Anaesthesia for surgery of the trachea and main bronchi

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Abstract

The anaesthetic challenges of major tracheobronchial surgery relate to airway control, ventilation management, maintaining optimal surgical exposure and appropriate patient selection. Although such surgery is generally performed in specialist centres, the strategies for dealing with central airway obstruction and bronchoscopy under general anaesthesia are of broader importance. Furthermore, an intra-thoracic airway obstruction presents difficulties that require a different mindset to the more familiar scenario of an extra-thoracic airway obstruction. Tracheal stenosis following a period of prolonged tracheal intubation is now the leading indication for tracheal resection. A standard approach involves total intravenous anaesthesia, a right-sided arterial line, epidural analgesia and early extubation. Usually, a sterile armoured cuffed endotracheal tube is placed under direct surgical vision for the period of segmental resection followed by reintroduction of the native orotracheal tube under bronchoscopic vision for the primary end-to-end anastomotic reconstruction.

Keywords Airway; anaesthesia; stenosis; surgery; trachea

Royal College of Anaesthetists CPD Matrix: 2A01; 2A07; 3G00

Learning objectives

After reading this article, you should be able to:

- describe intra- and extra-thoracic airway obstruction, with a focus on intra-thoracic tracheobronchial causes and their management
- discuss the role of bronchoscopy in the diagnosis and management of lower airway pathology, with a focus on the implications for anaesthesia
- discuss the different anaesthetic and airway options for upper and lower tracheal resection

Tracheobronchial anatomy

This is described in *Anaesthesia & Intensive Care Medicine* 2011;**12**(12):533–538.

Pathophysiology of tracheobronchial obstruction

Subject to the level in relation to the vocal cords, airway obstruction can be defined as extra- or intra-thoracic. Depending upon how airflow relates to the respiratory cycle, an obstruction can be either fixed or variable. The site of a variable extra-thoracic obstruction includes the nose, pharynx and larynx, where acute inspiratory stridor and elevated work of breathing are common. On the contrary, a variable intra-thoracic obstruction due to tracheal, bronchial or lung pathology precipitates an expiratory stridor that can be more difficult to diagnose (Figure 1). Common causes of a variable intra-thoracic airway obstruction include benign or malignant neoplasms, an inhaled foreign body, infection and inflammation. As such, in the anaesthetized and paralysed patient with a variable intra-thoracic obstruction, positive pressure ventilation can lead to progressive hyperinflation and baro- or volutrauma.

Common causes of a fixed large airway obstruction include post-intubation stenosis, goitre, endotracheal neoplasms and bronchial stenosis. Fixed airway obstructions cause a reduction in airflow throughout the respiratory cycle. Post-intubation and post-tracheostomy trauma has now superseded infection and external trauma as the most common mechanism for tracheal stenosis. One possible reason for this, despite the use of modern high-volume low-pressure cuffs, is that the number of patients surviving a period of prolonged intubation has increased. Patients with a fixed intra-thoracic obstruction often present weeks or months following intubation or tracheostomy with a slowly progressive dyspnoea, cough, wheeze and recurrent pneumonias.

Clinical assessment

The general principles of preoperative assessment for thoracic surgery are discussed in *Anaesthesia & Intensive Care Medicine* 2015;**16**(2):59–62. As the indications for surgery on the trachea and main bronchi are wide-ranging, the clinical history and examination will be dictated by the primary pathology, together with a more general enquiry of the degree of dyspnoea, wheeze, stridor and functional limitation (Table 1).

Whilst CT and MRI scans can demonstrate tracheal and bronchial narrowing, they may not accurately determine the exact size, length and position of the obstruction. Flow-volume loops (see *Anaesthesia & Intensive Care Medicine* 2014;**15**(11):495–498) are of limited diagnostic use, yet they may help identify whether the obstruction is fixed or variable. Bronchoscopy is of most use in the evaluation of an intra-thoracic tracheobronchial obstruction. Despite this usefulness, awake flexible bronchoscopy in the context of tracheal obstruction can precipitate complete central airway obstruction. Bronchoscopy should hence be performed in these patients under general anaesthesia.

Anaesthesia and tracheobronchial obstruction

The general principles of a shared airway, teamwork and clear planning are imperative for such procedures. There are, however, specific airway strategies for the anaesthetic management of patients with tracheobronchial obstruction (Table 2). A variable, opposed to a fixed obstruction, can present problems on loss of muscle tone, as distal gas trapping occurs with positive

