Percutaneous tracheostomy and cricothyrotomy techniques

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Abstract

Percutaneous tracheostomy is currently accepted as a standard technique for longer-term airway care in the critically ill patients in many intensive care units (ICUs). Early tracheostomy has not shown any survival benefit compared to late tracheostomy following prolonged tracheal intubation in ICU patients. The main indications for tracheostomy in the ICU setting include weaning from artificial ventilation or airway protection. Nevertheless, many questions about choice of techniques, post-tracheostomy care and decannulation remain unanswered. This review gives an overview of current techniques.

Keywords Artificial airway; cricothyrotomy; critical care; tracheal intubation; tracheostomy

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Learning objectives

After reading this article, you should appreciate that:

- standard length tracheostomy tubes are frequently too short even in patients with apparently normal anatomy. Departments should stock longer-stem adjustable tubes and introducer kits for obese and other patients
- good aftercare of patients with a tracheostomy is essential to avoid complications as highlighted in recent UK NPSA and NAP4 reports
- a thorough knowledge of applied anatomy is important for safe insertion procedures and management of complications

Percutaneous tracheostomy is one of the most frequently performed bedside surgical procedures in the intensive care unit (ICU). for long-term airway access. Conventional surgical tracheostomy is generally reserved for emergency airway obstruction, and in scenarios where percutaneous tracheostomy is contraindicated or considered difficult or failed. Emergency airway access in the settings of upper airway obstruction is achieved by either cricothyrotomy or tracheostomy. Cricothyrotomy is generally indicated where the airway obstruction is at or above the larynx, and cannot be relieved by other means, or the facility to perform a conventional surgical tracheostomy is not immediately available. Knowledge of applied anatomy of the larynx and trachea is essential to avoid serious and even life-threatening complications in both elective and emergency settings.[1]

Applied anatomy

The surface anatomy of the larynx and cervical part of the trachea is easily felt when palpating with a finger from the chin downwards in the midline. The thyroid notch on the laryngeal prominence of the thyroid cartilage is easily felt, particularly in males. From this point the finger descends along the body of thyroid cartilage into a space between the lower border of the thyroid cartilage and upper border of the cricoid cartilage. This space is the cricothyroid ligament, the landmark for cricothyrotomy.

The cervical proportion of the trachea can vary with flexion, extension, spinal curvature, antero-posterior diameter of the thorax and body build.[2] The depth of the trachea from the skin in the neck normally increases on moving downwards and this is more marked in patients with a thick short neck and in the presence of kyphosis, a goitre, tissue oedema and in obese individuals. On average it is 2.0–2.5 cm deep from skin at the level of the second tracheal ring below which a tracheostomy stoma is normally performed.[3]

The angle of tracheal slant from the vertical gradually increases with age; however, there can be significant individual variation. This is more prominent with severe kyphosis, with the larynx lying closer to the sternal notch, and the trachea loses its mobility on attempted cervical extension bringing up very little extra tracheal length into the neck.[2] By contrast, in young adults more than half the trachea rises into the neck on extension and sometimes by as much as two-thirds. These anatomical changes should be taken into consideration during tracheostomy.

Posteriorly, the oesophagus lies in close relation to the trachea throughout its course except at the level of carina, where the oesophagus lies slightly to the left. A thin layer of areolar tissue lies between the posterior membranous wall of the trachea and the oesophagus, making the walls of two organs closely juxtaposed.[2] Any damage to the posterior wall of the trachea potentially also damages the oesophagus.

The left brachiocephalic vein generally lies well anterior to the pretracheal plane. The brachiocephalic artery crosses over the mid-trachea obliquely from its point of origin from the aortic arch to reach the right side of the neck. In young adults a large proportion of trachea and the brachiocephalic artery regularly rise into the neck on extension. If a tracheostomy tube is placed close to the sternal notch in a young adult, there is a possibility of formation of a life-threatening tracheo-arterial fistula.

Previous radiotherapy or surgery in the neck (e.g. radical neck dissection, thyroidectomy or carotid surgery) may cause scarring and retraction of vessels out of their normal position, making them vulnerable to damage during tracheostomy. The veins in the neck are also very variable, with some older patients having a very large plexus of dilated anterior jugular veins in the midline.

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In contrast to what is stated in some textbooks, the midline cannot be considered to be devoid of large veins or arteries. These larger blood vessels can be visualized by ultrasound examination with the neck extended before tracheostomy.

Ultrasound anatomy of the neck

Ultrasound examination of the neck can be performed routinely or selectively in problem cases, with the neck extended before performing a tracheostomy. This may help identify aberrant blood vessels (Figure 1), the thyroid isthmus and lobes, and estimate the distance from the skin to the trachea.[4] This distance gives an indication of the length of tracheostomy tube required for that individual patient. Ultrasound guidance can be used for needle visualization during the tracheostomy procedure, but there is little space for the footprint of the probe. Therefore, tracheal needle placement is typically performed with the help of endoscopic guidance.[5]

Tracheostomy tube length

A tracheostomy tube can be divided into two segments: the section between the skin and anterior tracheal wall (stomal length); and a section within the tracheal lumen (the intra-tracheal length) (Figure 2). The distance from the skin to the anterior tracheal wall determines the required length of the stomal section. The functional intra-tracheal length of a tracheostomy tube will depend on the total length of the tube, the size and shape of its cuff, the angle of the tracheostomy tube and the angle at which the stoma is formed in an individual patient.[3] A preformed tube will not lie comfortably in an individual patient if the stomal or intra-tracheal lengths are too short or too long, with the risk of tissue damage at pressure points. Ventilator breathing systems, filters and closed suction apparatus when attached to a tracheostomy tube frequently drag on the tube, ultimately putting traction on its intra-tracheal length and increasing the risk of tube displacement. Standard-length tracheostomy tubes appear too short for a large proportion of ICU patients. Manufacturers have taken note of such findings and increased the stomal length of standard tubes. There are now a few adjustable flange long tubes available for deeper tracheal stomas with appropriate introducer kits (Figure 3).

