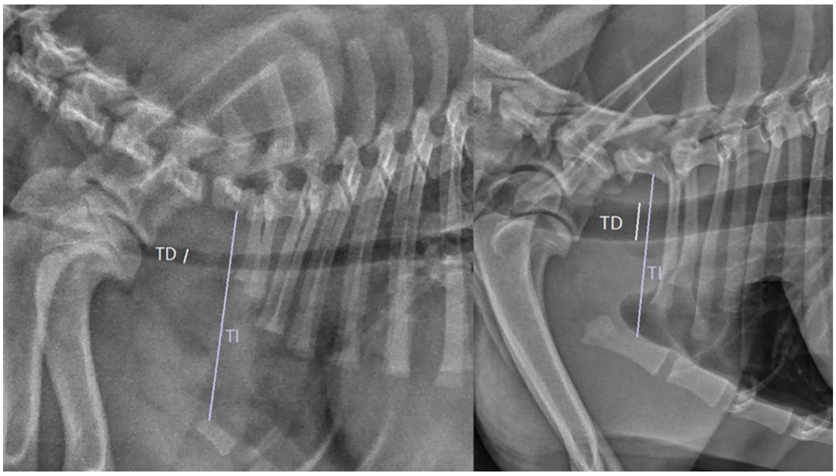

Figure 2. The TD:TI ratio in a brachycephalic and non-brachycephalic breed of the same weight.

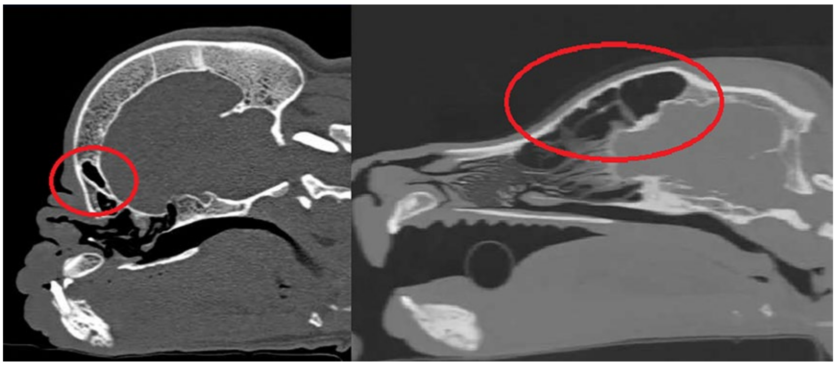

Figure 3. Sinus size of a Pug compared to a Labrador.

Table 2. The stages of laryngeal collapse.

Stage I – eversion of laryngeal saccules
Stage II – loss of rigidity and medial displacement of the cuneiform processes of the arytenoid cartilage
Stage III – collapse of the corniculate processes of the arytenoid cartilage with loss of the dorsal arch of the rima glottis
(Leonard, 1960)

The pre-anaesthetic physical exam

A basic assessment of the cardiovascular system is made by assessing the heart rate and rhythm, checking for pulse deficits and confirming the capillary refill time is adequate (Duncan, 2009). The heart should be auscultated for a minute on both sides of the chest to assess for murmurs (a low-grade murmur may be auscultated on one side and not the other).

The respiratory system is examined through auscultation of all lung fields (the cranial and caudal sections of both sides of the lungs (Lakelin, 2010)) and by observing the depth, rhythm and rate of ventilation. If wheezes or crackles are auscultated this can be an indication of aspiration pneumonia secondary to regurgitation. If aspiration pneumonia is suspected, conscious thoracic radiographs should be taken to assess the severity. This may lead to the veterinary surgeon postponing the anaesthetic until the clinical signs have subsided (Posner, 2016). Pneumonia can be devastating for these breeds due to their hypoplastic trachea, decreased airway clearance and an increased risk of respiratory fatigue (Shaver et al., 2017). Any respiratory noise should be differentiated between pneumonia or Upper Respiratory Tract (URT) noise. True URT noise is mostly heard during inhalation and sounds louder when the stethoscope is placed on the trachea.

Pre-anaesthetic blood testing

Prior to a healthy patient undergoing anaesthesia, minimal database testing consisting of packed cell volume (PCV), blood glucose (BG), blood urea nitrogen (BUN) and alanine aminotransferase (ALT) should be performed (Tear, 2017). These can give an indication of hydration status, protein binding ability, plus assessment of kidney and liver function. Additional testing can be performed if the patient is systemically unwell prior to anaesthesia, or dependant on if other abnormalities are detected in the previous blood testing. An arterial blood gas analysis would be a beneficial guide to assessing pulmonary gaseous exchange (Dugdale, 2011); however, this type of testing may not be readily available.

