Tracheostomy& related airway problems

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[1] http://www.nickalls.org/dick/papers/thoracic/hand-trachy.pdf

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Tracheostomy & related airway problems [1]

A tracheostomy is like a snake—it can rear up and bite you when you least expect it.

THIS is a path littered with unforeseen hazard. Some basic guidelines can therefore be useful since most of us anaesthetise relatively few patients with, or for, a tracheostomy. The key skills to learn are (a) changing a tracheostomy (Section 3.6) and (b) bronchoscopy (Chapter **??**).

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  [chapters: Endotracheal tubes / Tracheotomy: application and timing / Percutaneous dilational tracheotomy techniques / Percutaneous tracheostomy—special considerations / Techniques of surgical tracheostomy / Comparison of surgical and percutaneous dilational tracheostomy / Minitracheostomy / The Montgomery T-tube tracheal stent / Acute complications of artificial airways / Long-term complications of artificial airways / Long-term care of the tracheostomy patient / Transtracheal oxygen catheters / Management of hypoxemia during flexible bronchoscopy]

[1] `http://www.nickalls.org/dick/papers/thoracic/hand-trachy.pdf`

3.1 Introduction

As a general rule, whenever there is a problem with a tracheostomy (in theatre or on a ward) have a *very* low threshold for inspecting the position of the tracheostomy with a fibrescope—either with the intubating fibrescope or with the usual 'large' fibrescope. Many significant complications arising from a 'blind' manoeuvre would have been avoided completely if only a fibrescope had been used initially.

Simple visualisation of the trachea in order to check the position of the tracheostomy does not require local anaesthesia, since this generally can be done by positioning the fibrescope just at the tracheal-end of the tracheostomy, i.e., without needing to touch the tracheal mucosa. However, sometimes it is advantageous to give some local anaesthetic to allow more freedom with the fibrescope. The following simple technique generally works very well.

3.1.1 Local anaesthetic for fibreoptic bronchoscopy of the trachea

A reasonably effective adult dose is 80 mg plain lignocaine (2 mls of 4% lignocaine) which can either be blown down the bronchoscope, or down the dilator [2] of a Portex 'Seldinger' Mini-Trac (since this has a very useful Luer connector) with the tip positioned well down the tracheostomy.

Take a 20 ml syringe (with a straight Luer connector so it can be pushed into the fibrescope inject port) and pull the plunger out to the 20 ml position; now inject 2 mls of 4% lignocaine into the empty syringe via the nozzle and then hold it vertically (nozzle down); now connect the 20 ml syringe vertically into the inject-port of the fibrescope (tip now positioned at the tracheal-end of the tracheostomy) and inject quickly (ideally at the end of expiration) all 20 mls (2 mls lignocaine + 18 mls air). This will deliver the lignocaine as a fine spray throughout the trachea, and usually gives very effective local analgesia above the carina.

3.2 Tracheostomy tubes

There is a huge range of tracheostomy tubes—cuffed and uncuffed, fenestrated & non-fenestrated; standard forms with and without inner-tubes (e.g., Portex, Tracoe); specialised forms (e.g., Montgomery tube (Section 3.9), Mini-Trac, double-lumen), as well as various attachments (speaking valves, humidifiers). Most of these are well described by Russell and Matta (2004).

When purchasing standard tracheostomy tubes it is useful to consider only those for which the number defining the tube 'size' is the same as the internal diameter of the

[2] In this case use a 20 ml syringe having a Luer-*lock* connector (available in ITU), as you generally have to push the syringe plunger in with significant force (since the Portex Mini-Trac dilator has a very narrow channel). Unless you lock the syringe nozzle onto the Luer connector of the dilator it will probably disconnect as you inject, owing to the relatively high resistance to flow.

inner-tube, as is standard with endo-tracheal tubes. The tracheostomy tubes currently used by the City Hospital are Portex and Tracoe, both of which follow this rule.

3.2.1 Portex[3] (Smiths Medical)

(Smiths Medical, Hythe, Kent, UK; tel: +44-(0)-1303-260-551)

The Portex brand (Smiths Medical) includes a percutaneous dilation kit (*UniPerc*), as well as a range of tracheostomy tubes:

1. Non-fenestrated versions which are intended for short-term use only (usually changed weekly). The internal and external diameter specifications for the standard tracheostomy tube are given in Table 3.1.
2. Adjustable flange versions (e.g., the *UniPerc*) for use in obese patients.
3. A left double-lumen tracheostomy tube.

