Brachycephalic dogs (e.g., bulldogs, pugs, Shih Tzus) are extremely popular as pets, and their presentation for procedures that require anesthesia is common. This general review of anesthetic management of brachycephalic dogs focuses on dogs with components of brachycephalic obstructive airway syndrome (BOAS) but does not address specific procedures for airway surgery. Dogs with concurrent comorbidities or age-related physiologic changes may need drugs or dosages other than those discussed in this article. The overall health of the animal must be considered before choosing anesthetic protocols. The fundamental goals of anesthetic management in brachycephalic dogs are listed in BOX 1.

**BOX 1 Goals of Anesthetic Management in Brachycephalic Patients**
- Maintain a stress-free induction and recovery
- Support tissue oxygen delivery throughout the entire anesthetic procedure
- Secure and maintain a patent airway
- Control vomiting/aspiration to prevent aspiration pneumonia
- Provide a pain-free recovery

**PHYSICAL FACTORS AFFECTING ANESTHESIA MANAGEMENT IN BRACHYCEPHALIC DOGS**
Among other complications, the flattened features of the brachycephalic skull compress upper airway structures, which can cause a variety of medical problems and be particularly concerning for anesthetic safety. The main effect of narrowed airway structures in these animals is increased work of breathing. Any increase in respiratory effort, such as that caused by stress, excitement, pain, or hyperthermia, causes

**SPECIAL CONSIDERATIONS**
Brachycephalic obstructive airway syndrome increases the likelihood of anesthesia complications, making appropriate management of these patients critical for anesthetic safety.
increasingly negative airway pressure and further airway narrowing with subsequent hypoventilation, hypoxemia, hypercarbia, and, potentially, airway collapse. Thus, a major goal of anesthetic management in these patients is avoidance of stressful situations.

Brachycephalic Obstructive Airway Syndrome

Many brachycephalic patients have components of BOAS. Airway components of BOAS and their impact on anesthesia are listed in Table 1.

Brachycephalic dogs with BOAS are twice as likely to have anesthesia complications as nonbrachycephalic dogs, with most complications, primarily dyspnea, regurgitation, and aspiration pneumonia, occurring in the postoperative period.\(^1,2\) Prevention of aspiration pneumonia is also a main goal of anesthetic management,\(^2\) and the author recommends antiemetics for all brachycephalic patients undergoing anesthesia.

In one study, the rate of postoperative complications in brachycephalic dogs undergoing anesthesia for imaging or surgeries other than airway surgeries was 13.9% versus 3.6% in nonbrachycephalic dogs.\(^1\) In the same study, brachycephalic dogs were 1.57 times as likely to have intra-anesthetic complications and 4.33 times as likely to have postanesthetic complications. Although complications in recovery after surgery to correct BOAS are common, dogs that had a previous airway surgery to correct components of BOAS had fewer complications in the recovery period of a subsequent anesthetic event.\(^3\) Thus, surgical correction of BOAS components should be done at an early age to improve

<table>
<thead>
<tr>
<th>AIRWAY ABNORMALITY</th>
<th>RESULT</th>
<th>CLINICAL EFFECT</th>
<th>EFFECT ON ANESTHESIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoplastic trachea</td>
<td>Narrowed airway</td>
<td>Cause increased work of breathing, increased inspiratory pressure, and turbulent airflow</td>
<td>Requires smaller endotracheal tube than expected based on body size</td>
</tr>
<tr>
<td>Elongated soft palate, everted laryngeal sacules, redundant pharyngeal folds, tonsillar hyperplasia, laryngeal collapse</td>
<td></td>
<td>Can contribute to difficult intubation and airway narrowing/collapse after extubation</td>
<td></td>
</tr>
<tr>
<td>Airway inflammation and edema secondary to negative airway pressure and subsequent turbulent airflow</td>
<td>Narrowed airway</td>
<td>Increased inspiratory pressure can result in airway collapse</td>
<td>May require administration of steroids to control inflammation</td>
</tr>
<tr>
<td>Stenotic nares</td>
<td>Inability to cover tracheal opening to protect airway</td>
<td>Aspiration of vomitus or regurgitant fluid is common and can lead to aspiration pneumonia</td>
<td>Nares should be surgically enlarged early in life, often at time of neutering or earlier</td>
</tr>
<tr>
<td>Small epiglottis</td>
<td></td>
<td>Use antiemetics</td>
<td></td>
</tr>
</tbody>
</table>

Not all abnormalities are present in all BOAS patients. BOAS = brachycephalic obstructive airway syndrome.
both quality of life and safety of subsequent anesthetic procedures.

