Applied anatomy of cricothyrotomy and tracheostomy

Introduction to series

Doctors in training are called upon to perform many practical procedures – often under emergency conditions. All of these depend on a knowledge of their anatomical basis. All too often, the complications which occur, some serious and even life-threatening, are the result of failure to appreciate these anatomical facts. Arterial injury following 'venous' cannulation, damage to the liver or stomach after insertion of a chest drain, pneumothorax consequent on the insertion of a subclavian line – the list can go on and on.

In this series of articles, the anatomical basis of a number of everyday procedures is described and illustrated.These articles are not intended to tell you how to do the procedure, but hopefully will help you 'visualize' the structures that you are dealing with and help prevent their injury.

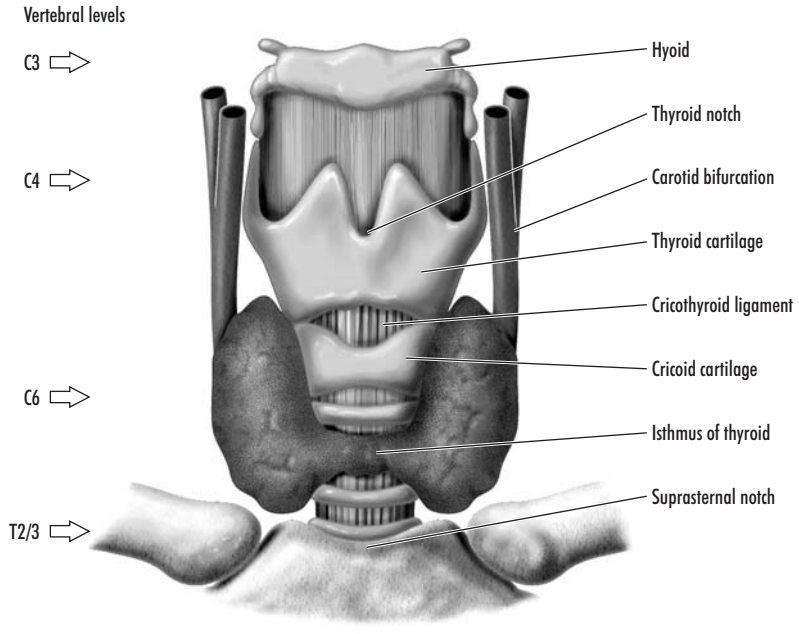
Introduction

Emergency access in upper airway obstruction can be achieved by tracheostomy or, more usually, by way of the cricothyroid ligament. A clear knowledge of the anatomy of this region is essential if these procedures are to be carried out quickly and safely.

The surface anatomy of the larynx and cervical part of the trachea can be revised by running the index finger down the midline of the neck (*Figure 1*). The body of the hyoid bone is at the level of the third cervical vertebra. The thyroid notch at the laryngeal prominence of the thyroid cartilage is easily felt below this, at the level of C4, and indeed is also visible in the post-pubertal male. From this point, the finger descends along the isthmus of the thyroid cartilage to encounter a distinct depression at the cricothyroid junction. Below this dip is felt the cricoid cartilage at C6, and then the rings of the cervical part of the trachea. The isthmus of the thyroid gland crosses over its third and fourth rings but is usually impalpable; if it is felt, it implies there is some degree of thyroid gland enlargement.

The gap felt between the thyroid and cricoid demarcates the cricothyroid ligament which, in its central part, is thick, tough and mainly made up of yellow elastic fibres.

Figure 1. Anterior view of the larynx and cervical trachea to show important landmarks and vertebral levels.



Cricothyrotomy

This procedure (*Figure 2*) is indicated when there is airway obstruction at or above the larynx which cannot be relieved by other means. With the patient supine, the head is held in the strictly midline position and, in the absence of cervical injury, with the neck fully extended. The gap between the thyroid cartilage isthmus and the cricoid is identified. Under local anaesthetic if necessary, a 2 cm transverse incision is made over the cricothyroid ligament, which is then incised. The handle of the scalpel is placed in the gap and rotated. A small tracheostomy tube or whatever other tube is available, such as a cut piece of catheter, is passed into the trachea. A tube with an internal diameter of 2.5 mm allows adequate gas flow for a self-inflating bag, while one of 3 mm allows spontaneous breathing.