3.2.2 Tracoe

(Kapitex Healthcare Ltd., Kapitex House, 1 Sandbeck Way, Wetherby, West Yorkshire LS22-7GH, UK; tel: 01937–580211. http://www.kapitex.com)

The Tracoe tracheostomy tubes used at the City Hospital (TRACOE *twist* MODEL 302) are fenestrated (multiple small holes) polyurethane radio-opaque low-pressure cuffed tubes, intended for medium-term use (up to 31 days). Note that neither the duration nor latex status seems to be specified in their documentation. The twist-lock connection is fully 'locked' when the two arrow heads are opposite one another. Each Tracoe box includes

- Outer tube with swivelling neck-plate
- A removable non-fenestrated inner-tube (white 15 mm connector; for suctioning and ventilation).
- A removable fenestrated inner-tube (blue 15 mm connector; for spontaneous respiration weaning)
- Obturator (for insertion) and neck strap

While Tracoe do make decannulation plugs and speaking valves, these are not included in the package (i.e., they are 'extras'). These speaking-valves and other 'extras' are stocked by ITU. The Passey-Muir clinical information pack relating to tracheostomy tubes and speaking-valves is available from Kapitex Healthcare.

[3] In 1940 Sydney Leader, a dental surgeon at the Dental Hospital, London, set up a company based in his flat in Great Portland Street. His company, which was called Portland Plastics Ltd., was later renamed Portex Ltd. in 1967 (see: Russell CA (1996). Developments in thermoplastic tracheal tubes. In: *Essays on the History of Anaesthesia.* (Royal Society of Medicine Press Ltd., London). p. 94–97).

3.2.3 Rüsch

(Rüsch UK Ltd.,High Wycombe, Bucks, HP12 3NB. UK; tel: 01494–532761).

Make a left and right 39 Fr double-lumen tracheostomy tube. Three intratracheal lengths are available (75, 85, 95 mm).

3.2.4 Moore tube

(Kapitex Healthcare Ltd., Kapitex House, 1 Sandbeck Way, Wetherby, West Yorkshire LS22-7GH, UK; tel: 01937–580211. http://www.kapitex.com)

The Moore tracheostomy tube (Boston Medical Products, Westborough, MA, USA) is a soft and flexible long (115 mm) silicone non-cuffed tracheostomy (with a similar inner tube), which is typically used to maintain tracheostomy access (in a spontaneously breathing patient) following removal of a long adjustable-flange tracheostomy. It can be easily cut to the appropriate length. Two sizes are available: 6 (ID 6.6 mm; OD 11 mm) and 8 (ID 7.5 mm; OD 12 mm).

3.3 Tracheostomy—when?

Commonly at 7–10 days or so, depending on likely duration of ITU care. A failed trial of extubation is a common indication for tracheostomy. Patients with concomitant respiratory disease tend to have a tracheostomy performed at an early stage. While a tracheostomy greatly facilitates nursing and respiratory care and shortens ITU stay, it does not generally reduce hospital stay as it tends to lengthen HDU stay, since most hospital wards cannot accommodate tracheostomy patients.

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3.4 Percutaneous tracheostomy

Percutaneous tracheostomy owes its popularity to the introduction of the 'Blue-Rhino' (William Cook Europe) modification of the dilational technique by the American surgeon Pasquale Ciaglia in 1985 (Eggert and Jerwood 2003). Careful patient selection is important, and there is a significant learning curve.

While a percutaneous tracheostomy tends to have lower rate of long-term complications (e.g., tracheal stenosis) than a surgical tracheostomy, the early 'percutaneous' complication rate (e.g., bleeding, tracheal damage, pneumothorax) tends to be higher. Percutaneous complications, when they do occur, tend to be serious. The advantages of prior ultrasound scanning for aberrant vessels is suggested by several authors—see Gwilyn and Cooney

(2004), Shlugman *et al.* (2003), Toni *et al.* (2003). Damage to the posterior tracheal wall is an ever present danger—see Madden *et al.* (2004) on one approach to this problem using a covered stent.

For a good overview see the handbook by Paw and Bodenham (2004); for details of two meta-analysis studies see the article by Eggert and Jerwood (2003). For experience with the Fantoni Trans-Laryngeal Technique see Lesmo and Ripamonti (2010).

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3.5 Surgical tracheostomy

Assuming the patient already has a single-lumen endotracheal tube in place, then the main considerations are as follows (Rogers *et al.* 2001).

- Make sure the cuff is not damaged by the surgeon.

  To this end it is recommended that the endo-tracheal tube be first pushed down close to the carina, using a fibreoptic bronchoscope to position the tube safely. Consider changing the endo-tracheal tube if it is too short to reach the carina.

- Be alert to the potential fire risk (see recommendations below).