Cardiovascular Concerns
Brachycephalics have higher vagal tone than dogs of other breeds, and those with BOAS can have an exaggerated vagal response with rapid and potentially profound bradycardia when the upper airway is manipulated, as during surgery, intubation, or extubation. Anticholinergics may be indicated in some patients (see Potential Adjunct Drugs).

Gastrointestinal Disease
Esophageal and gastrointestinal (GI) tract lesions, including esophagitis, gastroesophageal reflux, gastritis, and hiatal hernia, are prevalent in brachycephalic dogs with upper respiratory dysfunction. A history of signs of GI abnormalities is highly linked to risk of aspiration pneumonia. Stabilization or treatment of GI disease prior to anesthesia is recommended. However, correction of upper airway dysfunction is often the key to resolution of GI signs.

The presence of a hiatal hernia is a risk factor for gastroesophageal reflux, as is prolonged fasting. Thus, prolonged fasting may not be appropriate for brachycephalic dogs. A fast time of less than 6 hours is recommended in the American Animal Hospital Association guidelines, and a small meal 3 hours prior to anesthesia may be beneficial to decrease reflux. However, ideal fasting times are still unknown and “standard” fasting times (i.e., no food after midnight the day before surgery) may still be appropriate.

Antacids and gastroprotegrants, along with prokinetics, are often recommended for brachycephalics but can be overused (see Potential Adjunct Drugs). The American College of Veterinary Internal Medicine has published an in-depth review and consensus statement on the use of these drugs.

Ophthalmic Concerns
Exophthalmos (proptosis) can increase ocular contact with blankets, scrub solution, cage doors, and other items, making corneal ulceration or other eye damage more likely. Patients should be carefully positioned to prevent any external pressure on the eye, and eye lubricant should be liberally applied before, during, and after general anesthesia.

### TABLE 2 Sedatives/Tranquilizers

<table>
<thead>
<tr>
<th>DRUG/DRUG CLASS</th>
<th>DOSE</th>
<th>COMMENTS AND CONCERNS FOR BRACHYCEPHALICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acepromazine</td>
<td>0.01–0.02 mg/kg IM or IV</td>
<td>Light-moderate sedation with minimal to no respiratory depression for several hours; commonly used by the author in brachycephalic patients. No analgesia, effects not reversible.</td>
</tr>
<tr>
<td>α2 agonists (e.g., dexametomidine)</td>
<td>0.002–0.004 mg/kg IM or IV if calm; may require higher dosages if fear/anxiety/stress (FAS) is high</td>
<td>Potent sedatives, often necessary for adequate sedation, especially in patients with high FAS. If high dosages are necessary in dogs with brachycephalic obstructive airway syndrome, assign a veterinary nurse to stay with the patient and be prepared to provide oxygen or intubate. Vomiting can be prevented by pretreatment with antiemetics. Vomiting is unlikely with IV administration, but stress of restraint should be weighed against advantage of IV injection. Provides analgesia. Effects can be reversed with atipamezole.</td>
</tr>
<tr>
<td>Benzodiazepines (e.g., midazolam, diazepam)</td>
<td>0.2–0.4 mg/kg midazolam IM or IV; diazepam IV only</td>
<td>Rarely provide adequate sedation when used alone and have the potential to cause paradoxical excitement; thus, best used as part of induction. However, in compromised patients a benzodiazepine combined with an opioid may be effective.</td>
</tr>
<tr>
<td>Opioids</td>
<td>Various</td>
<td>Potent opioids can be sedating, especially when combined with a sedative; effects are reversible. See more comments in TABLE 4.</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>0.2–0.4 mg/kg IM or IV</td>
<td>Provides light to moderate sedation with minimal to no effects on respiration and is labeled as an antitussive; therefore, may decrease airway reactivity. Provides only mild, short-duration analgesia.</td>
</tr>
<tr>
<td>Drug combinations</td>
<td>Various</td>
<td>A combination of an opioid plus 1 of the sedatives listed above provides more effective, predictable sedation than sedatives or opioids used alone.</td>
</tr>
</tbody>
</table>
CONSIDERATIONS IN DRUG CHOICE FOR BRACHYCEPHALIC ANESTHETIC PROTOCOLS

