

# The emergency airway

## Introduction

The 'can't intubate, can't ventilate' scenario is a nightmare for all clinicians who manage airways. Cricothyroidotomy is one of several emergency airway management techniques. Cricothyroidotomy is a short-term solution which provides oxygenation, not ventilation, and is not a definitive airway.

Although there are tests which can help predict whether an intubation will be difficult, they are not always good predictors. As the can't intubate, can't ventilate scenario is rare, cricothyroidotomy is an unfamiliar procedure to many. In this situation, expert help must be called for early on. In the meantime, it is vital that all other simple airway manoeuvres have been attempted, such as good positioning of the patient with head tilt and chin lift, and use of airway adjuncts like the oral (Guedel) airway or nasopharyngeal airway, and the laryngeal mask airway. However, if attempts to secure the airway are unsuccessful, there may be no other option than to perform a cricothyroidotomy. It is a difficult decision to make, but with increasing hypoxia, it is essential that one oxygenates the patient.

Cricothyroidotomy provides an opening in the space between the anterior inferior border of the thyroid cartilage and the anterior superior border of the cricoid cartilage, allowing access to the airway below the glottis. The anatomical considerations are important when performing this procedure (Ellis, 2009), and there are other scenarios when it is used. It is not without consequence, as with any procedure.

## Anatomy

The thyroid cartilage (Adam's apple) is a useful landmark, but is less obvious in females than males. Above the thyroid car-

tilage the hyoid bone is palpable, and these two structures are joined by the thyrohyoid membrane. Below the thyroid cartilage lies the cricoid cartilage, joined by the avascular cricothyroid membrane. In the adult, the cricothyroid membrane is approximately 10 mm in height and 22 mm in width and is composed mostly of yellow elastic tissue (Figure 1). Palpation of the cricothyroid membrane can be made easier by extending the head and neck, and it is felt as a slight dip below the thyroid cartilage (Melker and Kost, 2007).

Adjacent structures include the overlying thyroid isthmus and superior thyroidal artery (Vukmir, 2001). The cricothyroid membrane is bordered by the cricothyroid muscle on either side. Lateral to the membrane are the venous tributaries from the inferior thyroid and anterior jugular veins. Tributaries from the anterior jugular veins only occasionally cross the cricothyroid space (Melker and Kost, 2007).

The vocal cords lie approximately 1 cm above the cricothyroid space, and therefore are not usually damaged during cricothyroidotomy.

The anatomy and dimensions of the cricothyroid membrane and the arterial and venous vessel patterns vary from person to person. Sometimes the cricothyroid membrane can be difficult to feel. If the small finger of the right hand is placed in the suprasternal notch, and each finger placed in turn next to the small finger, with the head in a neutral position, the index finger usually falls on or near the cricothyroid membrane (Melker and Kost, 2007).

## Indications

1. Failed intubation (can't intubate, can't ventilate scenario)
2. Anticipated difficult airway: elective prophylactic cricothyroidotomy. This route can provide a means of oxygenation while securing a definitive airway, and might be used in patients with distorted facial anatomy from trauma
3. Elective provision of oxygenation by the subglottic route (Patel and Frerk, 2008), e.g. in a situation where there is an obstruction above the glottis.

## Contraindications

There are no contraindications in the can't intubate, can't ventilate scenario. However, it may be extremely difficult to perform, for example when the anatomy is distorted in disease or injury.

In other situations, various relative or absolute contraindications should be taken into consideration, such as laryngeal infection and laryngeal trauma (Vukmir, 2001). If the patient has been intubated for more than 3 days, a cricothyroid puncture could increase the likelihood of subglottic stenosis. Pre-existing laryngeal disease such as cancer, acute or chronic inflammation, or epiglottitis will result in a higher morbidity when cricothyroidotomy is performed. A history of coagulopathy or bleeding disorders should also be taken into consideration (Melker and Kost, 2007).

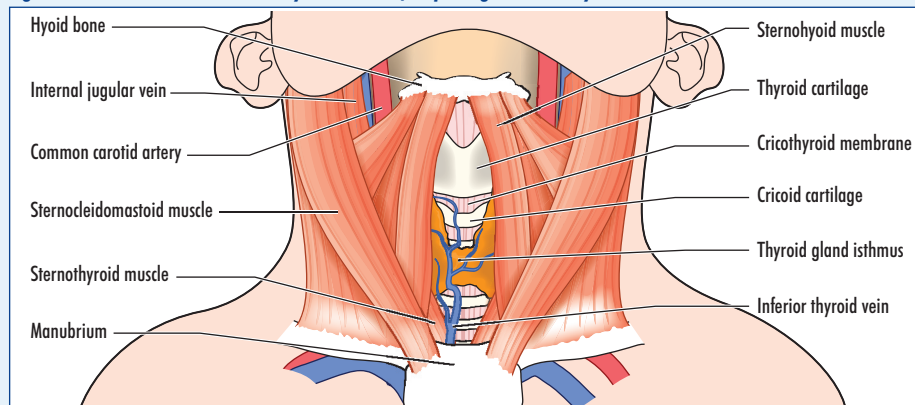
## Complications

Complications can be immediate, early or late, and either local or systemic (Table 1). A common complication is hypercarbia. If

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Figure 1. Anterior view of anatomy of the neck, depicting the cricothyroid membrane.



