TRACHEOSTOMY

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INTRODUCTION

Tracheotomy is the creation of a surgical opening into the trachea to allow ventilation. Tracheostomy refers to the stoma opening itself.

The history of tracheostomy is thought to be as early as 2000 BC, where there is mention of a similar procedure in sacred Hindu texts.[1] In 1546, the Italian physician Antonia Brasavola successfully performed a tracheostomy in a patient with a laryngeal abscess. Over the centuries the technique has been further refined, and its acceptance into modern clinical practice has resulted.

Four main indications for a tracheostomy

- upper airway obstruction
  eg, obstructing carcinoma, acute upper airway trauma
- longterm mechanical ventilation
  eg, in patients in whom extubation is unlikely for 14 days
- weaning failure
- inability to manage secretions
  eg, aspiration, excessive bronchopulmonary secretions

TYPES OF TRACHEOSTOMIES

Surgical Tracheostomy (ST)
An ST is a commonly performed procedure in theatre, with the patient positioned to hyperextend the neck allowing the trachea to move anteriorly. A 3-5cm transverse incision is made 1cm inferior to the cricoid cartilage, and is carried down through the skin, subcutaneous tissues and platysma. The strap muscles are retraced laterally, the thyroid isthmus retracted superiorly, inferiorly or transected and each side suture ligated.

The opening into the trachea can be made either by excising a window of tracheal cartilage or creating a flap which is sewn onto the inferior skin margin anteriorly. A flap makes re-intubation easier if accidental post-op extubation occurs.

It is essential that a tracheostomy is sited at least one or two rings beyond the cricoid, usually between the 2nd and 3rd, or 3rd and 4th cartilage rings. Subglottic stenosis can result if sited too high, and if too low there is a risk of damaging the brachiocephalic trunk.

Percutaneous Dilational Tracheostomy (PDT)
This procedure began as 'minitracheostomy', which was a percutaneously performed cricothyrotomy for the evacuations of bronchial secretions in critically ill patients who may have remained intubated for a long period of time.

The technique relies on progressive blunt dilation using a series of dilators through a small tracheal aperture. The aperture is created by introducing a needle into the trachea, and then passing a J-tipped guidewire through it. Subsequent dilation allows easy insertion of a tracheostomy tube. The procedure is performed under endoscopic guidance. With the advent of new surgical materials, various modifications of this technique have been introduced over the last 20 years.

Percutaneous tracheostomies offer some advantages compared to surgical tracheostomies:

- no need to schedule theatre time
- requires less time to perform[2]
- less expensive[2]
- can be performed at short notice
- reduced rate of complications[3]

However, the disadvantages of percutaneous tracheostomies over surgical tracheostomies include an increased risk of anterior tracheal wall injury and posterior tracheal wall perforation.[4] Additionally, it may not be possible to perform a percutaneous tracheostomy for a variety of anatomical reasons such as short neck, previous neck surgery and aberrant blood vessels.

The following are considered relative contraindications to percutaneous tracheostomy:

- patients <15 years
- uncorrectable bleeding diatheses
- previous neck surgery
- gross anatomical distortion of the neck
- suspected tracheomalacia
- soft tissue infection
- cervical spine instability

TRACHEOSTOMY TUBES

There are several different types of tracheostomy tubes which vary in diameter, length, and material composition (plastic *vs.* metal) and fenestrated/non-fenestrated. Cuffed tubes such as the Bjork-Shiley tubes have an inner cannula which is changed daily; there is no need to change the outer tracheostomy tube as frequently. After insertion of the tracheostomy, the first change of the tracheostomy should be by an experienced operator after one week to allow creation of the stoma.

Tracheostomy tube cuff pressures should be maintained in a range of 20-25mmHg. Cuff pressures exceeding this range

will exceed capillary perfusion pressure resulting in mucosal ischaemia and after prolonged exposure tracheal stenosis. Low cuff pressures (<18mmHg) will promote aspiration of secretions collected above the cuff increasing the risk of nosocomial pneumonia. It is important to monitor cuff pressures regularly using a calibrated device.