Anesthetic and Sedative Drugs
Safe anesthesia for patients with upper airway dysfunction depends more on patient management than on drug choice. Both intubation and extubation can be difficult for the anesthetist and dangerous for the patient. Almost all anesthetic and sedative drugs are acceptable for use in brachycephalic patients, but the most appropriate drugs are those that are fast acting (for rapid intubation), have a short duration of action, and/or are reversible (for quick return to consciousness and normal breathing) (TABLES 2 AND 3). Although considered a longer duration drug, low-dose

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE IN SEDATED PATIENTS</th>
<th>COMMENTS AND CONCERNS FOR BRACHYCEPHALICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propofol or alfaxalone</td>
<td>2–4 mg/kg of either drug</td>
<td>Propofol and alfaxalone can both be easily titrated to effect due to their rapid onset of action, making them both good choices. Administer with midazolam or diazepam to decrease the induction dose. In 1 study, midazolam (0.25 mg/kg) administered before dosing propofol to effect in 0.5 mg/kg increments decreased the final propofol dose, but not as much as the administration of 1 mg/kg propofol administered before 0.25 mg/kg midazolam, followed by propofol to effect. The latter technique also decreased midazolam-induced excitement. The author uses alfaxalone in a similar manner. Both are respiratory depressants; therefore, low doses and preoxygenation are important.</td>
</tr>
<tr>
<td>Ketamine plus a benzodiazepine</td>
<td>2–5 mg/kg ketamine + 0.2–0.4 mg/kg midazolam or diazepam</td>
<td>A good choice for most patients. Provides a slightly slower onset of action than propofol or alfaxalone, but causes minimal to no respiratory depression. The swallowing reflex is maintained for longer than with propofol or alfaxalone, but an adequate depth of anesthesia will prevent the reflex.</td>
</tr>
<tr>
<td>Tiletamine/zolazepam</td>
<td>1–4 mg/kg</td>
<td>Long duration may affect recovery time. If the procedure is very short (e.g., laryngeal examination), the author generally chooses a drug with shorter duration.</td>
</tr>
<tr>
<td>Etomidate</td>
<td>1–3 mg/kg</td>
<td>Primarily chosen if the patient has concurrent cardiac disease. Mild respiratory depressant; therefore, low doses and preoxygenation are important.</td>
</tr>
<tr>
<td>Inhalants</td>
<td>Not appropriate unless no other method is available (e.g., no vein accessible for IV induction)</td>
<td>Do not box or mask with inhalants. Induction with inhalants alone is a risk factor for death in dogs. The prolonged time to secure a patent airway is very dangerous for brachycephalic dogs.</td>
</tr>
</tbody>
</table>
Acepromazine can be a good option for sedation since it provides calming that lasts into recovery.

While there are no drug contraindications, deep sedation, if necessary, should be delayed until the anesthetist is prepared to quickly induce and intubate if sedation causes respiratory difficulty. Light sedation, on the other hand, is beneficial to prevent increased respiratory effort. Drugs and drug dosages that might cause prolonged recovery with subsequent delay to normal breathing are not ideal.

Most patients are anesthetized with inhalants (isoflurane, sevoflurane). These drugs cause dose-dependent respiratory and cardiovascular depression that can extend into the recovery period, especially if a high or prolonged dose of inhalants is administered. Use of robust and proactive analgesia is imperative to allow the lowest possible dose of inhalants.

Analgesic Drugs

Pain control throughout the entire anesthetic episode is critical, as pain is a major contributor to increased respiratory effort. Analgesic drugs and techniques should be incorporated into a balanced, multimodal protocol using knowledge of the drug(s) mechanism of action and site of action in the pain pathway (FIGURE 1).

Opioids are potent analgesics and should be included in most protocols; however, strong focus should also be on nonsedating drugs such as nonsteroidal anti-inflammatory drugs (NSAIDs) and local anesthetics. Analgesic choices are discussed in TABLE 4.

Potential Adjunct Drugs

Use of the following drugs/drug classes in anesthetic protocols for brachycephalic patients is somewhat controversial, with no strong expert consensus; however, they are commonly used adjuncts in clinical practice.

