Indications for and management of tracheostomies

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Abstract

There has been documented evidence of tracheostomies for over two millennia, the majority being descriptions of relieving acute upper airway obstructions in an emergency. Refinement of anaesthetic and surgical techniques resulted in the increased frequency and success of the procedure and in the latter half of the 20th century they were being used increasingly as adjuncts to long-term respiratory support for patients who had either lost their upper airway or who had limited bulbar function and reduced ability to clear secretions via coughing and expectorating. Further technical developments have resulted in the adoption of the percutaneous dilatational tracheostomy (PDT) as a means of facilitating ventilatory weaning in intensive care. In the UK approximately 16% of adult intensive care patients undergo PDT and if care of these patients is to be maintained at a high level clinicians must have a working knowledge of upper airway anatomy, indications for the procedure, complications and the ongoing care and management of such patients.

Keywords Airway; bronchoscopy; obstruction; tracheostomy; ventilation; weaning

Introduction

Tracheostomy (Ancient Greek 'to cut the trachea') creates a surgical airway in the cervical trachea. It has been in documented existence via ancient texts since at least 2000 BC in the context of immediately life-saving interventions, for example *The Rigveda* (Hindu text) refers to an individual with a healed tracheostomy incision and in Ancient Greece Asclepiades describes the tracheostomy as a means of improving the airway.[1] Further records subsequently arose in Europe and Asia.[1,2] In India it was as an accepted therapy in the *Susruta Samhita* and the Roman Physician Galen described tracheal anatomy and outlined the supralaryngeal airway's role in warming, humidifying and filtering air.[1]

Through the Renaissance, Reformation and Age of Enlightenment, case reports and case series appeared including the first documented use of trocars and cannulae, with cannulae remaining in situ for several days after the procedure.[1] However its use was controversial; Hippocrates condemned it 'as a threat to the carotid arteries' and the Roman Physician Caelius Aurelianus described it as 'senseless, frivolous and criminal.' The negativity was reinforced by Medieval Christians via Dante's *Divine Comedy* regarding it as 'a suitable punishment for a sinner in the depths of the Inferno!'

It was clearly associated with a high mortality but refinements in technique led to greater acceptance in 'last-ditch' life-saving interventions in cases of diphtheria; resulting in a 17th century quote stating that it 'Rebounds to the honour of the physician and places him on a footing with the gods', although US President George Washington was believed to have died from epiglottitis, when a group of eminent physicians overruled the opinion of a colleague wishing to perform a tracheostomy.[2] As anaesthesia developed it subsequently became more commonplace and by the 1930s it was being advocated in patients with severe poliomyelitis with a 1943 case report citing its usefulness in facilitating tracheo-bronchial suctioning.[1,3] With the 1952–53 Scandinavian polio epidemic its use in chronic respiratory insufficiency became widespread and it is now frequently used to facilitate ventilatory weaning in intensive care.[4–6] This article therefore deals with tracheal anatomy, indications for tracheostomy, techniques, complications and management of tracheostomy in intensive care patients with reference to recent guidance and commentary.[7]

Tracheal anatomy

The trachea is a cartilaginous membraneous tube (in adults) extending from the lower border of the cricoid cartilage to the carina where it bifurcates into right and left main bronchi. Bifurcation is usually at the level of the fifth thoracic vertebra (posteriorly) and the sternal angle anteriorly. In cross-section it is D-shaped with incomplete cartilaginous rings anteriorly and laterally and a posterior wall of mucous membrane. Children's tracheas are smaller with the carinal bifurcation being higher until the age of approximately 12 years.

Indications for tracheostomy (Box 1)

The two main indications are *management of upper airway obstruction* (actual or potential) and *facilitation of ventilatory support and weaning* in patients undergoing prolonged, advanced respiratory support. This can include the provision of pulmonary toilet via tracheal suction and minimizing (via its inflated cuff) the risk of aspiration. A third indication is for the formation of an end stoma following surgical removal of the larynx (usually for carcinoma.)

The overall effectiveness in facilitating weaning remains uncertain; however it is well tolerated by fully conscious patients, allowing for reduced sedation requirements and potentially improving intensive care outcomes (e.g. ventilator days, ventilator-associated pneumonia, intensive care length of stay and mortality).[6] Other likely advantages include reduced work of breathing (shorter tubes have less intrinsic resistance), better access to the lower airway plus improved oropharyngeal hygiene, reducing problems such as oral candidiasis and in the case of naso-endotracheal tubes improving sinus drainage potentially minimizing occult sepsis.[8,9] Reduced sedation also improves patients' abilities to communicate, contributing to reductions in adverse psychological and psychiatric sequelae of intensive care.[6,8–10] There remains a risk of the inflated cuff damaging the

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Indications for tracheostomy and airway obstruction

- Upper airway obstruction
  - Congenital, e.g. vascular web, laryngeal hypoplasia
  - Foreign body that cannot be dislodged via basic life support
  - Supraglottic or glottic pathology and associated oedema, e.g. infection, tumour, upper airway burns, trauma, anaphylaxis
- Prophylaxis, i.e. prior to extensive head and neck surgery