Arterial blood gas analysis allows assessment of the patient's partial pressure of oxygen and carbon dioxide (PaO_2 and $PaCO_2$). Hypoxaemia is defined as a PaO_2 below 75 mmHg (normally 75–100 mmHg on room air) with hypercapnia defined as a $PaCO_2$ above 42 mmHg (normally 38–42 mmHg). Brachycephalic breeds have a tendency towards a significantly higher $PaCO_2$ and lower PaO_2 than other breeds (Gruenheld et al., 2018).

Brachycephalic breeds can have a compensatory increase in haematocrit and haemoglobin due to the reduction in PaO_2 (Wrzesinska, Klucinski, & Garncarz, 2017). This increase in $PaCO_2$ can have significant effects on breathing. An increase in $PaCO_2$ is detected by the chemoreceptors, which are located in the carotid body on each side of the carotid bifurcation, the aortic body and in the medulla, resulting in increased activity of the medullary respiratory centre (Frazer, 2009). This leads to diaphragm contraction, an increased respiratory rate and depth, and a subsequent increase in work of breathing (WOB). Increased WOB exacerbates the negative pressure within the airway, causing inward collapse of the airway.

CO_2 in the body is converted to carbonic acid. This process releases hydrogen ions. Therefore, when $PaCO_2$ increases, the production of hydrogen ions increases and so respiratory acidosis results. Increases in CO_2 can also cause hyperkalaemia, decreased myocardial contractility and ventricular arrhythmias (Adshead, 2014). Therefore, if the level of hypoxaemia or hypercapnia is assessed prior to induction of anaesthesia, the veterinary team can prepare for its associated issues.

Body condition scoring (BCS)

An increase in BCS can lead to issues such as difficulty breathing, drug overdosing (versus dosing for the lean body weight) or drugs being injected into the fat rather than muscle, causing very slow distribution and effects. Some brachycephalic patients, such as pugs, can be difficult to BCS due to their skin folds. A breed-specific BCS has been developed for them, and is shown in Figure 4.

American Society of Anesthesiologists (ASA) physical status scale

This status is used to help the anaesthetist to determine the risk for each patient