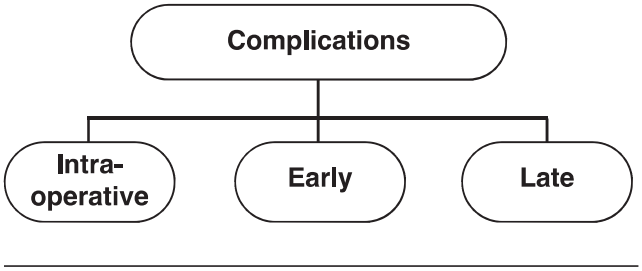

Figure 1 Complications of tracheostomy

COMPLICATIONS OF TRACHEOSTOMY

Intra-operative complications

- damage to the great vessels
- damage to the wall between the trachea and oesophagus
- damage to soft tissues, such as the pleura of the lung

Early complications

- *Haemorrhage*
  Minor bleeding is controlled by packing the area, and ensuring that the cuff is inflated. Major bleeding may need re-operation.
- *Infection*
  As with any surgical procedure there is a risk of infection, although a tracheostomy is a clean contaminated wound, the risk of severe infection is rare. If necrotising tracheal infection does occur, the area is debrided of dead tissues, and oral intubation is needed.
- *Surgical emphysema*
  This occurs because of positive pressure ventilation or coughing against a tightly packed wound. It normally resolves after a few days, but a chest X-ray is needed to exclude a pneumothorax.
- *Tracheotomy tube failure*
  The tube can become blocked by mucous plugs and/or blood clots, and displaced into surrounding tissues (often seen in children due to pliable necks). Occasionally the tip of the tube may sit up against the tracheal wall. If suctioning does not improve ventilation, then ideally the inner cannula should be replaced.

Late complications

- *Swallowing impairment*
  Due to decreased laryngeal elevation, obstruction from the tracheostomy tube cuff and oesophageal compression.
- *Tracheal stenosis*
  This occurs often as a result of ischemia and chemical erosion due to the old high-pressure cuffs. The incidence has been reduced due to the introduction of high-volume, low-pressure cuffs.
- *Tracheo-innominate artery fistula*
  Fortunately this is a rare but one of the most feared complications, as it carries a high mortality rate. The fistula appears to be as a result from direct pressure of the cannula against the innominate artery. Risk factors include; low-placed tracheostomy (below the level of the third tracheal ring), high-pressure cuffs, and tube torsion. Overall survival is only 25%.[5]
- *Granuloma formation*
  These occur as a result of a foreign body reaction to the tube, and more commonly seen in fenestrated tubes. The granulomas can be treated using a YAG laser.
- *Persistent stoma*
  This is as a result of the tube being *in situ* for prolonged periods, allowing epithelialisation between the skin and tracheal mucosa. This can be treated by surgical closure.

TRACHEOSTOMY *VS.* ENDOTRACHEAL TUBES

Both endotracheal and tracheostomy tubes are available with high-volume, low-pressure cuffs. There are two problems to consider when deciding when to offer a tracheostomy to a patient; firstly the possibility of laryngeal injury with longterm use of an endotracheal tube, and secondly, the potential surgical- and stoma-related complications following tracheostomy. There have been numerous studies looking at potential advantages and disadvantages of tracheostomy *vs.* endotracheal tube.[6,7]

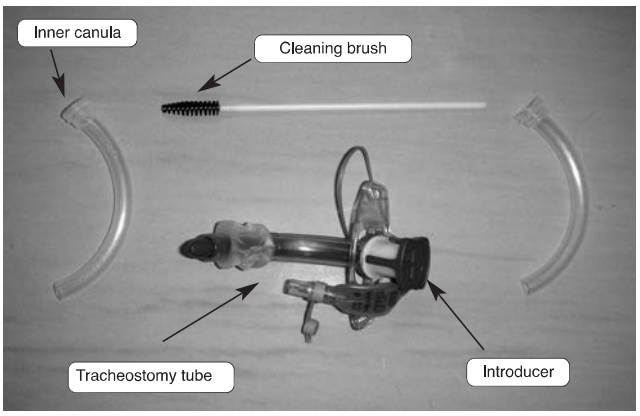

Figure 2 A non-fenestrated cuffed tracheostomy tube, with an inner cannula and cleaning brush shown separately

Some of the advantages are:

- Improvement of respiratory mechanics. Study data has shown that work of breathing, airway resistance, and auto PEEP decrease after tracheostomy in both ventilated and spontaneously breathing patients.[6] These changes along with improved secretion clearance and patient comfort may facilitate weaning from mechanical ventilation. An observational study showed that tracheostomised mechanically ventilated ICU patients required less intravenous sedatives, spent less time sedated and achieved more autonomy sooner.[7]
- Other advantages include improved nutrition, enhanced mobility and improved speech.

