

# EVALUATION OF A CHILD WITH ACUTE AND CHRONIC AIRWAY OBSTRUCTION

## Learning objectives

At the conclusion of this learning activity, participants should be able to;

- Discuss the mechanism of airway obstruction.
- Identify the different etiologies of upper and lower airway obstruction.
- Evaluate and manage a child with acute airway obstruction.

## Overview

Airway obstruction is more common in children than in adults and can be a life-threatening emergency. This is because of the anatomical differences in the airway of children and an increased propensity to develop infection. Complete obstruction of the respiratory tract is a medical emergency as it can lead to respiratory failure followed by cardiac arrest in a short span of time. On the other hand a child with a partial obstruction may initially have an adequate airway and if appropriate supportive care is not given the condition can deteriorate rapidly. As children have smaller airways and less respiratory reserve the increased work of breathing that results due to obstruction can rapidly progress leading to adverse outcomes. Hence it is important to identify such cases and administer appropriate therapy immediately.

1 millimeter of swelling in an infant airway can cause BIG problems

## Mechanics of airway obstruction

Anatomically, the upper airway is divided from the lower airway at the level of the subglottis. The upper airways are the extrathoracic airways (nose, nasopharynx, larynx and upper trachea) and the lower airways are the intrathoracic airways (lower trachea and bronchi, figure 1).

In fixed airway obstruction such as subglottic stenosis, the cause and effect are clear: there is a narrow airway with subsequent limitation of airflow. In other cases like laryngomalacia or tracheomalacia, the calibre of the airway at rest or during expiration is normal and it is only during inspiration that the soft airway collapses under a pressure gradient.

In inspiration, a negative pressure is generated in the thoracic cavity and during expiration, the elastic recoil of the lungs and chest wall generate a positive pressure, which drives air from the lungs through the airways. The pressure within the airways also depends on the speed of the air flowing through the airways. According to Bernoulli's principle the pressure exerted by the gas is inversely related to the velocity of the gas flow, hence as the speed of airflow increases, the pressure falls.

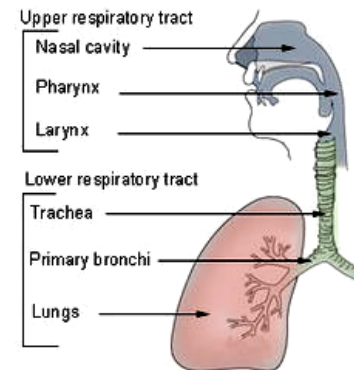


Fig. 1 Anatomy of airway

In inspiration the negative pressure generated in the thoracic cavity is transmitted to the airways (both the extrathoracic and intrathoracic airways). Atmospheric pressure always exists outside the extrathoracic airways. This pressure gradient across the extrathoracic airways causes compression in inspiration and produces stridor when collapsible or partially obstructed extrathoracic airways are present (as seen in laryngomalacia and croup).

In expiration, the positive intrathoracic driving pressure can cause compression and consequently wheeze when collapsible or partially obstructed intrathoracic airways are present (as seen in bronchomalacia and asthma).

### Recognizing airway obstruction in the spontaneously breathing child

#### Signs in upper airway obstruction

- ⇒ In the spontaneously breathing child, extrathoracic airway obstruction produces inspiratory or biphasic stridor.
- ⇒ There is prominence of accessory muscles and tracheal tug, sternal, subcostal and intercostal recession may be seen even with moderate upper airway obstruction.
- ⇒ The child often adopts a position which maximizes the airway diameter and reduces the work of breathing, hence the ‘tripod position’.
- ⇒ Changing such a child’s position can precipitate complete airway obstruction and hence it should be avoided.

- In severe obstruction biphasic stridor or wheeze can be heard and this is an ominous sign.
- When airflow diminishes because of almost complete obstruction, stridor or wheeze can disappear: this is usually a sign of impending collapse.

#### Signs in lower airway obstruction

- ⇒ Wheeze is usually present.
- ⇒ Hyperinflation of the chest may be present and can be unilateral if one lung is affected more than the other (such as with a foreign body).
- ⇒ The signs of increased work of breathing are similar to upper airway obstruction (accessory muscle use etc).
- ⇒ There may be prolongation of the expiratory phase and active expiration with use of the abdominal muscles.

### Etiology

Some of the causes of acute and chronic airway obstruction are outlined in Table 1. In most cases the etiology is identifiable and patients respond well to appropriate intervention.