  Although flammable anaesthetic agents are no longer used in the UK, fires in the operating theatre continue to be an occasional hazard, particularly with operations on the airway. Thankfully, most such fires are evanescent and cause no harm, but unfortunately deaths do still occur. For example, in two separate fatalities reported by Stouffer (see Rogers *et al.* 2001), the fires spread uncontrollably with alarming speed, and in one case the operating theatre had to be evacuated. Interestingly, tracheostomy fires tend not to be as catastrophic as other airway fires, possibly because the tracheostomy acts as a vent.

3.5.1 Recommendations

The following recommendations for anaesthesia for surgical tracheostomy are from the article by Rogers *et al.* (2001). The emphasis is on (a) avoiding a fire, and (b) avoiding surgical damage to the ETT cuff. Note the interesting idea of instilling carbon dioxide directly into the tracheostomy wound described by Mani *et al.* (2007).

1. All theatre staff should be aware that an airway fire may occur during tracheostomy.

- Have a fire extinguisher immediately available. It should be mounted inside the operating theatre near the entrance. In practice a carbon-dioxide fire-extinguisher will be the usual choice. Halon fire extinguishers are significantly better for operating theatre fires, but their use is declining owing to environmental concerns.
- Have a bowl of saline and wet drapes available on the surgical instrument trolley at all times.
- Have a self-filling ventilation bag (e.g., Ambu bag) available for ventilating the patient with room air.
- Do not use nitrous oxide or any of the other flammable/explosive anaesthetic agents.

2. Use a single-lumen endotracheal tube which is long enough to allow the tip to be advanced to the carina (the carina is approximately 24–25 cms from the teeth in an average male). If a single-lumen endotracheal tube is in situ and is too short to reach the carina, then change it for one with a suitable length. If a double-lumen endotracheal tube (or a nasotracheal tube) is already in situ then change it for a single-lumen tube before tracheostomy.

3. Use saline to inflate the endotracheal cuff. Make sure there is no leak of anaesthetic gases past the endotracheal cuff.

4. Use the lowest safe $F_{I_{O_2}}$ in either nitrogen (air/oxygen mixture) or helium.

5. If the tracheostomy wound is significantly deep (e.g., in an obese patient), use a suction device to clear any build up of diathermy products from within the wound.

6. Before the trachea is opened, advance the endotracheal tube down the trachea so the tip is close to the carina, in order to minimise the likelihood of damage to the cuff when the trachea is incised. Use a fibreoptic bronchoscope to position the tip of the endotracheal tube close to the carina, and mark the tube at the teeth when correctly positioned—this will serve as a useful position guide later if the surgeon fails to place the tracheostomy and you need to push the tube down quickly to get the cuff *below* the tracheal hole.

7. Incise the trachea using either a scalpel, scissors, or a harmonic knife. Do not use diathermy to cut through the trachea.

8. Once the trachea has been opened and the surgeon is ready to insert the tracheostomy tube, stop ventilating, deflate the endotracheal tube cuff and withdraw the endotracheal tube carefully under direct vision until the tip is just above the tracheal hole (do not withdraw the tube any further at this stage). Be prepared to push the endotracheal tube back down the trachea to secure the airway if there are any difficulties, either while inserting the tracheostomy, or during the initial ventilation

through the tracheostomy. Remember to keep the oral ETT in situ so you can put the bronchoscope down it (after suctioning) to inspect the tracheostomy.

9. Once the tracheostomy tube is secure in the trachea, inflate the tracheostomy cuff and suck out the tube using a suction catheter, checking that the suction tube passes easily through the whole length of the tube. If this is satisfactory then commence ventilation through the tracheostomy. However, *always* check that the tracheostomy tube is *correctly* located/positioned within the trachea using a fibreoptic bronchoscope—either now (if in doubt), or at the end of the procedure—remember to keep the oral ETT in situ so you can put the bronchoscope down it. This is primarily to check that the new tube is not partially obstructed or in a false passage (note that being able to pass a suction catheter does *not* exclude these possibilities), and to check that the end of the tracheostomy tube is not too close to the carina (this can occasionally be a problem with a long adjustable-flange tracheostomy tube).

10. If any difficulties arise with the tracheostomy tube, remove the tracheostomy tube and advance the endotracheal tube down the trachea so that the cuff lies below the tracheal hole. Have a long endotracheal bougie available (e.g., a gum-elastic bougie), to facilitate advancing the endotracheal tube in case of difficulties. Sometimes, if the tube is soft, it may bend in the pharynx and fail to go down into the trachea when you push it, in which case consider placing a bougie down the tube to stiffen it; a long gum-elastic bougie can also be useful in this situation.