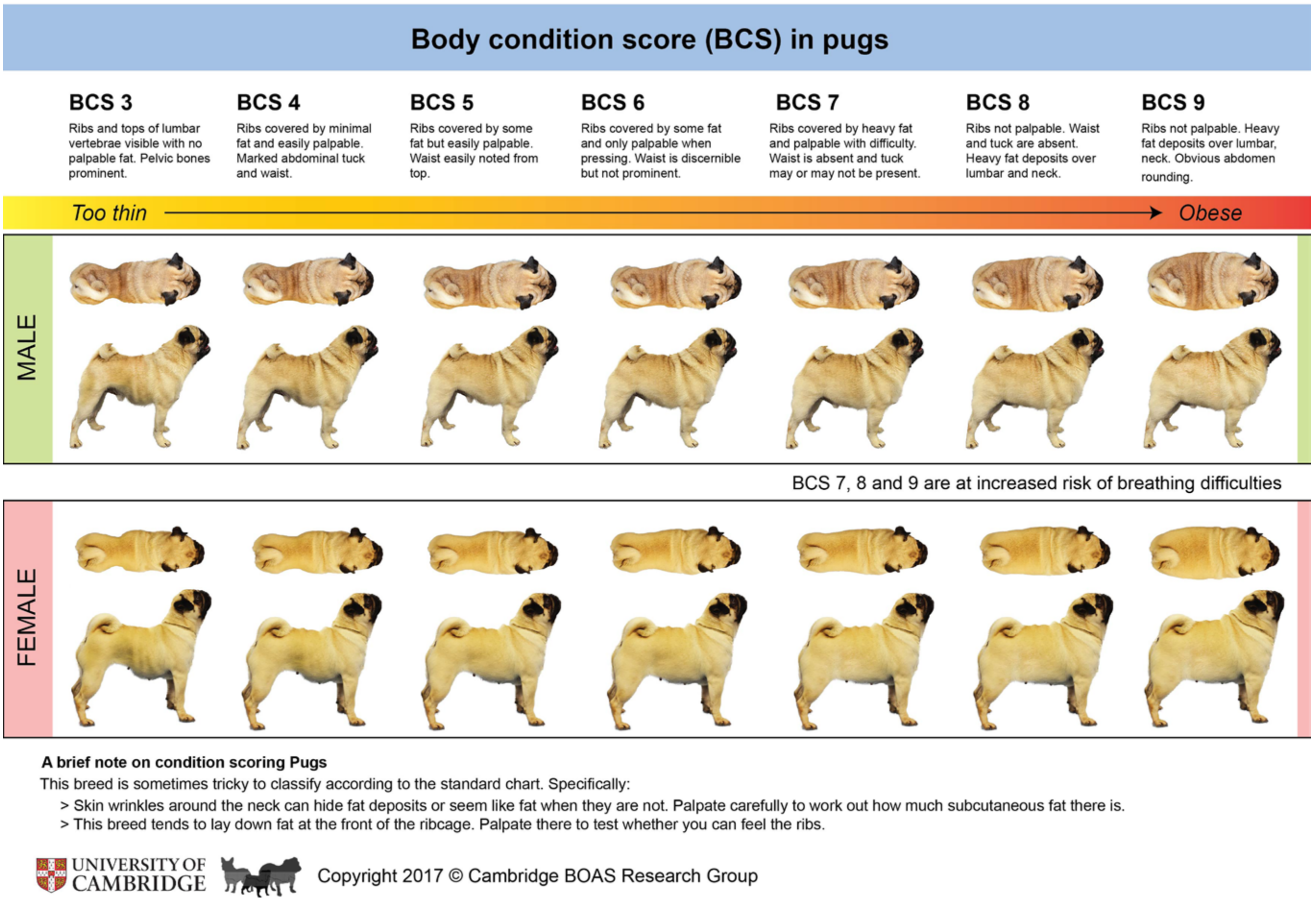

Figure 4. Breed-specific BCS for Pugs. Credit: Cambridge BOAS Research Group.

Table 3. ASA status adapted from Lysa P. Posner (2016), p. 6.

ASA scale	Physical description	Veterinary patient examples
I	Normal patient with no disease	Healthy patient scheduled for spay or castration
2	Patient with mild systemic disease that does not limit normal function	Controlled diabetes mellitus, mild cardiac valve insufficiency
3	Patient with moderate systemic disease that limits normal function	Uncontrolled diabetes mellitus, symptomatic heart disease
4	Patient with severe systemic disease that is a constant threat to life	Sepsis, organ failure, heart failure
5	Patient that is moribund and not expected to live 24 hours without surgery	Shock, multiple organ failure, severe trauma
E	Describes patient as an emergency	Gastric dilatation–volvulus, respiratory distress

undergoing general anaesthesia. Brachycephalic breeds are generally classed as an ASA II due to their morphology (Gruenheld et al., 2018), causing mild systemic disease that does not limit their normal function. However, some brachycephalic patients are not able to compensate for the issues caused by their morphology and therefore their systemic disease could limit their normal function, classifying them as an ASA III, putting them at a moderate risk of mortality under anaesthetic. The ASA classifications are given in Table 3.

Conclusion

This first article has shown the multifactoral considerations for brachycephalic breeds in the pre-anaesthesia period, and hopefully makes the veterinary team more informed to provide a tailored and safer pre-anaesthesia period.

Credits

Radiology Department of The Queen Mother Hospital for Animals for the MRI and radiograph images.

The Cambridge BOAS Research Group for the use of the Pug BSC Charts.

The support of the Anaesthesia Department of The Queen Mother Hospital for Animals.

Carol Hoy for the drawing of the airway.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Adshead, S. (2014). Reducing the risk of anaesthetic complications in patients with brachycephalic obstructive airway syndrome. *The Veterinary Nurse*, *5*(2), 78–87.

Aron, D., & Crowe, D. (1985). Upper airway obstruction general principles and selected conditions in the dog and cat. *Veterinary Clinics of North America: Small Animal Practice*, *15*(5), 891–917.

Brehm, H., Loeffler, K., & Komeyli, H. (1985). [Skull forms in dogs]. *Anatomia, Histologia, Embryologia*, *14*(4), 324–331.

Brodbelt, D., Blissitt, K., Hammond, R., Neath, P., Young, L., Pfeiffer, D., & Wood, J. (2008). The risk of death: The confidential enquiry into perioperative small animal fatalities. *Veterinary Anaesthesia and Analgesia*, *35*(5), 365–373.

Brown, D., & Gregory, S. (2005). In Daniel J. Brockman (Ed.), *BSAVA manual of canine and feline head, neck and thoracic surgery* (pp.84–87). London, UK: British Small Animal Veterinary Association.

Callan, M., Washabau, R., Saunders, H., Kerr, L., Prymak, C., & Holt, D. (1993). Congenital esophageal hiatal hernia in the Chinese Shar-Pei dog. *Journal of Veterinary Internal Medicine*, *7*(4), 210–215.