Anticholinergics

Based on the risk for bradycardia due to exaggerated vagal response, some veterinarians premedicate all brachycephalic dogs with an anticholinergic (atropine or glycopyrrolate), while others use anticholinergics for treatment of bradycardia if it occurs. The author does not routinely administer anticholinergics; however, routine anticholinergics can be considered in heart-healthy patients that have not received an α₂ agonist.

<table>
<thead>
<tr>
<th>PHASE OF ANESTHESIA</th>
<th>DRUG</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preanesthesia/ Premedication</td>
<td>Nonsteroidal anti-inflammatory drugs (NSAIDs)</td>
<td>Often withheld until the recovery phase in case steroids are required</td>
</tr>
<tr>
<td></td>
<td>Opioids</td>
<td>Opioids generally provide both sedation and analgesia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Choose the opioid based on the pain level. Methadone, hydromorphone, morphine, or fentanyl should be used for moderate to profound pain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Opioid-induced vomiting can be prevented by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) pretreatment with an antiemetic (author’s preference),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) administration of opioids that are unlikely to cause vomiting (e.g., methadone, fentanyl, butorphanol, buprenorphine),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3) IV administration of the opioid just before induction, and/or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4) administration of the opioid after the patient is anesthetized but before initiating pain.</td>
</tr>
<tr>
<td></td>
<td>α₂ agonists</td>
<td>Provide both sedation and analgesia. See more comments in TABLE 2.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Local/regional anesthetic blocks</td>
<td>Highly recommended. Powerful analgesics, not sedating.</td>
</tr>
<tr>
<td></td>
<td>Opioid bolus</td>
<td>Equal to or half of the premedication dose</td>
</tr>
<tr>
<td></td>
<td>Constant-rate infusions</td>
<td>Opioids, lidocaine, and/or ketamine</td>
</tr>
<tr>
<td>Recovery</td>
<td>Opioids</td>
<td>Equal to or half of the premedication dose, depending on the level of pain and other analgesics that were administered.</td>
</tr>
<tr>
<td></td>
<td>α₂ agonists</td>
<td>Low dose of dexmedetomidine (0.0005–0.002 mg/kg) for calming and mild analgesia</td>
</tr>
<tr>
<td></td>
<td>NSAIDs</td>
<td>If steroids were not administered</td>
</tr>
</tbody>
</table>
Steroids
Airway inflammation in brachycephalics with BOAS is often severe and may require steroids (e.g., dexamethasone-SP 0.1 mg/kg IV) for control. Due to steroid-mediated effects, many veterinarians recommend steroids for all airway surgeries and potentially for surgeries on other systems if preexisting inflammation is moderate to severe or intubation was difficult and potentially traumatic.

Steroids can be administered preoperatively if the presence of moderate to severe inflammation is known or expected, postintubation if intubation was traumatic or if moderate to severe inflammation is identified on visualization of the upper airway during intubation, or in recovery if the patient is having difficulty breathing after extubation. NSAIDs should not be administered preoperatively if steroid use is predicted and are often withheld for use in the recovery phase as long as steroids were not administered.

Gastroprotectants and Prokinetics
Due to the strong association of BOAS and GI lesions, gastroprotectants and/or prokinetics have been recommended for brachycephalic dogs undergoing surgery. Histamine blockers, proton pump inhibitors, and promotility drugs (e.g., cisapride, metoclopramide) have all been used with varied success. However, there is no consensus on the routine use of these drugs in brachycephalics and indiscriminate use can be detrimental. The current recommendation is to administer the appropriate drug to dogs showing signs of GI disease, but there is evidence that not all dogs with GI lesions exhibit signs. The author uses protectants in dogs with GI signs and/or severe BOAS.

STEP-BY-STEP ANESTHESIA MANAGEMENT OF BRACHYCEPHALIC DOGS

As for all patients, a plan should be developed prior to anesthetizing the patient and should address the needs and concerns for all 4 phases of anesthesia: preanesthesia, induction, maintenance, and recovery/discharge. For all phases of anesthesia, focus on airway management/oxygenation and dose drugs on lean body weight. Keys to successful anesthesia in brachycephalic patients are outlined in BOX 2.

Phase 1: Preanesthesia
Main concerns and potential complications:
Increased inspiratory effort with potential for severe dyspnea/airway collapse leading to hypoxemia, hypercarbia, and hyperthermia.