**Table 1. Frequently reported complications of emergency cricothyroidotomy**

Timing	Complication
Immediate	Hypoxia Subcutaneous or mediastinal emphysema Needle displacement, or kinking, causing respiratory obstruction Embolus (from insufflation into a vessel) Haemorrhage Oesophageal or mediastinal perforation
Early	Pneumothorax Vocal cord injury or laryngeal disruption Aspiration
Late	Tracheal and subglottic stenosis Swallowing dysfunction Tube obstruction Tracheoesophageal fistula Infection and late bleeding Persistent stoma Tracheomalacia

Adapted from Melker and Kost (2007)

the upper airway is still obstructed, passive exhalation will be inadequate and air trapping will occur. It is important to maintain the upper airway during oxygenation through the cricothyroidotomy, as without exhalation barotrauma will occur.

### Techniques

- Using a needle or needle-over-needle catheter placed directly into the cricothyroid space (Tables 2 and 3)
- Percutaneously via a skin incision. A guidewire is inserted through a needle or catheter. An airway catheter is then introduced over a dilator threaded over the guidewire (percutaneous dilational cricothyroidotomy, Seldinger technique)
- Surgical cricothyroidotomy, using a scalpel and other surgical instruments to enter the cricothyroid space (Table 4). A tracheostomy or endotracheal tube is then inserted (Melker and Kost, 2007). Remember, in the can't intubate, can't ventilate scenario, try simple airway manoeuvres first. Figures 5a and b show head positioning, with a 'chin lift' and 'jaw thrust'.

**Table 2. A comparison of needle and surgical cricothyroidotomy**

Needle cricothyroidotomy	Simpler and quicker to perform More equipment required for oxygenation, and more time to set up Can provide a means of oxygenation only Not a definitive airway If there is upper airway obstruction, passive exhalation cannot occur, and this leads to barotraumas
Surgical cricothyroidotomy	More chance of haemorrhage Simple circuit can be used, for example the Ambu bag Can provide a means for oxygenation and ventilation Cuffed tube can be used, therefore preventing aspiration once inserted Can still be used in situations with upper airway obstruction Not recommended in prepubescent children because of the increased risk of damage to the cricoid cartilage

Adapted from Vukmir (2001)

**Table 3. Cannula cricothyroidotomy**

<b>Equipment</b>	Kink-resistant cannula, e.g. Patil (Cook) or Ravussin (VBM), high pressure ventilation system, e.g. Manujet III (VBM)
<b>Technique</b>	<p>Step 1 Position the patient with extension of the neck</p> <p>Step 2 Identify the cricothyroid membrane with the index finger and stabilize the thyroid cartilage with the non-dominant hand</p> <p>Step 3 Using a saline-filled syringe, direct the catheter and syringe at 45° in a caudal direction to avoid the posterior tracheal wall, until free flow of air is obtained</p> <p>Step 4 Withdraw the needle stylet and advance the catheter to the hub. Aspirate air to reconfirm position. Attach and assemble ventilation system (Figures 2 and 3)</p> <p>Step 5 Ventilate using a ratio of inspiration 1 second to expiration 4 seconds to prevent air trapping (Figure 4)</p> <p>Step 6 Secure the cannula and hold on to it</p> <p>Step 7 Convert to surgical cricothyroidotomy if there is any evidence of barotrauma, hypotension, or subcutaneous emphysema</p>

Adapted from Vukmir (2001)

If these fail, and the decision has been made to perform a cricothyroidotomy (Figure 6), the ideal position for bag valve mask ventilation is completely different from that required for needle or surgical cricothyroidotomy. For cricothyroidotomy, the patient needs to be positioned with

**Figure 2. Equipment for needle cricothyroidotomy and oxygenation with the Manujet.**



**Figure 3. Assembled equipment.**



**Figure 4. Using the Manujet to oxygenate via the needle cricothyroidotomy.**



## PRACTICAL PROCEDURES

extension of the neck in order to increase the chances of success of the procedure. Ideally there should be a bolster or pillows placed below the shoulders, and a head ring to steady the head (*Figure 7*).