11. If the endotracheal tube cuff has been damaged and the leak is significant, then adequate ventilation can usually be maintained by (a) using large tidal volumes, (b) pushing swabs firmly onto the tracheostomy hole to occlude the leak. Consider using a wide plastic occlusive dressing (e.g., OpSite or Tegaderm) under the swabs to reduce the leak further. Control the leak intermittantly as necessary between surgical attempts to insert the tracheostomy tube. Consider re-intubating if necessary.[4]

Hazard note: If a *significant* leak occurs during a tracheostomy when using a pressure-cycled ventilator (e.g., an ITU ventilator in BIPAB mode), the ventilator may fail to cycle and not ventilate the patient. Have a low threshold for switching to manual bag-ventilation whenever there is a leak in this particular setting.

12. In the event of fire, immediately disconnect the patient from the anaesthetic machine, switch off the anaesthetic gas flow, disconnect the gas pipelines, and ventilate with air using a self-inflating bag. Use an airway filter if there is smoke in the theatre. Consider flushing saline down the endotracheal tube to extinguish any intraluminal fire. Consider removing or changing the tube to minimise the inhalation of toxic products of combustion and spread of fire into the tracheobronchial tree. However,

[4]The neck will likely be well extended and without a pillow at this stage, and so you may need to insert a pillow to get good visualisation of the larynx. Also, use an uncut tube in order to make sure you will be able to get the cuff *below* the tracheostomy hole, and check the position relative to the carina with a fibrescope.

changing the tube may be more risky than leaving it in if the patient was previously difficult to intubate, or the airway has become oedematous.

13. **Finally**: It is important to check the position of a fenestrated tracheostomy with the fibreoptic-bronchoscope by viewing it from above—from the larynx—in order to check whether the whole of the fenestration, or fenestration holes, of the outer tube are *within* the trachea. In practice this is most easily done via the original oral ETT—which should still be in situ for just this purpose. Note that the Tracoe tracheostomies have a total of nine small fenestrations symmetrically arranged in a circle on the larynx side of the tube; the three holes forming the vertical diameter should all be visible through the fibreoptic bronchoscope.

    In obese patients the distance between the skin and the anterior tracheal wall is often too big for the tracheostomy, resulting in some of the fenestration(s) being outside the trachea. The potential consequence of this, especially for ventilated patients, is that air may track back up the tracheostomy (between the inner and outer tubes) and out through the fenestration and into the tissue spaces of the neck, resulting in surgical emphysema. If the neck is too big, then use an adjustable flange tracheostomy instead.

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A useful list of references relating to '*Fire prevention and safety during surgical procedures*' can be found at: http://www.valleylabeducation.org/fire/pages/fire-read.html

3.6 Changing a tracheostomy tube

See also Section 3.11

Typically a tracheostomy is changed because it is either time-expired,[5] damaged (hole in the cuff), or because a different size or format is now required. Occasionally a tracheostomy has to be changed as an emergency procedure owing to malposition, in which case particular care has to be taken as regards bronchoscopic visualisation and railroading over a suitable guide (bougie, oxygenating catheter, bronchoscope etc.).

The main practical considerations are (a) whether the tracheostomy was percutaneous or surgical, (b) the external diameter of the existing tracheostomy tube, (c) whether the patient is ventilated or breathing spontaneously, (d) whether the patient is awake or anaesthetised, (e) how long since tracheostomy formation or last tube change, (f) whether malposition is suspected.

Percutaneous: Since a percutaneous tracheostomy tube is often tightly held by the skin it may be quite difficult to remove and replace. In view of this it is important to use only tracheostomies having an inner-tube, in order to avoid the necessity of having to change it soon after when the patient goes to the ward, or to facilitate weaning.

It is important to be aware of the external diameter of the existing tracheostomy and aim to replace it with one having the same or slightly smaller external diameter if the skin is tight around it.

Surgical: Since a surgically placed tracheostomy tube is usually only loosely held by the skin, changing the tracheostomy tube rarely presents a problem with regard to the size of the new tube, and it can usually be replaced (even with a slightly larger tube) without difficulty.

[5] A tracheostomy without an inner-tube (e.g., Portex) should be changed weekly; a tracheostomy with an inner-tube (e.g., Tracoe) should be changed monthly.

Table 3.1:
Portex and Tracoe tracheostomy tubes

Size	PORTEX		TRACOEtwist (fenestrated)	
	ID mm	OD mm	ID mm (inner-tube)	OD mm (outer-tube)
4	4·0		4·0	7·2
5	5·0		5·0	8·6
6	6·0	8·3	6·0	9·2
7	7·0	10·5	7·0	10·4
8	8·0	11·9	8·0	11·4
8 Long	8·0	11·0	—	—
9	9·0	13·3	9·0	12·5
10	10·0	14·0	10·0	13·8
10 Long	10·0	13·8	—	—