Tracheostomy and potential advantages for facilitating ventilatory weaning

- Reduced sedation
  - Improved intensive care outcomes
  - Better ability to communicate
  - Potential for reduction in psychological and psychiatric sequelae from prolonged intensive care stay
- Reduced resistance to flow
- Reduced work of breathing
- Improved suction clearance of tracheo-bronchial secretions
- Reduced damage to the upper airway
- Improved maintenance of coughing and swallowing reflexes
- Reduced risk of accidental extubation

Box 1

tracheal mucosa and causing tracheal stenosis, however damage to higher parts of the airway is avoided (e.g. long-term intubation is associated with damage to the posterior commissure of the larynx after 2–5 days and an increased incidence of continuous damage to the posterior glottis through to the cervical trachea between 11 and 24 days).[9,10]

The timing of tracheostomy in intensive care patients also remains uncertain with 'early' (3–5 days) showing little benefit over 'late' (7–10 days) tracheostomy and whilst there is no absolute rule tracheostomy should be considered in any intensive care patient likely to require prolonged ventilation (>7 days) or who has failed a trial of extubation.[9] The procedure is not without risk and clinicians must consider such matters when determining the need for tracheostomy, particularly where there is an increased risk of bleeding or the patient is dependent on high levels of invasive respiratory support (see *Contra-indications to PDT*.)

Surgical tracheostomy

A horizontal skin incision is made midway between the lower edge of the thyroid cartilage and the suprasternal notch. In an emergency a vertical midline incision may be used but the surgeon must take care not to veer laterally from the trachea. The surgeon should regularly check tracheal position by manual palpation and thus avoid dissection of the paratracheal space. The thyroid isthmus is then divided between clamps and ligated with transfixion sutures. It can be retracted either upwards or downwards, although this is potentially hazardous if the tracheostomy tube becomes displaced on insertion as it can hamper re-insertion if it springs back into place.

The cricoid ring is identified and retracted upwards. Before opening the trachea a suitable tracheostomy tube is chosen and the tube, cuff viability and the adequacy of connections to anaesthetic equipment assessed. The vertical incision is made in the second, third and fourth tracheal rings with silk stay sutures placed on either side of the incision line to allow the tracheostomy to be held open if the tube needs resiting prior to formation of a patent track. Removing a cartilage window is to be avoided as it increases risks of tracheal stenosis and tracheomalacia. Once the tracheotomy incision is performed the anaesthetist should remove the endotracheal tube slowly from the mouth and pause when its distal end moves past the tracheostomy. The tracheostomy tube with internal obturator is inserted. Following haemostasis the tracheostomy tube is securely fastened by means of tapes around the neck with the head in flexion. As an addition and precaution, the flange of the tube may be sewn to the skin. This suture can be removed at the first change of tube. The skin incision should be loosely secured to avoid surgical emphysema.

Percutaneous dilatational tracheostomy (PDT)

Development of the procedure

Approximately one in seven intensive care patients in the UK undergo PDT.[7] Its use in intensive care medicine was first described by Ciaglia in 1985 whereby the trachea was accessed percutaneously via a cannula and Seldinger wire. Sequential dilators dilated a hole between tracheal rings before the tracheostomy tube was inserted over the wire using a suitably sized dilator as a bougie.[11] Griggs (1990) described the use of dilation forceps after similar percutaneous access.[12] In time techniques and equipment have evolved enabling more effective insertion via a single 'tipped' dilator to prevent the shoulder of the tracheostomy tube catching against tracheal rings (Figure 1). Whilst no method has been shown to have an overwhelming safety profile the ease of insertion of the single 'tipped' dilator and a trend towards lower immediate complication rates have made it a technique of choice.[12]

PDT is at least as safe as surgical tracheostomy and has a number of perioperative advantages.[12] It can be performed on the intensive care unit without intra-hospital transfer, a process that can precipitate respiratory and cardiovascular instability.[7,9] Additionally it allows intensive care clinicians the opportunity to schedule within normal working hours reducing perioperative risks. Furthermore there are associated logistical and health-economic advantages freeing up operating theatre time and personnel.[11] Thus the remainder of this section outlines the procedure (single dilator technique), complications, contra-indications and the influence of coagulopathy.[13,14]

Performing a PDT

The first consideration is consent.[7,14] Very few intensive care patients will have full capacity. A working knowledge of the Mental Capacity Act 2005 is therefore necessary and current guidance focuses on Consent Form 4; *Form for Adults who are Unable to Consent to Investigation or Treatment*.[14]

Selected patients are pre-oxygenated with FiO_2 1.0 for a minimum of 10 minutes, whilst receiving intravenous anaesthesia (typically propofol and an opiate infusion) and paralysis with a non-depolarizing muscle relaxant. The patient is positioned flat or 15° head-up with their neck hyper-extended