Cambridge BOAS Research Group. (2017). Pug body condition score chart. Retrieved from https://www.vet.cam.ac.uk/boas/about-boas/Pug_health_scheme_BCS_v2.jpg

Doxey, S., & Boswood, A. (2004). Differences between breeds of dog in a measure of heart rate variability. *Veterinary Record*, *154*(23), 713–717.

Dugdale, A. (2011). *Veterinary anaesthesia principles to practice*. New York, NY: John Wiley & Sons, p. 244.

Duncan, J. (2009). Preoperative assessment and preparation of the patient. In L. Welsh (Ed.), *Anaesthesia for veterinary nurses second edition* (pp. 39–70). Oxford, UK: Wiley-Blackwell.

Frazer, M. (2009). Physiology relevant to anaesthesia. In: L. Welsh (Ed.), *Anaesthesia for veterinary nurses* (2nd ed., pp. 39–70). Oxford: Wiley-Blackwell.

Galatos, A., & Raptopoulos, D. (1995). Gastro-oesophageal reflux during anaesthesia in the dog: The effect of preoperative fasting and premedication. *Veterinary Record*, *137*(19), 479–483.

Gruenheld, M., Aarnes, T., McLoughlin, M., Simpson, E., Mathys, D., Mollenkopf, D., & Wittum, T. (2018). Risk of anesthesia-related complications in brachycephalic dogs. *Journal of the American Veterinary Medical Association*, *253*(3), 301–306.

Lakelin, A. (2010). The preanesthetic workup. In E. Byrant (Eds.), *Anesthesia for vet techs* (pp. 42–66). Iowa: Wiley-Blackwell.

Lodato, D., & Hedlund, C. (2012). Brachycephalic airway syndrome: Pathophysiology and diagnosis. *Compendium of Continuing Education*, *34*(1–5), E3.

Martin, M. (2015). *Small Animal ECGs: An Introductory Guide* (3rd ed, p.115) London: John Wiley & Sons.

Meola, S. (2013). Brachycephalic airway syndrome. *Topics in Companion Animal Medicine*, *28*(3), 91–96.

Milella, L., & Gurney, M. (2016). In T. Duke-Novakovski, M. De, and C. Seymour (Eds.), *BSAVA manual of canine and feline anaesthesia and analgesia* (3rd ed., p. 275). London, UK: John Wiley & Sons, British Small Animal Veterinary Association.

Miller, J., & Gannon, K. (2015). Perioperative management of brachycephalic dogs. Cliniciansbrief.com. Retrieved from https://www.cliniciansbrief.com/article/perioperative-management-brachycephalic-dogs.

Oliveira, P., Domenech, O., Silva, J., Vannini, S., Bussadori, R., & Bussadori, C. (2011). Retrospective review of congenital heart disease in 976 dogs. *Journal of Veterinary Internal Medicine*, *25*(3), 477–483.

Panti, A., Bennett, R. C., Corletto, F., Brearley, J., Jeffery, N., Jeffrey, N., & Mellanby, R. J. (2009). The effect of omeprazole on oesophageal pH in dogs during anaesthesia. *The Journal of Small Animal Practice*, *50*(10), 540–544.

Park, Y., Son, W., Jeong, M., Seo, K., Lee, L., & Lee, I. (2013). Evaluation of risk factors for development of corneal ulcer after nonocular surgery in dogs: 14 cases (2009–2011). *Journal of the American Veterinary Medical Association*, *242*(11), 1544–1548.

Peeters, M. E. (1991). Pyloric stenosis in the dog: Developments in its surgical treatments and retrospective study in 47 patients. *Tijdschrift Diergeneeskunde*, 116, 137–141.

Pink, J., Doyle, R., Hughes, J., Tobin, E., & Bellenger, C. (2006). Laryngeal collapse in seven brachycephalic puppies. *Journal of Small Animal Practice*, *47*(3), 131–135.

Poncet, C., Dupre, G., Freiche, V., Estrada, M., Poubanne, Y., & Bouvy, B. (2005). Prevalence of gastrointestinal tract lesions in 73 brachycephalic dogs with upper respiratory syndrome. *Journal of Small Animal Practice*, *46*(6), 273–279.

Posner, L. (2016). In T. Duke-Novakovski, M. De, and C. Seymour, eds. *BSAVA manual of canine and feline anaesthesia and analgesia* (3rd ed., pp. 6). New York: John Wiley & Sons, British Small Animal Veterinary Association.