3.6.1 Preparation

- Always check the chest x-ray, listen to the chest, check pulse & blood pressure, oxygen saturation, inspired oxygen, and make sure there is venous access (flush an existing cannula to make sure it is working). Check the notes to see (a) if the patient was difficult to intubate through the mouth, (b) if previous tracheostomy changes were problematic, and (c) if there is any drug allergy. Have drugs and intubation equipment available.
- Check whether the tracheostomy was percutaneous or surgical.
- Check the size and make of the existing tracheostomy tube. Check its external diameter—if this is smaller than that of the one you propose to replace it with then you may have difficulties, particularly if the tracheostomy was made percutaneously (usually this is not a problem if the tracheostomy was a 'surgical' one). The external diameters of tracheostomy tubes are given in Table 3.1.
- Check if the tracheostomy has a cuff (look for the pilot balloon). If there is no cuff then the patient may be breathing via the tracheostomy and via the nose/mouth (this will have implications for pre-oxygenation—see next Section).
- Check the status of the inner-tube. If a fenestrated inner-tube is in situ (Tracoe blue connector) first change it for the non-fenestrated version (Tracoe white connector),

since this (a) allows you to ventilate the patient if you need to, and (b) allows easy passage for a suction catheter/bougie since there is no hole for it to get stuck against.

3.6.2 Changing the tube

- If the patient is awake, explain exactly what you are going to do.
- Preoxygenate the patient. If there is *no* cuff (or it is damaged) then remember to preoxygenate via both the mouth (with a mask) and the tube. If there is a cuff then preoxygenate via a catheter mount at the tracheostomy, and check that you can gently ventilate the patient by hand, inflating the cuff as necessary. If there is no cuff, then preoxygenate both via a catheter mount at the tracheostomy and with a face mask, as the patient may be breathing via both routes.
- Suck out the tracheostomy checking that the suction catheter passes easily into the trachea. If there is a lot of secretions, then continue suctioning until it is as dry as possible before changing the tube.
- Have a large (orange tipped) suction catheter available for railroading the new tube.
- Extend the patient's neck using a supporting pillow under the shoulders for maximum access.
- Prepare the new tracheostomy tube by first checking the cuff is intact, and then deflate the cuff fully and lubricate the cuff with some KY-jelly. Make sure that you have the non-fenestrated inner-tube inside, and that the suction catheter (for railroading) passes easily through the middle (use KY-jelly as necessary). Use the largest diameter suction catheter you can (orange is usually best) which will pass through the non-fenestrated inner-tube, and remember to cut the connector off the suction catheter. Have a smaller size tracheostomy available just in case.
- Remove the neck ties holding the tracheostomy in place.
- Have an assistant hold the patient's head as a precaution. Have an assistant ready with a suction device for sucking out the stoma if necessary once the tracheostomy is out, since removing the tracheostomy often releases a lot of secretions into the stoma.
- Insert the railroading catheter through the existing tracheostomy and pass it a good way into the trachea.
- Remove the existing tracheostomy (remember to let the cuff down), suction the stoma as necessary, and railroad the new one into position. Be prepared to use a smaller tracheostomy if necessary.

- Once the new tracheostomy is in place inflate the cuff and check (a) you can pass a suction catheter easily into the trachea, (b) that you can ventilate the patient easily and that there is no cuff leak, (c) if the patient is breathing spontaneously check that the bag moves easily, and (d) listen carefully to the chest.
- If there are difficulties consider (a) removing the new tracheostomy and trying again after suctioning, (b) railroading the tube over a bronchoscope, (c) intubating through the mouth if necessary.

3.6.3 Check the position bronchoscopically

- *Always* check at the end of the procedure that the new tracheostomy tube is *correctly* located/positioned within the trachea using a bronchoscope—check you can see the carina. This is the *only* reliable way of confirming that the new tube is not partially obstructed or in a false passage (note that being able to pass a suction catheter does *not* exclude these possibilities). Note the distance between the end of the tracheostomy and the carina.
- Finally, do a chest X-ray, and make an entry in the medical notes (size, method, problems, and bronchoscopy findings).

3.7 Anaesthetising a patient with a laryngectomy

Patients with a well established laryngectomy will of course be familiar with tracheostomy use and its management. Consequently, I find the most convenient approach is to insert a *cuffed* tracheostomy on the ward preoperatively on the day of the operation, thus allowing plenty of time for the patient to get used to the tracheostomy before arriving in the anaesthetic room. This greatly facilitates induction and reduces the incidence of coughing.

3.8 Anaesthetising a patient with a tracheostomy in situ

A few basic precautions are worth bearing in mind. Be prepared to change the tracheostomy if necessary (Section 3.6), and always have a bronchoscope handy so you can check position/location if necessary. Before inducing the patient make sure you can actually ventilate the patient through the tracheostomy; i.e., check whether (a) the tracheostomy has a working cuff, and (b) if there is an inner-tube, make sure it is the *non-fenestrated* one.