Site		Acute	Chronic
Upper	Nose		<ul style="list-style-type: none"> <li>▪ Choanal atresia</li> <li>▪ Congenital stenosis of piriform aperture</li> </ul>
	Nasopharynx	<ul style="list-style-type: none"> <li>▪ Peritonsillar abscess</li> <li>▪ Diphtheria</li> <li>▪ Retropharyngeal abscess</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adenotonsillar hypertrophy</li> </ul>

	<b>Larynx</b>		
	1. Supraglottic	▪ Epiglottitis	▪ Laryngomalacia ▪ Laryngeal web
	2. Glottic	▪ Laryngospasm ▪ Angioneurotic oedema	▪ Vocal cord palsy (congenital or acquired) ▪ Infantile haemangiomas ▪ Laryngeal papillomatosis
	3. Subglottic	▪ Croup ▪ Subglottic haemangioma	▪ Subglottic stenosis (congenital or acquired)
<b>Lower</b>	<b>Trachea</b>	▪ Bacterial tracheitis ▪ Inhalational burns	▪ Tracheomalacia ▪ Vascular compression ▪ Tracheal stenosis ▪ Mediastinal mass
	<b>Bronchi</b>	▪ Asthma	▪ Bronchomalacia
		▪ Foreign body	▪ Bronchiectasis (including cystic fibrosis)
		▪ Bronchiolitis	▪ Obliterative bronchiolitis

### Nose and nasopharynx

- ⇒ Bilateral choanal atresia usually presents within hours of birth with breathing difficulties, apnoea or cyanotic episodes often associated with feeding.
- ⇒ Unilateral choanal atresia can present later in childhood with persistent unilateral rhinorrhoea. Adenoidal and tonsillar hypertrophies are the commonest cause of chronic upper airway obstruction and usually manifest as snoring, frequent waking at night, day time sleepiness etc.

### Larynx and upper trachea

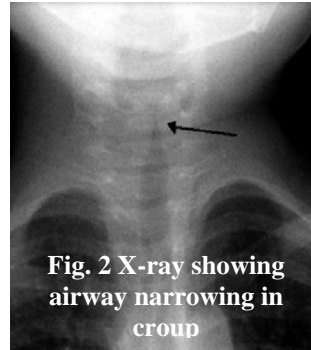
- ⇒ Laryngomalacia is the commonest laryngeal cause of upper airway obstruction in young children and is characterized by inspiratory stridor which typically develops days to weeks after birth and improves as the child grows.
- ⇒ Vocal cord palsy can be congenital or acquired. If bilateral it can produce severe obstruction requiring immediate intervention.
- ⇒ In infants, haemangiomas can produce stridor and obstruction.
- ⇒ Laryngeal oedema following infection or trauma due to a procedure can present with difficulty in breathing and can be effectively managed with nebulized epinephrine, nebulized budesonide or systemic steroids.
- ⇒ Anaphylaxis may be severe and life-threatening when edema involves the larynx. Onset of symptoms is usually sudden, and there may be associated signs such as urticaria and facial swelling. Emergent treatment can be life-saving

<b>Characteristic</b>	<b>Croup</b>	<b>Epiglottitis</b>
▪ <b>Voice</b>	Hoarse	Muffled
▪ <b>Cough</b>	Barking	Usually none
▪ <b>Fever</b>	Yes	Yes
▪ <b>Saliva</b>	Minimal	Lots
▪ <b>Neck swelling</b>	Little	Lots
▪ <b>Begins</b>	Slowly	Suddenly
▪ <b>Season</b>	Autumn	All year
▪ <b>Time</b>	Evening/night	All day

⇒ Subglottic stenosis usually occurs following prolonged or repeated intubation. A history of difficulty with extubation previously, or a history of stridor or recurrent croup points towards subglottic stenosis.

⇒ A child with epiglottitis appears toxic, with drooling, a quiet stridor and a fixed position (often the 'tripod' position).

⇒ In croup the child often seems systemically well, although he or she may have a high fever, and will have a stereotypical barking or seal-like cough (Table 2, figure 2 & 3).



⇒ Bacterial tracheitis can be difficult to distinguish from croup. The child appears toxic, but the cough is usually less harsh than in croup as the larynx may be less involved and there are often more tracheal secretions.

⇒ Management

- Maintaining spontaneous ventilation is vital in airway obstruction.
- Even laboured respiratory efforts by the child are usually more effective than ventilation with bag and mask following abolition of the child's breathing with muscle relaxants.
- Gradual induction of anaesthesia with oxygen and an inhalational agent is preferable.
- Muscle relaxants should be used only if necessary.

## Lower airways obstruction

### Bronchospasm

⇒ Asthma remains the commonest cause of lower airway obstruction in children. Children can have hyper-reactive airways without satisfying the other criteria of classic atopic asthma.

⇒ Mild asthma is usually not an emergency but should be treated with inhaled bronchodilators.

⇒ In moderate-to-severe asthma, it is useful to emphasize the importance of complying with anti-inflammatory treatment such as inhaled corticosteroids.

### Tracheomalacia and bronchomalacia

⇒ Bronchomalacia may be localized or generalized. It involves a weakness of the large cartilaginous airways with subsequent collapse under pressure.

### Cystic fibrosis

⇒ Lower airways obstruction in cystic fibrosis is caused by the accumulation of the thick airway secretions and occasionally bronchospasm.

### Foreign bodies and post-obstructive pulmonary oedema

⇒ Foreign bodies tend to lodge in the narrowest parts: nose, larynx or bronchi. It is most common in pre-school children.

