Brachycephalic Airway

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Brachycephalic Airway Syndrome in Dogs and Cats

Introduction

Brachycephalic airway syndrome (BAS), also known as brachycephalic obstructive airway syndrome (BOAS), represents a collection of congenital and acquired abnormalities that affect short-nosed (brachycephalic) dog and cat breeds. The syndrome results from selective breeding for facial shortening, which has produced anatomical abnormalities that impede normal respiration. The prevalence of BAS has increased in recent years due to the popularity of brachycephalic breeds such as French Bulldogs, English Bulldogs, Pugs, Boston Terriers, Shih Tzus, and Persian cats.

Pathophysiology

The pathophysiology of BAS involves both primary and secondary anatomical abnormalities. Primary abnormalities are congenital and include:

1. **Stenotic nares**: Narrowed external nostrils that restrict airflow during inspiration.
2. **Elongated soft palate**: The soft palate extends beyond the tip of the epiglottis, partially obstructing the entrance to the larynx.
3. **Hypoplastic trachea**: Reduced tracheal diameter relative to body size, creating a functional bottleneck for airflow.
4. **Aberrant nasopharyngeal turbinates**: Malformed nasal turbinates that project into the nasopharyngeal airway.

Recent research has identified additional primary components, including:

- **Intranasal airway obstruction**: Reduced nasal cavity volume and aberrant growth of nasal turbinates causing significant resistance to airflow.
- **Macroglossia**: Disproportionately large tongue size relative to the oropharyngeal cavity.

- **Thickened pharyngeal tissues**: Pharyngeal soft tissues with increased thickness and reduced compliance.

Secondary abnormalities develop as a consequence of increased respiratory effort and chronic airway obstruction:

1. **Everted laryngeal saccules**: The laryngeal ventricles evert into the airway lumen due to high negative pressure during inspiration.
2. **Laryngeal collapse**: Progressive weakening and medial displacement of the laryngeal cartilages.
3. **Bronchial collapse**: Weakening of bronchial walls leading to dynamic airway collapse during respiration.
4. **Tonsil eversion**: Chronic inflammation leading to enlargement and eversion of the palatine tonsils.
5. **Gastrointestinal disturbances**: Gastroesophageal reflux and hiatal hernias secondary to increased respiratory effort.

The most recent pathophysiological understanding emphasizes the "vicious cycle" of BAS. Increased negative pressures generated during inspiration to overcome upper airway resistance lead to inflammation, edema, and progressive tissue damage. This further narrows the airway, increasing respiratory effort and perpetuating the cycle. Chronic hypoxemia activates inflammatory pathways, contributing to systemic inflammation and multiorgan effects.

Clinical Signs

Clinical manifestations of BAS vary in severity and may include:

1. **Respiratory signs**:
    - Stertor (snoring) and stridor (high-pitched respiratory noise)
    - Inspiratory dyspnea and increased respiratory effort
    - Exercise intolerance and heat intolerance
    - Cyanosis, especially during exertion
    - Syncope (fainting) after exercise or excitement
    - Sleep apnea and sleep-disordered breathing

2. **Gastrointestinal signs**:
    - Regurgitation and vomiting
    - Dysphagia (difficulty swallowing)
    - Aerophagia (excessive air swallowing)
3. **Other manifestations**:
    - Nasal discharge
    - Sneezing and reverse sneezing
    - Coughing
    - Poor sleep quality
    - Reduced quality of life
    - Exercise and heat intolerance

Recent clinical studies have developed grading systems for BAS severity, such as the Functional Grading System, which categorizes patients from Grade 0 (unaffected) to Grade 3 (severe). Advanced imaging techniques including CT scans and functional endoscopy have improved clinical assessment by quantifying airway dimensions and dynamic collapse.