Prior to the Day of Anesthesia
Prepare the patient for safe anesthesia before the anesthetic event. This includes stabilization of any disease processes.

Tip: Take thoracic radiographs preoperatively. In one study, 40% of dogs with aspiration pneumonia postoperatively had evidence of pneumonia preoperatively. Preexisting pneumonia should be treated prior to anesthesia if possible.

Preexisting GI lesions should also be treated prior to anesthesia if possible.

The Day of Anesthesia at Home
Tip: To decrease increased respiratory effort and work
of breathing from fear/anxiety/stress (FAS) in patients already exhibiting FAS or expected to develop FAS at the hospital, have the pet owner administer oral anxiolytics (e.g., gabapentin 10 to 20 mg/kg or trazodone 3 to 5 mg/kg) 2 hours prior to leaving home.

**Tip:** Have the pet owner administer an oral antiemetic (e.g., maropitant) at home on the day of anesthesia to reduce not only in-clinic causes of vomiting (e.g., administration of emetic drugs like opioids) but also emesis that may occur during transportation to the hospital.

The Day of Anesthesia in the Hospital

Prepare the anesthesia equipment before or immediately after the patient’s arrival at the hospital.

One of the most important safety factors for anesthetizing patients, especially those with airway dysfunction, is to have the necessary anesthesia equipment ready in the event of an airway emergency.

- Ensure that the oxygen supply is open/connected, the appropriate breathing circuit is attached to the machine, and the machine/breathing circuit combination has been pressure-checked.
- Prepare for an emergency intubation.

![FIGURE 2. Approximate endotracheal tube sizes for (A) a 10-kg non-brachycephalic dog (sizes 7, 7.5, 8) and (B) a 10-kg brachycephalic dog (sizes 6, 6.5, 7).](image)
injection and delivered slowly if administering IV (over 1 to 2 minutes) to prevent maropitant-induced hypotension.\(^{22}\)

- Anticholinergics are not necessarily recommended as routine premedicants for all patients, but a dose of either atropine (0.04 mg/kg) or glycopyrrolate (0.01 to 0.02 mg/kg) should be calculated in case sudden bradycardia occurs.
- GI protectants may be necessary or recommended.

**Phase 2: Induction and Intubation**

**Main concerns and potential complications:** Difficult intubation or prolonged time to intubation with subsequent hypoxemia and/or airway collapse and decreased tissue oxygen delivery. See **BOX 3** for tips for a difficult intubation.

- Choose appropriate induction drug and dose (**TABLE 3**).
- Be prepared to intubate.
- Preoxygenate to support tissue oxygen delivery (**FIGURE 3**). Administration of 100% oxygen for as short as 3 minutes increases the time to desaturation (oxygen saturation \(\text{SpO}_2\) <90%) from approximately 1 minute to approximately 5 minutes.\(^{23}\)
- Administer the induction drug and intubate when the

**BOX 3 Tips for a Difficult Intubation**

- Use a laryngoscope for good visualization.
- Have an assistant extend the tongue as far as possible from the mouth and use gauze to hold the maxilla so that the holder’s fingers do not obscure the view (**FIGURE A**).
- Ensure adequate anesthetic depth. Titrate more induction drug if the patient is swallowing.
- Place several drops of lidocaine on each arytenoid and deliver oxygen for 3 minutes while the lidocaine is taking effect.
- Place a relatively stiff but bendable stylet in the endotracheal tube (ETT) to give the tube some rigidity to use in lifting the soft palate out of the field of view (**FIGURE B**). Unless the stylet tip is soft, do not extend it beyond the tip or Murphy eye of the ETT.
- Lubricate the ETT so it slides easier. Lubrication also aids in achieving an adequate ETT cuff seal to the tracheal wall.
- If necessary to obtain a patent airway, place an ETT smaller than desired. When the patient is more deeply anesthetized, attempt to replace the ETT by first inserting a flexible stylet (e.g., red rubber catheter) through the existing tube. Leave the catheter in the airway as the existing ETT is removed and slide a larger ETT over the catheter. This often helps guide the new tube into place.
- **Advanced tip:** Slow IV administration of 1.5 mg/kg of lidocaine 5 minutes prior to administration of propofol (and likely alfaxalone) decreases the gag and cough reflexes and may make intubation easier.\(^{23}\) This is not always necessary but can be useful.
- If all else fails, a tracheotomy can be lifesaving, although it can be difficult in patients with a hypoplastic trachea. This technique is described elsewhere.\(^{24}\)

**FIGURE A.** Gauze holding the maxilla open.

**FIGURE B.** Bendable stylet in the endotracheal tube. This type of stylet should not be extended beyond the tracheal opening of the endotracheal tube, as it could damage the airway.
jaw tone is decreased and no swallowing occurs if the pharynx/larynx is touched with the tube. Do not attempt to intubate if the patient is still swallowing. This could cause trauma to an already potentially inflamed/edematous upper airway.

