Percutaneous tracheostomy and cricothyrotomy techniques

Nicola Doody

Neil Smart

Abstract

Percutaneous tracheostomy is an increasingly common procedure performed in the intensive care unit setting. This review discusses the evidence behind its use, provides detailed description of the techniques, and considers the principles of post-tracheostomy care based on recent national audit. It also outlines the most recent recommendations for emergency front of neck access, an essential skill for all anaesthetists and other emergency specialists.

Keywords Airway obstruction; artificial respiration; cricothyrotomy; critical care; intubation; tracheostomy

Royal College of Anaesthetists CPD Matrix: 1C01, 2A01, 3A02, 3C00

Learning objectives

After reading this article, you should be able to:
- describe the steps required in preparing and performing percutaneous tracheostomy
- explain the importance of tracheal tube selection
- discuss the principles of post-tracheostomy care
- demonstrate surgical cricothyrotomy on a mannequin

Percutaneous tracheostomy and cricothyrotomy fall under the umbrella term front-of-neck-access (FONA) techniques, and both may be used electively and in the emergency situation.

Applied anatomy

The structures of importance in performing percutaneous tracheostomy and cricothyrotomy are similar, and it is essential to have a good working knowledge of these for the techniques to be performed as smoothly and safely as possible.

Surface anatomy

The most prominent landmark on the anterior aspect of the neck is the thyroid notch (or Adam's apple), particularly in males. This marks the superior border of the thyroid cartilage. At its inferior border a depression can be felt between it and the cricoid cartilage. This is the cricothyroid membrane. Below this the tracheal rings are palpable (Figure 1).

Planes of dissection

The structures of the neck are compartmentalized by fascial layers. The planes which need to be dissected are skin — superficial cervical fascia (subcutaneous layer) — investing layer of deep cervical fascia — pre-tracheal fascia. Whilst the larynx lies superficially in the neck, the trachea dives progressively posteriorly as it enters the thoracic inlet. The depth of the cervical portion of the trachea is subject to large variation depending on factors such as obesity, the presence of a goitre or tissue oedema — but may be expected to lie at around 2 cm deep.

Larynx

The larynx consists of a framework of articulating cartilages linked together by ligaments lying anterior to C3—C4. The largest cartilage is the thyroid cartilage which connects to the signet-ring shaped cricoid cartilage inferiorly via the cricothyroid membrane.

Trachea

The trachea extends from its attachments to the cricoid cartilage to the bronchial bifurcation. In adults around 5 cm lies above the suprasternal notch; however, this varies greatly with movement and body stature. It is made up of C-shaped cartilages which are joined posteriorly by the trachealis muscle, and are connected by fibroelastic tissue. Within the neck the trachea lies in the midline. The 2nd to 4th tracheal rings are covered by the isthmus of the thyroid.

Adjacent structures

Lying adjacent to the cricothyroid membrane and trachea are the lobes of the thyroid, the superior and inferior thyroid arteries and veins (giving rise, respectively, to the superior and inferior laryngeal arteries), as well as the superior and recurrent laryngeal nerves (Figure 2). The brachiocephalic artery crosses the thoracic trachea on its course from the aortic arch to the right side. It may rise into the neck on extension and therefore be subject to damage with a low lying tracheostomy. Although the midline should be devoid of any vessels, it is prudent to visualize with ultrasound (US) to identify aberrant anatomy.

Indications for percutaneous tracheostomy

Tracheostomy is a surgical airway created through the front of the neck, usually between the 2nd and 3rd tracheal rings. There are multiple indications which include:
- to relieve upper airway obstruction
- to prevent laryngeal and upper airway damage due to prolonged translaryngeal intubation
- to maintain a safe airway in patients with an inability to maintain an airway independently (reduced consciousness, neuromuscular disorders)
- to facilitate maxillofacial surgery
- in patients with poor cough effort
- to allow long-term ventilation or oxygenation support.

Nicola Doody *BSc, FRCA is a Specialty Registrar at the Queen Elizabeth University Hospital, Glasgow, UK. Conflicts of interest: none declared.*

Neil Smart *BSc(Hons), FCAI, MBA is a Consultant Anaesthetist and Honorary Clinical Senior Lecturer at the Queen Elizabeth University Hospital, Glasgow, UK. Conflicts of interest: none declared.*

Please cite this article in press as: Doody N, Smart N, Percutaneous tracheostomy and cricothyrotomy techniques, Anaesthesia and intensive care medicine (2017), http://dx.doi.org/10.1016/j.mpaic.2017.01.012