- Check the notes to see if the patient was difficult to intubate through the mouth.
- Check the notes to see whether the tracheostomy was surgical (usually easy to replace with the same or larger size), or percutaneous (usually more difficult to change; may need a smaller size available).

- Check the tracheostomy itself carefully to determine (a) the manufacturer, (b) the size, (c) whether it has a cuff (look for the pilot balloon), (d) is the inner-tube fenestrated or not? (remove it and see if there is a posterior hole in it), (e) is the inner-tube 'locked' in position? (check that the two small arrows (Tracoe) are aligned; Shiley tracheostomy tubes have two small dots which need to be aligned). Turn the inner tube *clockwise* to lock it.
- Check you have a *new* (unopened) [6] same-size same-make tracheostomy tube available. For tracheostomy tubes having an inner-tube this precaution will also guarantee that you have to hand the all-important non-fenestrated inner-tube (white connector for both Shiley and Tracoe tubes). If the tracheostomy is a percutaneous one, then have the next size smaller also available.
- Since a spontaneously-breathing patient may come to theatre with a fenestrated inner-tube in situ (Shiley green connector; Tracoe blue connector) remember to check before induction the status of the inner-tube (remove it and see if it has a posterior hole), and change to the non-fenestrated version (white connector for both Shiley and Tracoe) if necessary—this is why it is important to have a new unopened tracheostomy tube of the same size immediately available in theatre. Note that if you induce a patient with a fenestrated inner-tube in situ you may well not be able to ventilate the patient adequately owing to the huge leak into the pharynx which will become apparent as soon as you try to ventilate the patient.
- If the patient comes to theatre with a fenestrated inner-tube in situ, do any suctioning *after* first changing to a non-fenestrated inner-tube (white connector), as otherwise the suction catheter may get held up by the fenestration in the inner-tube. In the case of a Shiley tracheostomy tube the catheter may even pass through the large single fenestration in the outer tube and damage the posterior wall of the trachea. Note that Tracoe tracheostomy tubes have multiple small holes in the outer tube which prevent this problem.
- Check that the patient's tracheostomy is a *cuffed* one (i.e., look for the pilot balloon) and that the cuff is intact (check with a bag that there is no leak, and that you can (gently) ventilate the patient by hand). If the cuff leaks consider replacing the tracheostomy before induction (but remember, a *fenestrated* inner-tube will also cause a leak—see above).
- Have some large (orange tipped) suction catheters available (for railroading) in case you need to change the tracheostomy tube.

- **Disconnection hazard**: Since the anaesthesia circuit connects directly on to the *inner-tube* of the tracheostomy, then if the alignment arrows (or dots) at the connection become misaligned during the operation (e.g., if the patient is turned laterally),

[6] Check that the plastic bag inside the box is unopened—it is not uncommon (unfortunately) for someone to have opened it and taken the non-fenestrated inner-tube!

the anaesthesia circuit may rotate (anticlockwise) sufficiently to unlock the inner-tube, and may cause the inner-tube to fall out resulting in a disconnection. It is therefore extremely important to make sure that the tracheostomy and the alignment arrows (or dots) are clearly visible at all times, and that no anticlockwise torque is exerted by the circuit on the inner-tube.

3.8.1 Postoperative management

While patients with a tracheostomy generally wake up very smoothly, they do present an unusual airway risk with regard to aspiration should they vomit. Consequently, the recovery staff need to be familiar with tracheostomy care, and be aware of the aspiration risk. A useful approach is to protect the airway using a catheter mount (on the tracheostomy), and have it directed to one side.

3.9 Montgomery T-tube placement

These T-tubes are used to stent a collapsing trachea. Surgical placement is via the trachea, and is usually extremely difficult (may take up to 1 hour). Anaesthesia ideally requires two anaesthetists—one to manage the airway and jet-ventilation, and one to control TIVA and relaxation (see Section **??**). Note that once the tube is in place it is then not possible to use an endotracheal tube for ventilation, and so the options are either an LMA, bag & mask, or perhaps jet-ventilation via a catheter.

- Ernst A and Mehta C [Eds.] (2003). Artificial airways. *Clinics in Chest Medicine*, 24 (September). (WB Saunders Company, London) [includes a chapter on the Montgomery T-tube tracheal stent]
- Guha A, Mostafa SM and Kendall JB (2001). The Montgomery T-tube: anaesthetic problems and solutions. *Br. J. Anaesth.*; 87, 787–790 [excellent article]

3.10 Difficult airway & trans-tracheal needle ventilation

See also Section **??** for references regarding Sanders jet ventilation via endotracheal tubes and rigid bronchoscopes.