Diagnostic Approach

Diagnosis of BAS involves a comprehensive approach:

1. **History and physical examination**: Assessment of respiratory patterns, noise, and effort at rest and after mild exercise.
2. **Direct visualization**: Rhinoscopy, pharyngoscopy, and laryngoscopy to assess upper airway structures.
3. **Advanced imaging**:
    - Computed tomography (CT) to evaluate nasal cavity volume, soft tissue dimensions, and tracheal diameter
    - Fluoroscopy to assess dynamic airway collapse during respiration
    - Functional airway endoscopy during different respiratory phases

4. **Functional testing**:
    - Plethysmography to measure airflow parameters
    - Arterial blood gas analysis to assess oxygenation and ventilation
    - Exercise tolerance testing with pulse oximetry monitoring

Surgical Corrective Procedures

Surgical intervention aims to reduce airway resistance and improve respiratory function. Modern approaches include:

1. **Rhinoplasty (Alar Nares Resection)**:
    - Vertical wedge resection
    - Horizontal wedge resection
    - Alapexy techniques
    - Laser-assisted rhinoplasty

2. **Staphylectomy (Soft Palate Resection)**:
    - Traditional sharp resection
    - Folded flap palatoplasty
    - Modified palatoplasty with muscle preservation
    - Laser-assisted palatoplasty
    - Thermal palatoplasty using radiofrequency ablation

3. **Laryngeal Procedures**:
    - Everted laryngeal saccule resection

4. **Tracheal Procedures**:
    - Permanent tracheostomy (in severe cases)

5. **Advanced/Emerging Surgical Techniques**:
    - Laser turbinectomy for intranasal obstruction

Recent advances include minimally invasive approaches using endoscopic guidance and laser therapy. The trend has shifted toward early intervention, with studies showing better outcomes when surgery is performed before secondary changes develop. Multimodal approaches addressing all anatomical abnormalities in a single procedure have shown superior results compared to traditional staged approaches.

Anesthetic Considerations

Anesthesia for brachycephalic patients carries significant risks and requires specialized protocols:

1. **Preoperative Assessment**:
   - Thorough cardiopulmonary evaluation
   - Stress minimization and preemptive sedation
   - Careful assessment of concurrent disorders

2. **Premedication and Induction**:
   - Anti-cholinergics due to higher-than-average vagal tone
   - Propofol or alfaxalone for rapid, smooth induction
   - Extremely careful titration of acepromazine due to potential airway obstruction
   - Dexmedetomidine in carefully titrated doses for its anxiolytic effects
   - Anti-emetics (miropitant) and acid reducers (omeprazole) to minimize risk with vomiting and reflux

3. **Airway Management**:
   - Prepared for emergency tracheostomy
   - Rapid intubation with appropriately sized endotracheal tubes (often smaller than expected due to hypoplastic trachea)
   - Capnography and pulse oximetry monitoring
   - Maintenance of endotracheal intubation until fully recovered

4. **Maintenance and Recovery**:
   - Inhalational anesthetics with accurate vaporizers
   - Total intravenous anesthesia (TIVA) techniques

- Multimodal analgesia with local and regional blocks
- Extended post-operative monitoring
- Anti-inflammatory medications to reduce post-operative airway swelling if deemed appropriate
- Incremental recovery in oxygen-enriched environment
- Delayed extubation until fully conscious

5. **Post-operative Care**:
   - Close monitoring
   - Oxygen supplementation as needed
   - Temperature regulation (avoid overheating as that can increase panting)
   - Avoid feeding until fully awake and can keep down clear liquids
   - Anti-inflammatory therapy
   - Gastric protectants for patients with GI signs

Prognosis and Outcomes

The prognosis for BAS patients has improved with early intervention and comprehensive surgical approaches. Recent long-term outcome studies report:

- Significant improvement in respiratory function in 85-95% of patients
- Reduced frequency and severity of clinical signs
- Improved exercise tolerance and quality of life
- Better outcomes with early intervention before secondary changes develop
- Need for ongoing management of concurrent conditions

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