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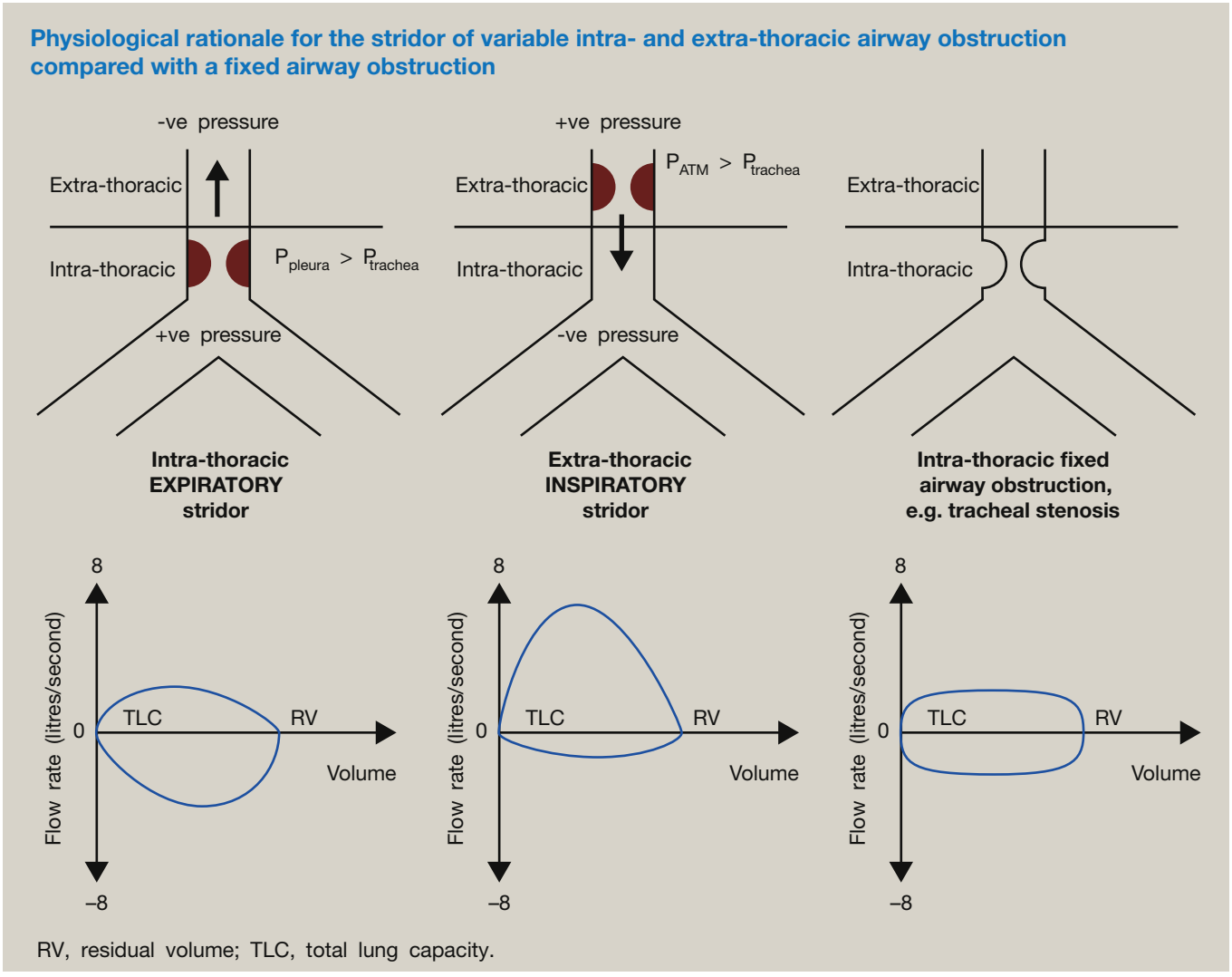

Figure 1

pressure ventilation. Strategies for opposing this include removing positive end-expiratory pressure (PEEP), limiting P_{MAX} and increasing the expiratory time. The critical scenario of central airway obstruction must be anticipated at all stages from induction to full emergence, and a rigid rescue bronchoscope must always be on-hand. The more familiar methods of airway rescue, such as cricothyroid puncture, are of limited use in such circumstances. Whilst heliox may be of some use in near-complete central airway obstruction, 100% oxygen should always be employed in cases of complete central airway obstruction. Steroids, nebulized adrenaline and diuretics may reduce mucosal oedema and lessen the degree of obstruction.

Anaesthesia for bronchoscopy

The choice between flexible or rigid bronchoscopy is usually a function of surgical preference, yet the consequences for anaesthesia are significant. In tracheobronchial stenosis, flexible bronchoscopy carries the risk of central airway obstruction, and is therefore rarely performed under sedation or local anaesthesia. The insertion of an endotracheal tube or laryngeal mask airway (LMA) through which the scope can be advanced into position follows the induction of anaesthesia. Despite many advocating the advantages of an inhalation induction with spontaneous ventilation, most now, in practice, opt for an intravenous induction with positive pressure ventilation. Regardless, anaesthesia can thus be maintained with a volatile agent and a titrated FiO_2. As flexible bronchoscopy may present suboptimal diagnostic windows, an examination with a rigid bronchoscope may be preferred. Rigid bronchoscopy produces profound surgical stimulation and the use of opiates and neuromuscular blockade is therefore necessary. Anaesthesia is typically maintained with propofol and remifentanil, either through a target-controlled infusion or intermittent boluses, and a short-acting muscle relaxant such as suxamethonium or atracurium. The use of rocuronium for such procedures is now acceptable, as reversal of neuromuscular blockade with sugammadex is increasingly available for such circumstances. Low-frequency jet ventilation is commonly employed with a Sanders-injector or equivalent.

Anaesthesia for laser therapy

Laser therapy of tracheal lesions provides variable results and is usually a temporary or palliative measure. A carbon dioxide

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