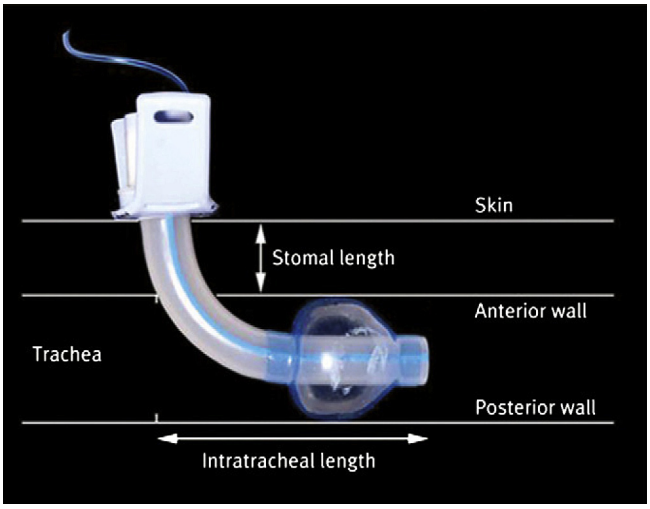

Figure 2 Demonstration of the stomal and intra-tracheal segments of a tracheostomy tube.

Cricothyrotomy

This intervention is primarily indicated to gain control of an airway that cannot be otherwise accessed in an emergency situation. It is the final step in the difficult airway algorithm in the 'cannot intubate and cannot ventilate' scenario.[6] This intervention is essentially life-saving if performed correctly. There are a number of techniques but two commonly used ones include: a wire-guided Seldinger method; or catheter-over-needle technique.[7] Irrespective of the method used, the head is held in the midline position with the patient supine and neck fully extended

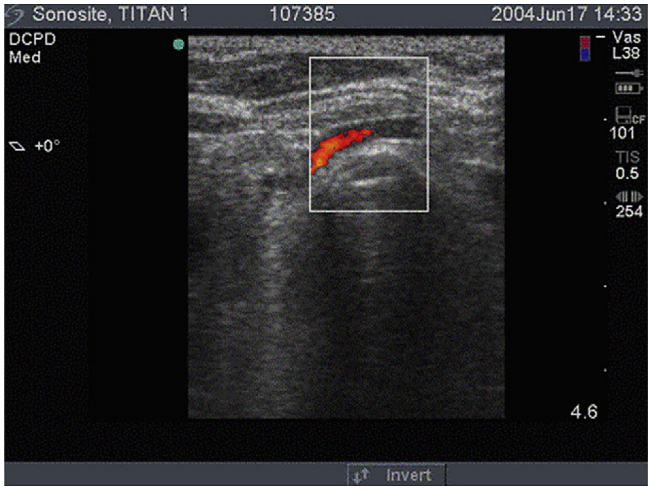

Figure 1 A transverse ultrasound image of the anterior neck just above the sternal notch at the level of the third to fourth tracheal ring in an elderly patient. There was noticeable arterial pulsation at this site. Ultrasound with colour Doppler demonstrated a large ectatic subclavian artery directly in front of the trachea. This was avoided by carefully siting a percutaneous tracheostomy higher up between the first and second tracheal rings.

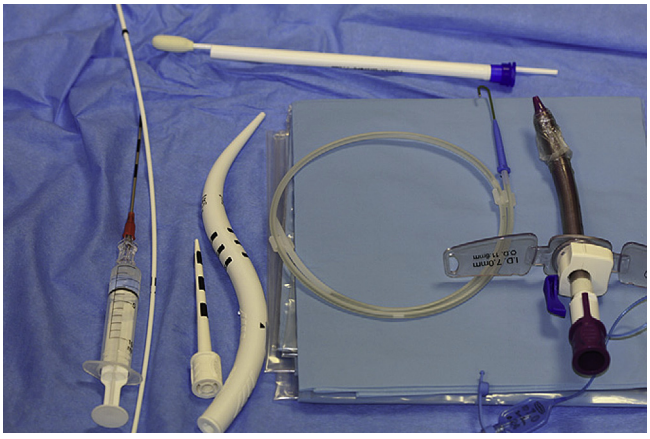

Figure 3 Components of Smiths Uniperc kit consisting of from left to right; (a) Introducer needle graduated in centimetres connected to syringe, (b) sheath for guide-wire, (c) first dilator graduated in centimetres, (d) main S-shaped dilator, (e) drape with a rectangular transparent portion for the surgical site, (f) guide-wire, and (g) armoured longer tracheostomy tube loaded over a loading dilator. On the rear (a) inner cannula and (b) the sponge to clean the inner cannula.