- The anesthetist should visualize the larynx using a laryngoscope or other light source both to assist with intubation and to evaluate the degree of upper airway pathology, which is important for the anesthetic recovery plan.

- Following intubation, immediately inflate the ETT cuff and connect the ETT to the breathing circuit with oxygen flowing.

- Lubricate the eyes.

Phase 3: Maintenance

**Main concerns and potential complications:** Excessive anesthetic depth due to inadequate analgesia and difficulty breathing if obese.

The inhalant dose should be kept as low as possible to decrease the negative effect on blood pressure and ventilation and to decrease inhalant effect on prolonged recovery. The procedure should be kept as short as possible, as increasing anesthetic duration has been associated with anesthetic complications. ³

**Anesthesia**

- Choose appropriate maintenance drug and dose.

- Very short procedures may be completed using injectable anesthesia (e.g., ketamine/benzodiazepine, tiletamine-zolazepam bolus, propofol or alfaxalone infusion), but intubation is required. The procedure time should be kept to an absolute minimum and repeat or prolonged dosing avoided, as drug accumulation could delay recovery, especially if drug metabolism is slowed for any reason. Propofol and alfaxalone cause more respiratory depression than the 2 dissociatives listed but also have shorter duration of action.

**Analgesia**

- Choose appropriate analgesic drug, technique, and dose (TABLE 4).

- Provision of analgesia is necessary not only for pain control but also to allow use of the lowest possible inhalant dose.

- **Use local anesthesia blockade whenever possible.** Local anesthetics are very potent analgesics that have numerous benefits for the patient. Local anesthetic blocks are not sedating and so do not compromise return to consciousness. Blockade of the maxillary nerve desensitizes structures often involved in upper airway surgery (e.g., nares, sinuses, soft palate); for surgery in other areas, use appropriate local/regional blocks. More information on blocks and on local anesthetic drugs is published elsewhere. ¹⁶,¹⁷

- Constant-rate infusions are also strongly recommended, and an open-access infusion calculator is available. ¹⁸ Infusions are administered at very low dosages and can provide analgesia with minimal to no sedation. In addition to, or instead of, opioids, which can cause some degree of respiratory depression, ketamine and/or lidocaine (ketamine 10 µg/kg/min; lidocaine 25 to 50 µg/kg/min) should be considered.

**Monitoring and Support**

Physiologic monitoring and support during maintenance are not specific for BOAS but might include specific monitoring and support for underlying...
disease. The anesthetist should address all organ systems (e.g., cardiovascular and respiratory systems) and make any corrections necessary to support normal physiologic function (e.g., correction of hypotension and/or hypoventilation).

Although the clinical relevance is unknown, brachycephalic animals can have inherently decreased arterial oxygen saturation, increased carbon dioxide levels, and hypertension, potentially increasing the likelihood of anesthesia-related adverse events and emphasizing the need for diligent anesthetic monitoring and support.

Many brachycephalic patients are also obese, necessitating intermittent or continuous ventilatory support. Ventilation must also be supported if the ETT is significantly smaller than the trachea to avoid excessive work of breathing. Ventilate to an end-tidal CO₂ of 35 to 45 mm Hg and SpO₂ greater than 95% in patients receiving 98% to 100% supplemental oxygen. More on ventilation of brachycephalics is published elsewhere.

Body temperature monitoring is critical as hypothermia can contribute to respiratory depression and delayed recovery.

Phase 4: Recovery and Discharge

Main concerns and potential complications: Hypoxemia, dyspnea/apnea, airway collapse/obstruction in the extubated patient.

Recovery

Have a recovery plan for the patient that includes timing of extubation. Recovery is generally the most
critical part of the entire anesthetic episode with the highest incidence of adverse effects.