- Benumof JL (1999). Airway exchange catheter: simple concept, potentially great danger [editorial] *Anesthesiology*; 91, 342–344.
- Debenham TR (1985). Emergency transtracheal ventilation in anaesthesia or casualty department. *Anaesthesia*; 40, 599-560. [describes use of a standard IV fluid giving-set—cut off the drip chamber and insert the sharp point (which is usually inserted into the infusion bag) into the trachea, and then connect the oxygen to the drip chamber using some connector]

- Gerig HJ, Schnider T and Heidegger T (2005). Prophylactic transtracheal catheterisation in the management of patients with anticipated difficult airways: a case series. *Anaesthesia*; 60, 801–805. [see excellent reply by Higgs and Vijayanand, pp. 1245–1246 (7 refs)]
- Kaiser EF, Seschachar AM and Popovich MJ (2001). Tracheostomy tube replacement: role of the airway exchange catheter. *Anesthesiology*; 94, 718–719 [letter reply to Benumof 1999]
- Layman P (1996). Difficult intubation. *Today's Anaesthetist*; April, p. 52 [letter describing his technique of elective trans-tracheal (crico-thyroid) needle placement under local anaesthesia prior to a gas induction or difficult intubation. This letter cites the following three references.]
- Layman P (1983). Trans-tracheal ventilation in oral surgery. *Annals of the Royal College of Surgeons*; 65, 318–320.
- Layman P (1983). By-passing a problem airway. *Anaesthesia*; 38, 478–480.
- Layman P (1983). An alternative to blind nasal intubation. *Anaesthesia*; 38, 165.
- Mentzelopoulos SD and Tzouf MJ (2002). Anesthesia for tracheal and endobronchial interventions. *Current Opinion in Anesthesiology*; 15, 85–94.
- Paw HGW and Sharma S (2006). Cricothyroidotomy; a short-term measure for elective ventilation in a patient with challenging neck anatomy. *Anaesthesia & Intensive Care* ; 34 (June), 384–387. [used the Melker cuffed device (Cook); 9 refs]

3.11 Miscellaneous problems

You may sometimes be called to see a patient whose tracheostomy tube has developed some 'problem'. In general, the problem is either obstruction (partial or total), an air leak, or the tube has come out slightly and cannot be re-sited. If in doubt bronchoscope down the tracheostomy to check alignment and position.

If the patient is paralysed & ventilated and the problem cannot be fixed quickly, then consider reintubating through the mouth using an uncut [7] tube and advance the tube so it is *just* below the stoma (taking care not to inadvertently intubate a main bronchus [8]),

[7] Uncut—since the tube must be long enough to get the cuff below the stoma.

[8] This is a very common error, and all too easy to make when using a long (uncut) tube in an emergency situation. Unfortunately, if you are intubating orally in order to overcome an obstructed tracheostomy (and are already wondering whether the tracheostomy tube has made a false passage), and then you discover the new oral tube seems to be obstructed as well, it is easy to wrongly assume that the cause is somehow related to the original tracheostomy problem and fail to appreciate that this new obstruction is simply due to the uncut oral tube being too far down. Checking the tube distance at the teeth is the best clue, since even a quick bronchoscopy at this stage may well be confusing (for example, showing strange and unfamiliar anatomy of small lower-lobe basal bronchi) unless you are already considering the possibility of the tube being too far down.

and then bronchoscope to check position in relation to the carina. If you have to bag the patient on a mask after the tracheostomy has been removed, then cover the hole with a wide plastic occlusive dressing (e.g., OpSite, Tegaderm) and ask someone to press on it to keep it in place and make it air-tight. If oral intubation is difficult, consider intubating through the tracheostomy stoma, railroading over a bougie if necessary—stop as soon as the cuff is in the trachea, since you will be very close to the carina—and bronchoscope to check position.

If the patient is breathing spontaneously and the problem cannot be fixed easily, then consider removing the tracheostomy and railroading a new one. Consider oxygenating using both a face mask and a tracheostomy circuit, since the patient may be breathing through both routes.

3.11.1 Obstruction

The commonest presenting problem is difficulty to pass a suction catheter.[9] Any suggestion from the nursing staff that there are difficulties with suctioning must be taken seriously and investigated urgently. It is essential to use a bronchoscope in such cases in order to exclude partial (or even total) obstruction due either to **malposition** (e.g., where the tip of the tracheostomy may be only partially within the tracheal lumen), or to **dried secretions**.[10]

Remove any **valve attachment** (e.g. speaking valve etc) connected to the tracheostomy. Remove the **inner-tube** and check the lumen is patent. Check whether a suction catheter can be passed easily; check air movement with a bag (note that one can often pass a suction catheter and see bag movement even in cases of severe partial obstruction). Consider the **cuff**—this may be overinflated and obstructing the end (unlikely though as the cuff will be made of plastic and not rubber)—and see if letting the cuff down makes any difference. Consider **malposition**, especially if recent tracheostomy, recent tracheostomy change, or if the tracheostomy flanges do not lie flush with the skin. Sometimes simply releasing the retaining straps completely and observing whether the tracheostomy flanges sit nicely on the skin or not (sometimes this manoeuvre reveals a malpositioned tracheostomy being forced into an apparently normal position by the straps). Finally, consider removing the tracheostomy tube altogether if necessary. *Always* inspect with a bronchoscope.