### Oxygenation and ventilation

When oxygenating through a cricothyroid cannula, inspiration lasts for 1 second, and there must be 4 seconds to allow passive expiration. If the upper airway is still obstructed, passive exhalation will be inadequate and air trapping will occur. It is imperative that a surgical or definitive airway, such as a tracheostomy or oral endotracheal tube, is obtained as soon as possible.

There are several methods to provide oxygenation and ventilation via a cricothyroid cannula, including the following:

1. Connect the cricothyroidotomy cannula to a high pressure oxygen supply with a three-way tap. The open limit of the tap is occluded to provide ventilation, with oxygen flows of 12–15 litres/minute. This method is mentioned in the Adult Advanced Life Support course manual (Resuscitation Council (UK), 2000).

The Paediatric Advanced Life Support course manual (Advanced Life Support Group, 2005) recommends a 400 kPa oxygen supply with a flowmeter. A flow of 1 litre/minute per year of age is used, and it is increased by increments of 1 litre/minute if there is no chest movement (Bould and Bearfield, 2008).

2. The Manujet (VBM Medizintechnik GmbH, Sulz, Germany) has an adjustable dial to put a limit on the maximum jetting pressure. There is a separate manually controlled trigger to control the respiratory rate. Jetting pressures can be set from low to high. 1 atmosphere can achieve adequate lung ventilation via a small cricothyroid cannula in a small adult (Bould and Bearfield, 2008).

It is plugged into the oxygen supply in the wall, or an adaptor is used to plug it into a portable oxygen cylinder. The clear plastic tubing has luer lock connections which allow a connection to be made between the Manujet and the cannula. The jetting pressures can be set with the adjustable dial, and are colour coded for infant, child and adult.

A standard ventilation circuit such as the ambu bag can be used to ventilate via a surgical cricothyroidotomy, but not with a needle cricothyroidotomy.

### Conclusions

In the can't intubate, can't ventilate scenario, cricothyroidotomy can be a life-saving procedure. Consideration of the anatomy and good patient positioning will increase the chances of success. **BJHM**

Figure 1 is reproduced from Melker and Kost (2007) by kind permission.

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#### Useful websites

Difficult Airway Society ([www.das.uk.com](http://www.das.uk.com))

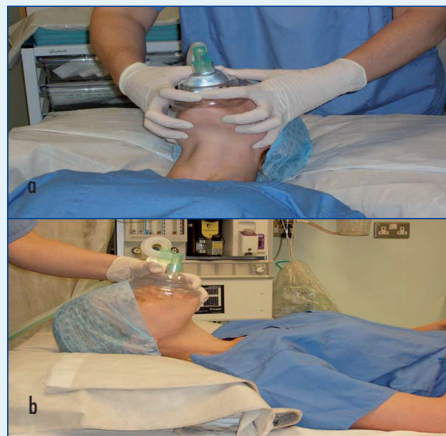
The Airway Site ([www.theairwaysite.com](http://www.theairwaysite.com))

### Table 4. Surgical cricothyroidotomy

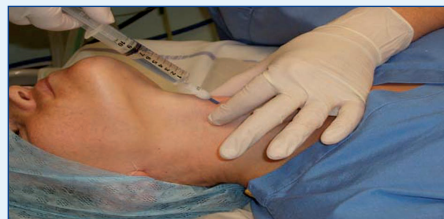
<b>Equipment</b>	Scalpel – short and rounded (number 20, or Minitrach scalpel). Small (e.g. 6 or 7 mm) cuffed tracheal or tracheostomy tube
<b>Technique</b>	<p>Step 1 Identify cricothyroid membrane</p> <p>Step 2 Stab incision through skin and membrane. Enlarge incision with blunt dissection (e.g. scalpel handle, forceps or dilator)</p> <p>Step 3 Caudal traction on cricoid cartilage with tracheal hook</p> <p>Step 4 Insert tube and inflate cuff</p>
	Ventilate with low-pressure source. Verify tube position and pulmonary ventilation

From Difficult Airway Society (2004)

**Figure 5.** Using the 'chin lift and jaw thrust' manoeuvres to open the airway. **a.** Front view. **b.** Side view.



**Figure 6.** Performing a cannula cricothyroidotomy.



**Figure 7.** Good neck extension to enhance success in performing a cricothyroidotomy.



### KEY POINTS

- In the rare 'can't intubate, can't ventilate' emergency scenario, try simple airway manoeuvres to maintain oxygenation.
- Cricothyroidotomy may be required as a last resort, and it is important to make this decision.
- Good patient positioning is key to increasing the chances of success.
- The complications are serious, and unless competent at the procedure, it should only be used in life-threatening situations.
- Convert to a definitive airway as soon as possible.