- The patient should be kept calm and pain-free for optimal recovery. Specific drugs for the recovery period might include:
  - Dexmedetomidine (0.0005 to 0.002 mg/kg) or acepromazine (0.005 to 0.01 mg/kg). IV administration for fast onset may be beneficial and is necessary in patients experiencing respiratory distress.
  - Opioids administered at equal to or half of the premedication dose, depending on the level of pain and other analgesics administered.
  - The patient should be kept warm for optimal recovery. Hypothermia will prolong recovery time and return to normal breathing. Shivering increases oxygen consumption, which may not be met by oxygen delivery if the patient cannot breathe, and oxygen debt (inadequate tissue oxygenation) may occur.
  - Use the pulse oximeter to monitor adequacy of oxygenation, especially after extubation. If the tongue is not accessible, alternative sites of pulse oximeter probe placement can be used (FIGURE 4).

- If excessive sedation is present, administer reversal drugs for opioids (butorphanol, naloxone) or α₂ agonists (atipamezole), but carefully weigh the excitatory/pain effects that can occur with reversal. The most prudent path is generally to wait for the patient to metabolize injectable drugs and/or exhale inhalants. A calm, controlled recovery is ideal. A rapid, excitatory recovery is dangerous.

- If reversal is chosen, reverse to effect: Draw up the patient’s dose of naloxone (opioids) or atipamezole (α₂ agonists) and dilute with 5 mL of saline. Then slowly administer IV and monitor response until the patient is more alert but not necessarily fully awake. IV administration of atipamezole is off-label.

- Always be prepared to reanesthetize and reintubate if the patient cannot breathe.

- Reintubation allows time for analgesics, steroids, or other drugs to take effect and for pharyngeal edema and inflammation to resolve. More advanced techniques, such as placing gauze sponges soaked with mannitol on the edematous tissue, can be done in an intubated patient.²

- Reintubation also allows the anesthetist to breathe for the patient. This prevents respiratory muscle fatigue secondary to increased work of breathing, which is often a major component of mortality. Inhalants can be used to prolong intubation, as can repeat doses or infusions of propofol or alfaxalone if used for a short duration.

- Consider a tracheotomy if the upper airway dysfunction is severe or if the airway is obstructed. This technique is reported elsewhere.²⁷

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- Consider a tracheotomy if the upper airway dysfunction is severe or if the airway is obstructed. This technique is reported elsewhere.²⁷

**Discharge**

- Discharge with analgesic drugs and, if needed, anxiolytics.

- NSAIDs are nonsedating and surgical pain is primarily caused by inflammation; therefore, NSAIDs are an excellent choice for pain relief for this group of patients. If perioperative steroids were administered, initiation of NSAID therapy should be delayed as appropriate for the duration of action of the steroid.

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**BOX 4 Tips to Handle Dyspnea and/or Desaturation After Extubation**

- If the patient is dyspneic, administer oxygen via the blow-by method or face mask (preferred, but may make the patient struggle) until patient begins breathing normally.

- To decide if oxygen can be discontinued, monitor the patient with the pulse oximeter for 5 to 10 minutes after oxygen delivery is stopped. If the patient desaturates (SpO₂ <90%), continue providing supplemental oxygen until it is breathing more normally.

- Stretch the neck rostrally and gently extend the tongue from the mouth to open the airway. The lips may need to be taped or propped up to further open the airway. Continue to administer oxygen.

- Administer steroids (generally dexamethasone-SP 0.1 mg/kg) if upper airway inflammation is moderate to severe, if extubation was difficult, or if the patient underwent airway surgery, assuming that steroids were not administered preoperatively.

- If the patient is fully awake but calm and that pain is alleviated prior to extubating.

- Brachycephalic patients often still tolerate the ETT when completely conscious and can be carefully extubated at this point (FIGURE 5).

- See BOX 4 for tips on treating airway complications after extubation.

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² "Reintubation also allows the anesthetist to breathe for the patient. This prevents respiratory muscle fatigue secondary to increased work of breathing, which is often a major component of mortality. Inhalants can be used to prolong intubation, as can repeat doses or infusions of propofol or alfaxalone if used for a short duration."
Dr. Grubb is a diplomate of the American College of Veterinary Anesthesia and Analgesia with a strong focus in pain management. She owns an anesthesia/analgesia and continuing education consulting practice that serves both small and large animals. Dr. Grubb is a national and international educator and lecturer, a certified acupuncturist, an adjunct professor of anesthesia and analgesia, and the president-elect of the International Veterinary Academy of Pain Management. She is co-author of 2 books, including *Anesthesia and Pain Management for Veterinary Nurses and Technicians*. Dr. Grubb's favorite achievement is winning the Distinguished Teaching Award at 2 universities.