Alternatively, commercial sterile cricothyrotomy sets are now available which use the Seldinger technique.

This procedure cannot be performed in patients where the area adjacent to the cricothyoid ligament has been traumatized and is contraindicated in children because of the small size of the larynx.

Tracheostomy

This is only rarely required as an emergency, although an elective tracheostomy may be required for long-term airway access (*Figure 3*). The great secret of the operation is to have the head fully extended, with a sandbag between the shoulders, held absolutely straight with the chin and sternal notch in a straight line, and to keep exactly to the midline so that the major neck vessels are out of danger. A short transverse incision is made halfway between the cricoid cartilage and the suprasternal notch, although the novice may find it easier to use a midline incision from the

Professor Harold Ellis *is Clinical Anatomist, Guy's, King's and St Thomas' School of Biomedical Science, London SE1 1UL*

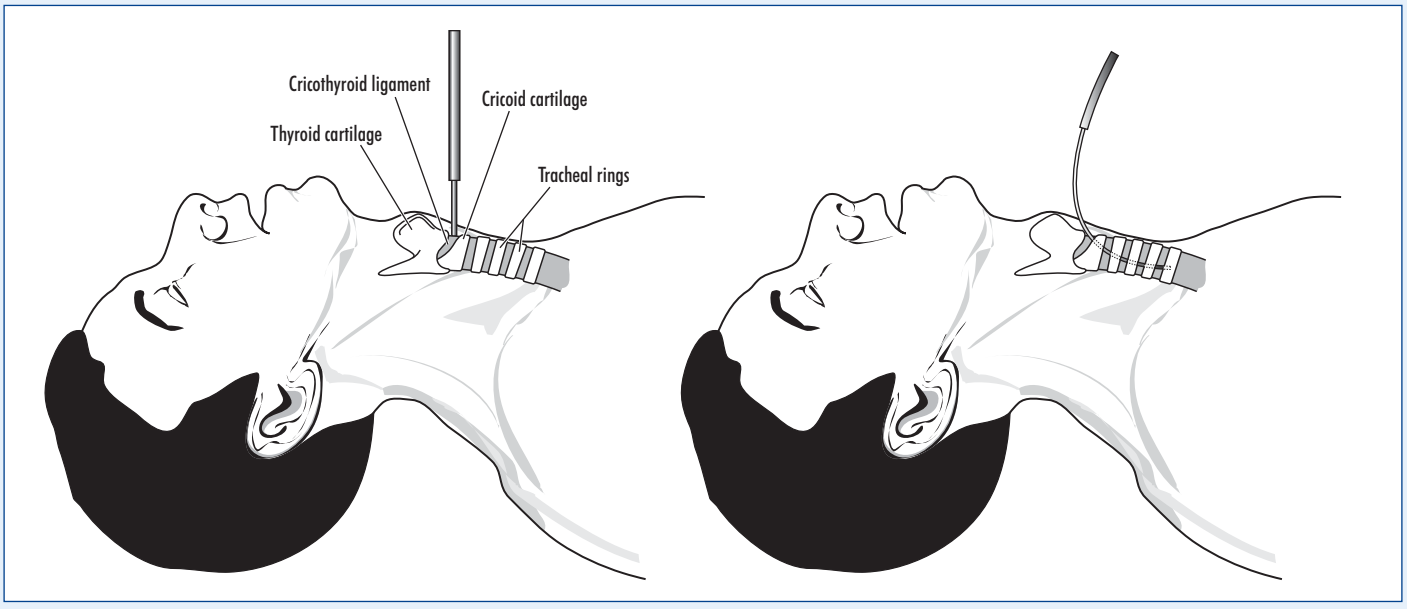


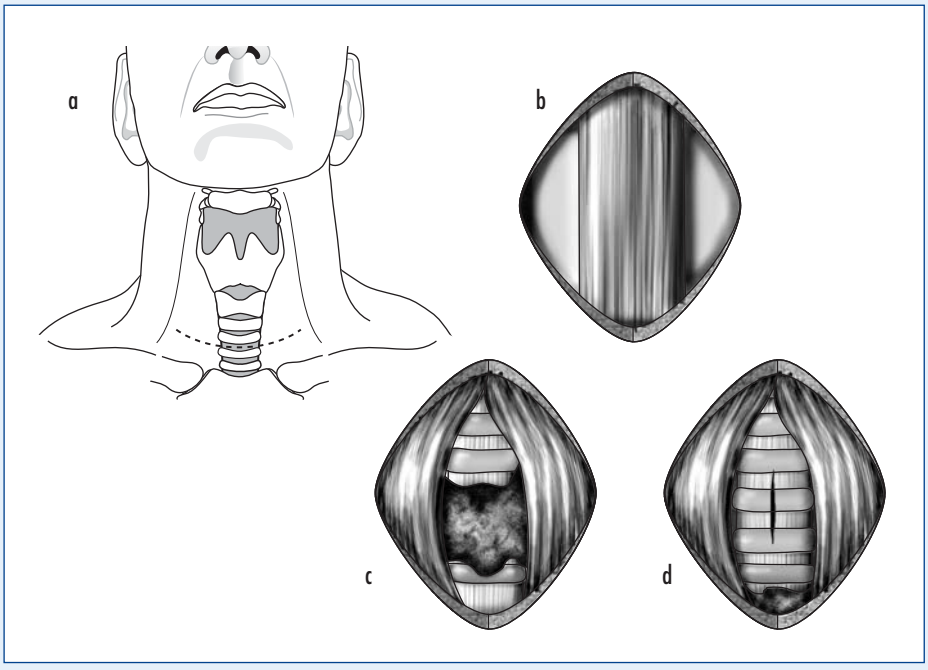
Figure 2. Emergency cricothyrotomy.

lower border of the thyroid cartilage to just above the suprasternal notch. The incision divides the investing (deep) fascia vertically, and passes between the strap muscles which are held apart with retractors. The trachea is now exposed and confirmed by palpating its rings. Usually it is possible to push down the isthmus of the thyroid gland to expose the upper tracheal rings; if not, the isthmus is lifted up and divided between artery forceps. The trachea is then opened vertically, usually dividing the second and third rings, and a tracheostomy tube of the largest size that will fit the opening comfortably is inserted, the trachea aspirated through it and the wound loosely sutured around the tube. (In the elective procedure, the surgeon will fashion a fenestra or a flap in the trachea rather than an incision.)