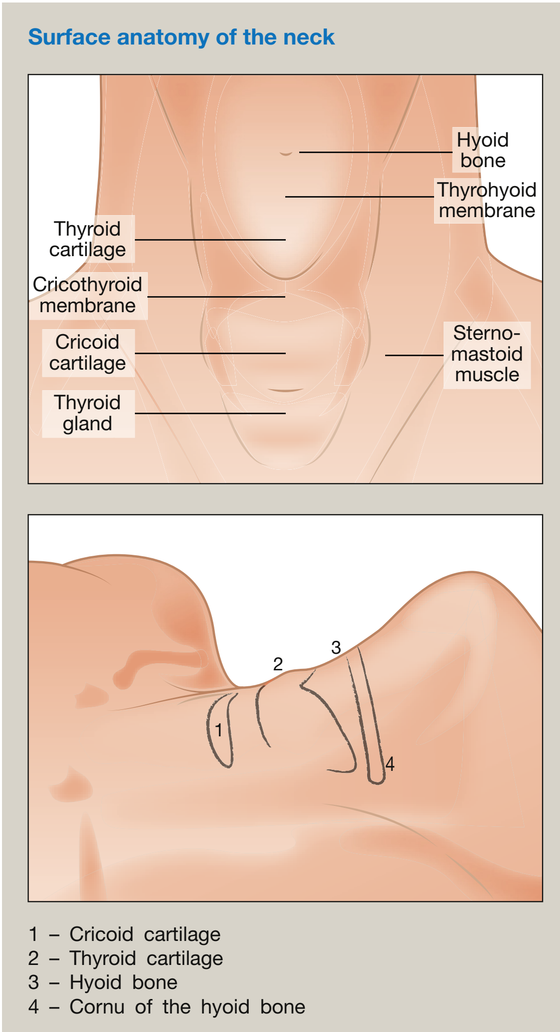

Figure 1

Access to the trachea can be achieved by open (surgical) tracheostomy or by a percutaneous dilational technique. Around 70% of tracheostomies are carried out percutaneously in England and Wales,[1] most commonly in the intensive care unit (ICU) setting where a prolonged period of ventilation is envisaged. In ICU, a number of benefits are posited; reduced length of stay in both ICU and hospital care are supported by meta-analysis while improved patient comfort is demonstrated in several RCTs. Evidence for other benefits including decreased work of breathing, improved patient safety and better long term laryngeal function is weaker.[2]

In an ICU setting, the optimal timing for tracheostomy remains contentious. The TracMan study sought to identify differences in patients receiving a tracheostomy within 4 days or following 10 or more days of translaryngeal intubation. Early tracheostomy at day 1–4 resulted in a decrease in duration of sedation but no difference in overall mortality, or length of ICU or hospital stay.[3]

Percutaneous versus surgical tracheostomy

The technique of percutaneous dilational tracheostomy (PDT) was first described by Ciaglia in 1985, and has become commonplace in intensive care units today. When compared to surgical tracheostomy, PDT produces lower rates of bleeding, wound infection and scarring, although higher rates of complications associated with decannulation, obstruction or false passage. Overall, however, there is no difference in mortality or overall complication rate[4]; therefore the choice depends on individual patient characteristics, available staff and local guidelines. Cost-effectiveness analysis showed PDT to be less resource intensive in terms of cost per procedure, time and personnel involved.[4]

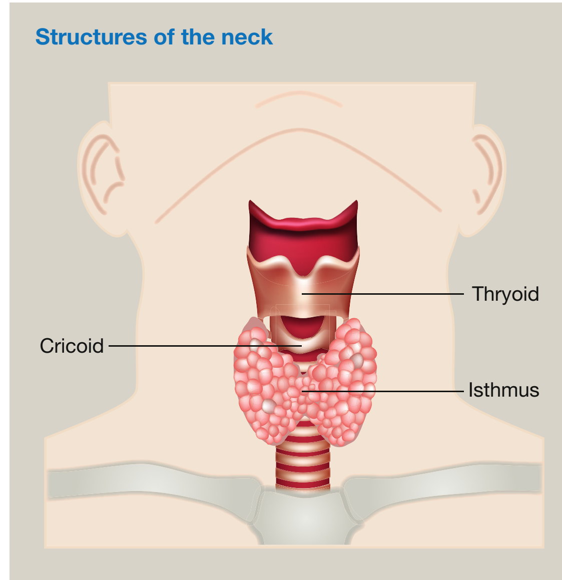

Figure 2

Preoperative assessment

PDT should be regarded as an operative procedure and therefore preoperative planning should be as thorough as for a patient going to theatre.[1] Preparations need to be made for both the patient and the environment.[5]

Patient preparation

- Efforts should be made to obtain consent; otherwise an incapacity form must be completed.
- The patient should be fasted – NG feed switched off 6 hours prior to procedure.
- Bloods should be up-to-date including group-and-save.
- Coagulation abnormalities should be corrected.
- Monitoring should include ECG, saturation, invasive BP and capnography.

Environment preparation

- Adequate space and lighting.
- Immediate availability of an airway rescue trolley and cardiac arrest trolley.
- Presence of an ultrasound (US) machine – pre-procedural US allows identification of cervical vasculature, identification of the puncture site, and may help with selection of tube size and length.
- Sterilized bronchoscope.
- Adequate staffing – minimum of two operators (one to provide airway care and administer anaesthesia, one to perform procedure) as well as an assistant familiar with the technique.

Please cite this article in press as: Doody N, Smart N, Percutaneous tracheostomy and cricothyrotomy techniques, Anaesthesia and intensive care medicine (2017), http://dx.doi.org/10.1016/j.mpaic.2017.01.012