- A small object such as a bead in the nose can remain undetected, producing unilateral rhinorrhoea.
- Impaction in the larynx produces dramatic symptoms and if not cleared can result in complete and often fatal airway obstruction.
- Coughing may dislodge the foreign body.
- Treatment of the choking child forms part of the basic life support algorithms put forward by the Advanced Life Support Group. Removal of an aspirated foreign body is usually undertaken by rigid open-tube bronchoscopy.

### **Evaluation**

⇒ The initial evaluation of a child with acute airway obstruction must begin with a rapid assessment of respiratory status to identify those who need resuscitation. Conditions that require immediate intervention include the following:

- Complete airway obstruction
- Rapidly progressing partial airway obstruction
- Respiratory failure

⇒ To identify these conditions, the physician should focus upon signs of airway patency, the degree of respiratory effort, and the effectiveness of respiratory function. While doing this it is of utmost important to keep the child calm and comfortable.

⇒ Worsening respiratory distress suggest that the obstruction is rapidly progressive.

⇒ Look out for signs of severe obstruction or respiratory failure;

- Poor color (ashen or centrally cyanotic)
- Obtunded mental status
- Decreased chest wall movement, with or without signs of respiratory distress
- Bradypnea or marked tachypnea

⇒ Taking a proper history

- The sudden onset of choking, gagging, or stridor suggests a foreign body or an allergic reaction.
- A history of fever suggests an infectious etiology such as epiglottitis, bacterial tracheitis, retropharyngeal abscess, or peritonsillar abscess.
- Most children with acute upper airway pathology will have a change in voice (see table 2).
- An allergic reaction due to exposure to a known allergen or new food or medication may be the cause of upper airway obstruction.
- Smoke inhalation can result in chemical or thermal injury to the airway.

⇒ Physical examination

- Vital signs, including weight, should be obtained. A careful examination of the pharynx and lungs can be performed as soon as the child's condition is stabilized.
- Look for signs of airway obstruction (discussed above)

⇒ Imaging

- Imaging may be useful in identifying the location and nature of the airway obstruction
- X rays may demonstrate the presence of an opaque foreign body

Summary of probable diagnosis of conditions causing airway obstruction in children	
Signs & symptoms	Probable diagnosis
• High fever, toxic appearance, and moderate respiratory distress in a school age child	Bacterial tracheitis, rarely, epiglottitis
• Choking, gagging, or difficulty swallowing	Presence of upper airway foreign body
• Acute onset of upper airway symptoms with facial swelling and wheezing	Allergic reaction
• Bleeding, bruising, or subcutaneous air	Blunt or penetrating trauma
• Child with burns or singed hair who has hoarseness or respiratory distress	Burn injury
• An infant or toddler who is irritable, not moving the neck, and who will not swallow	Retropharyngeal abscess
• Hot potato voice and trismus	Peritonsillar abscess

## References

- S.J. Daniel, The upper airway: congenital malformations, *Paediatr Respir Rev* 7S (2006), pp. S260–S263.
- C.L. Bjornson and D.W. Johnson, Croup, *Lancet* 371 (2008), pp. 329–339.
- Gary M. Doherty. Acute and chronic airway obstruction in children. *Anaesthesia & Intensive Care Medicine*. 2009; vol. 10 (4): 191-195

## TEST QUESTIONS

- 1. Children are more prone to have adverse outcomes due to airway obstruction as compared to adults because of all, except;**
  - A. Smaller airways
  - B. Less respiratory reserve
  - C. Childs airway is softer
  - D. Larger diameter of bronchi**
  
- 2. The upper airways includes the following except;**
  - A. Nasopharynx
  - B. Bronchi**
  - C. Larynx
  - D. Upper trachea

3. **Prominence of accessory muscles and presence of sternal, subcostal and intercostal recession may be seen in;**
- A. **Upper airway obstruction**
  - B. Lower airway obstruction
  - C. Neuromuscular disorder
  - D. All the above
4. **A child with a history of choking, gagging, or difficulty in swallowing is suggestive of \_\_\_\_\_**
- A. Bacterial tracheitis
  - B. **Upper airway foreign body**
  - C. Blunt or penetrating trauma
  - D. Retropharyngeal abscess
5. **Hot potato voice and trismus is a sign of \_\_\_\_\_.**
- A. **Peritonsillar abscess**
  - B. Tonsillitis
  - C. Adenoiditis
  - D. All the above
6. **Conditions that require immediate intervention include the following:**
- A. Complete airway obstruction
  - B. Rapidly progressing partial airway obstruction
  - C. Respiratory failure
  - D. **All the above**
7. **Signs of severe obstruction or respiratory failure are all except;**
- A. Poor color (ashen or centrally cyanotic)
  - B. Obtunded mental status
  - C. **Increased chest wall movement**
  - D. Bradypnea or marked tachypnea
8. **The commonest cause of lower airway obstruction in children is;**
- A. **Asthma**
  - B. COPD
  - C. Bronchitis
  - D. Croup