Obviously, an emergency tracheostomy is a far more complex operation than cricothyrotomy, requires more instruments and a modicum of surgical skill.

In the emergency or semi-emergency situation the technique of 'mini-tracheostomy' can be used. This involves a 1.5 cm vertical incision over the second and third thyroid cartilages. The trachea is entered between these two rings with a needle attached to a fluid-filled syringe. Entry into the trachea is confirmed by the aspiration of air. A guide wire is then passed through the needle, which is withdrawn. A series of dilators is then passed over the wire, finally replaced by a tracheostomy tube. BJHM

Figure 3. Formal tracheostomy. a. The incision. b. Strap muscles exposed deep to the investing fascia. c. Straps retracted, isthmus of thyroid gland exposed. d. Incision made into trachea above the isthmus.



Conflict of interest: none.

Further reading

Ellis H, Feldman S, Harrop-Griffiths W (2004) *Anatomy for Anaesthetists.* 8th edn. Blackwell Publishing, Oxford

KEY POINTS

- Knowledge of the anatomical basis of common procedures reduces risks of complications.
- Cricothyrotomy is performed by puncture through the cricothyroid ligament – easily identified as the depression between the thyroid and cricoid cartilages in the midline.
- Tracheostomy is a more difficult formal operation, but mini-tracheostomy through a short incision and serial dilatations over a guide wire insertion is simpler.