![FIGURE 5. Fully conscious brachycephalic dog with the endotracheal tube still in place.](image)

- Minimally sedating opioids can be used (e.g., buprenorphine).
- Gabapentin, trazodone, or other anxiolytics should be administered if the patient experiences FAS at home.

**References**


Anesthesia and Analgesia in Brachycephalic Dogs

TOPIC OVERVIEW
Brachycephalic dogs with brachycephalic obstructive airway syndrome are twice as likely to have anesthesia complications as non-brachycephalic dogs, with most complications occurring in the recovery period. Appropriate management of these patients is critical for anesthetic safety. Brachycephalic anesthetic management, from preanesthesia to recovery from anesthesia, is discussed in this review.

LEARNING OBJECTIVES
After reading this article, participants will be able to describe the brachycephaly-related factors that contribute to the risk of anesthetic complications, develop an anesthetic/analgesic protocol with appropriate drugs for each phase of anesthesia, and develop an anesthetic management plan with focus on airway management from preanesthesia to recovery.

1. Brachycephalic dogs with brachycephalic obstructive airway syndrome (BOAS) are ____ time(s) as likely to develop anesthesia complications as non-brachycephalic dogs.
   a. 1
   b. 2
   c. 4
   d. 8

2. Most anesthesia-related complications occur in which phase of anesthesia?
   a. Preanesthesia/sedation
   b. Induction
   c. Maintenance
   d. Recovery/postoperative

3. Which of the following is most important in achieving safe anesthesia for patients with BOAS?
   a. Patient management
   b. Drug choice
   c. Avoiding sedatives in the preanesthesia period
   d. Using a deep plane of anesthesia so that the patient does not wake up too fast

4. Brachycephaly-related narrowed airway structures (e.g., stenotic nares, hypoplastic trachea) contribute to increased respiratory effort (or “work of breathing”). Factors that further increase respiratory effort should be avoided. These include
   a. Stress and/or excitement
   b. Pain
   c. Hyperthermia
   d. All of the above

5. Avoidance of increased respiratory effort is critical for safe management of patients with BOAS because it
   a. Causes increasingly negative airway pressure
   b. Can cause airway collapse
   c. Can cause or worsen hypoventilation and hypoxemia
   d. All of the above

6. Which of the following statements regarding analgesia for BOAS patients is true?
   a. Use local anesthesia blockade whenever possible because local anesthetic drugs are potent and do not compromise return to consciousness.
   b. High dosages of opioids are necessary to control pain in BOAS patients.
   c. All BOAS patients should receive non-steroidal anti-inflammatory drugs preemptively.
   d. Analgesia should be used minimally or not at all in these patients because analgesics can prolong recovery time.

7. General considerations for anesthetic management of patients with BOAS include
   a. Minimal use of eye lubricant so the lubricant does not get rubbed off on towels or cage doors
   b. Preparation of endotracheal tubes that are smaller than expected based on body weight
   c. Avoidance of laryngoscope use to protect upper airway structures from scope-related damage
   d. Avoidance of preoxygenation

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8. General considerations for adjunct drugs used in anesthetic management of BOAS patients include
   a. Avoidance of gastrointestinal protectants because they cause numerous adverse effects
   b. Administration of atropine or glycopyrrolate to all brachycephalic dogs
   c. Administration of antiemetics to decrease the incidence of postoperative aspiration pneumonia
   d. Avoidance of anxiolytics even if the patient has high fear/anxiety/stress

9. Anesthetists recovering BOAS patients should always
   a. Administer steroids
   b. Keep the patient deeply anesthetized during the surgical procedure
   c. Be prepared to reanesthetize and reintubate
   d. Wake the patient up as rapidly as possible

10. Other tips for patient care in recovery include
    a. Use the pulse oximeter to determine if the patient can maintain adequate oxygenation.
    b. Stretch the neck rostrally and gently extend the tongue from the mouth to open the airway.
    c. Provide supplemental oxygen if the patient is dyspneic and consider placing the patient in an oxygen cage.
    d. All of the above