Roedler, F. S., Pohl, S., & Oechtering, G. U. (2013). How does severe brachycephaly affect dog's lives? Results of a structured preoperative owner questionnaire. *The Veterinary Journal*, *198*(3), 606–610.

Savvas, I., Rallis, T., & Raptopoulos, D. (2009). The effect of pre-anaesthetic fasting time and type of food on gastric content volume and acidity in dogs. *Veterinary Anaesthesia and Analgesia*, *36*(6), 539–546.

Severin, G. A. (1995). *Severin's veterinary ophthalmology notes* (3rd ed.). Ft. Collins, CO: Veterinary Ophthalmology Notes.

Shaver, S. L., Barbur, L. A., Jimenez, D. A., Brainard, B. M., Cornell, K. K., Radlinsky, M. G., & Schmiedt, C. W. (2017). Evaluation of gastroesophageal reflux in anesthetized dogs with brachycephalic syndrome. *Journal of the American Animal Hospital*, *53*(1), 24–31.

Tear, M. (2017). *Small Animal Surgical Nursing* (3rd ed, p. 45). St. Louis: Elsevier.

The Kennel Club. (2018). Top twenty breeds in registration order for the years 2016 and 2017. Retrieved from https://www.thekennelclub.org.uk/media/1159441/top_20_breeds_2016_-_2017.pdf.

Thrall, D., & Widmer, W. (2002). *Textbook of veterinary diagnostic radiology* (4th ed.). Philadelphia: WB Saunders.

Toombs, J. P., & Hardy, R. M. (1981). Neurologic signs associated with congenital anomalies in a Yorkshire terrier. *Veterinary Medicine, Small Animal Clinician: VM, Sac*, *76*(2), 207–214.

Wrzesinska, A., Klucinski, W., & Garncarz, M. (2017). Usefulness of basic laboratory parameters for monitoring during the perianesthetic period for selected ophthalmic operations in mesaticephalic and brachycephalic dogs. *Medycyna Weterynaryjna*, *73*(10), 666–670.

Multiple Choice Questions

1. **Which factor is not relevant when assessing a brachycephalic patient's risk of pneumonia?**
   - **(a)** Whether eating difficulties are present
   - **(b)** Auscultating all lung fields
   - **(c)** Thoracic radiographs, if indicated
   - **(d)** Assessing presence of a heart murmur

2. **How can the mechanism that causes increased work of breathing be simply described (WOB)?**
   - **(a)** Increased carbon dioxide in blood increases diaphragm contractions
   - **(b)** Increased oxygen in blood increases activity in the medullary respiratory centre
   - **(c)** Increased carbon dioxide in blood decreases negative pressure
   - **(d)** The carotid bifurcation increases negative pressure

3. **Which of the following is FALSE? Other considerations in the pre-anaesthetic period include:**
   - **(a)** Using a Body Condition Scoring system specifically adapted to brachycephalic breeds
   - **(b)** Assuming all brachycephalic patients are a III on the ASA scale
   - **(c)** Taking care during intramuscular injections not to accidentally inject into fatty tissue
   - **(d)** Assessing whether the patient experiences sleep disruption due to breathing prior to anaesthesia

4. **A secondary anatomical abnormality related to BAS is:**
   - **(a)** Stenotic nares
   - **(b)** Hypoplastic trachea
   - **(c)** Laryngeal collapse
   - **(d)** Long soft palate

5. **Which of the following is TRUE of pre-operative fasting for the brachycephalic patient?**
   - **(a)** Patients should be fasted for 24 hours to ensure the GIT is empty
   - **(b)** A small snack of wet food 3 hours before anaesthesia can reduce acid reflex
   - **(c)** The length of time since last feed will influence whether or not to provide pre-anaesthetic omeprazole
   - **(d)** Eating difficulties have little to do with anaesthetic regurgitation risks

6. **Other anatomic differences in brachycephalic breeds include (which is FALSE?):**
   - **(a)** Increased oesophageal pH
   - **(b)** Proptosis
   - **(c)** Reduced palpebral reflexes
   - **(d)** Congenital cardiac abnormalities

7. **Compared to other breeds, brachycephalic breeds have:**
   - **(a)** Increased partial pressure of carbon dioxide and increased partial pressure of oxygen
   - **(b)** Decreased partial pressure of carbon dioxide and increased partial pressure of oxygen
   - **(c)** Decreased partial pressure of carbon dioxide and decreased partial pressure of oxygen
   - **(d)** Increased partial pressure of carbon dioxide and decreased partial pressure of oxygen

For the answers to the MCQs, please go to: **http://www.bvna.org.uk/publications/veterinary-nursing-journal**