Disadvantages include the risks associated with a surgical procedure as mentioned already. Current evidence also suggests tracheostomy in mechanically ventilated patients was independently associated with a six-fold increase in the risk of developing nosocomial pneumonia.[8]

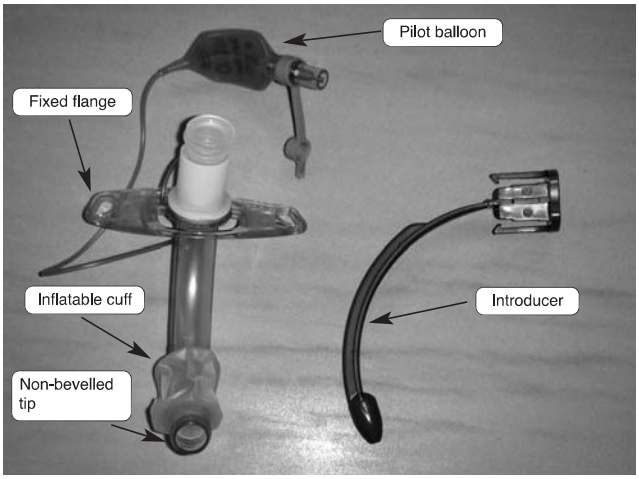

Figure 3 A non-fenestrated tracheostomy tube, shown with the introducer removed

REMOVAL OF TRACHEOSTOMY

Removing a tracheostomy after acute upper airway obstruction is only performed if a patent airway is re-established. Patients who have been weaned from prolonged mechanical ventilation are only considered if they are clinically stable, have good swallowing, able to expectorate and do not have any psychiatric disorders.

Criteria used to assess the patient[9]

- stable arterial blood gasses
- heamodynamically stable
- PaCO2 < 60mmHg
- absence of distress / delirium / psychiatric disorder
- adequate swallowing and able to expectorate
- absence of fever or infection
- normal endoscopic examination

There are several approaches for weaning patients from tracheostomy tubes. The three most common methods are:

1. Progressively decreasing the size of the tracheostomy tube.
2. Progressive capping of a fenestrated tracheostomy tube, until tolerating up to 48 hours. Passy-Muir valves are used as an alternative to capping. They tend to be better tolerated by the patient, and promote re-establishment of laryngeal reflex activity, phonation and cough.
3. Using a tracheostomy button is useful in patients who may not be clearing secretions adequately, and still requiring maintenance of the stoma.

Before removing the tube, respiratory distress is observed by occluding the opening of the tube with a finger. If there is visible distress, then endoscopic examination is needed to rule out an upper airway obstruction. Once the tube is removed, sterile dressings should cover the site, until the wound spontaneously heals in about ten days.

SUMMARY POINTS

- Tracheostomy is considered for upper airway obstruction, prolonged mechanical ventilation, weaning and bronchial toilet.
- Tracheostomy decreases the work of breathing, improves phonation, and improves patient comfort in ventilated patients.
- Percutaneous dilational tracheostomy is an alternative to a surgical tracheostomy.
- Tracheo-innominate fistula and haemorrhage is a life-threatening complication.
- Decannulation can be performed when mechanical ventilation is not required, upper airway obstruction is absent, cough is adequate and secretions are well controlled.

REFERENCES

1. Goodall EW. The story of tracheostomy. Br J Child Dis 1994;31:167-253

2. Freeman BD, Isabella K, Lin N, Buchman TG. A meta-analysis of prospective trials comparing percutanoeus and surgical tracheostomy in critically ill patients. Chest 2000;118(5):1412-8

3. Dalaney A, Bagshaw SM, Nalos M. Percutaneous dilational tracheostomy versus surgical tracheostomy in critically ill patients: a systematic review and meta-analysis. Crit Care 2006;10(2):R55

4. Trottier SJ, Hazard PB, Sakabu SA, *et al*. Percutaneous tracheal wall perforation during dilational trachesotomy: an investigation into its mechanism and prevention. Chest 1999;115(5):1383-9

5. Grillo HC. Surgery of the trachea and bronchi. Hamilton and London: BC Decker Inc; 2004. p341-56 (Chapter 12. Acquired tracheoesphageal and bronchoesophageal fistula)

6. Leader SB. Incidence and type of aspiration in acute care patients requiring mechanical ventilation via a new tracheotomy. Chest 2002;122(5):1721-6

7. Nieszkowska A, Combes A, Luyt CE, *et al*. Impact of tracheotomy on sedative administration, sedation level, and comfort of mechanically ventilated intensive care patients. Crit Care Med 2005;33(11):2527-33

8. Ibrahim EH, Tracy L, Hill C, Fraser VJ, Kollef MH. The occurrence of ventilator-associated pneumonia in a community hospital: risk factors and clinical outcomes. Chest 2001;120(2):555-61

9. Christopher KL. Tracheostomy decannulation. Respir Care 2005;50(4):538-41