- Kazi ST, Ali MA and Donohoe BO (2006). Accidental oro-endtracheostomy intubation. *Anaesthesia*, 61, 918.
  [death following tracheal obstruction, owing to failure of oral intubation—the oral ETT made an undetected anterior false passage at the tracheostomy stoma: importance of inspecting and then railroading over a fibrescope even with oral intubation if difficulties occur; may have overcome the problem if had fibrescope down ETT for guidance, or had railroaded the tracheostomy over a fibrescope initially]

[9] It is quite alarming in ITU how often ETTs are found to be partially obstructed, even after quite short periods of intubation. Even moderate secretions (and especially with thick secretions) should alert you to the posibility of impending obstruction, and to consider pre-emptive check-bronchoscopy and tube change if necessary.

[10] Note that ability to pass a suction catheter does not exclude significant obstruction due to dried secretions.

- McGurie G and El-Beheiry H (2001). Loss of the airway during tracheostomy: rescue oxygenation and re-establishment of the airway. *Canadian Journal of Anesthesia*; 48, 697–700. [from Kazi *et al.* 2006]
- McNamara J and Chisholm DG (1996). Use of a fibreoptic intubating laryngoscope to replace a misplaced tracheostomy tube. *Anaesthesia*, 51, 894. [from Kazi *et al.* 2006]
- Mirza S and Cameron DS (2001). The tracheostomy tube change: a review of techniques. *Hospital Medicine*; 62, 158–63. [from Kazi *et al.* 2006]
- Rajendram R and McGuire N (2006). Repositioning a displaced tracheostomy tube with an Aintree intubation catheter mounted on a fibre-optic bronchoscope. *Br. J. Anaesth.*; 97, 576–579.

3.11.2 Difficulty inserting the inner tube

Just occasionally, in a long term tracheostomy patient on a ward, the inner tube becomes difficult to insert. The most likely causes are (a) wrong size inner tube, (b) deformed inner tube etc. Try a new inner tube from a new tracheostomy package. Otherwise, consider inspecting the tube fenestrations with a fibreoptic bronchoscope (from the inside without the inner tube in) and also checking whether the tracheostomy is seated correctly on the skin. If the outer tube is not in sufficiently far, it may be that some of the more superficial holes are outside the trachea, in which case inspecting these from the inside with the bronchoscope reveals that the superficial holes appear pink (outside the trachea), while the deep ones appear black (inside the trachea). Tissue growing in through the holes may be enough to make it difficult to insert the inner tube. The solution is either to push the tracheostomy in fully, or possibly, just change the tracheostomy.

This sort of problem arises because the tracheostomy has come out slightly on the ward, and remained not properly seated on the skin for several days or more. Although the bronchoscope and light-source can be taken to the ward, it is usually more practical to bring the patient to the ITU for investigation.

3.11.3 Air leak

Consider a damaged cuff, poor position of the tracheostomy, wrong inner-tube (e.g., trying to ventilate a patient with a *fenestrated* inner-tube), or tracheostomy being too small (cuff leaks even when fully inflated). Finally, consider untying the straps and looking at the natural position of the tube and its flange in relation to the neck. Occasionally this reveals an obviously malpositioned tube, with the flange not sitting on the skin; the tracheostomy being forced into an apparently normal looking position by tight straps.

3.11.4 Tracheostomy recently removed

Its not uncommon for a patient whose tracheostomy has recently been removed (decannulated) to experience renewed secretion or airway problems, and require a new tracheostomy to facilitate suction, bronchoscopy and airway management. If the interval since decannulation is less than about one week then it is generally a simple matter to insert a new tracheostomy since there is usually still a hole, albeit small, at this stage.

Since the aim is typically to facilitate suctioning, then occasionally just a Portex Mini-Trac may suffice, but generally a small tracheostomy (say, size 7) is the minimum requirement,[11] at least initially. Note that for ward use, the tracheostomy must have an inner-tube.[12] Both the Portex 'Seldinger' Mini-Trac dilator,[13] and also the blue rhino dilator,[14] are extremely useful tools to have handy when dealing with this problem.

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[11] Note that while a size 7 will allow tracheal inspection/visualisation with the small 'intubating' fibrescope (available from theatres), a size 8 tracheostomy is the smallest which will allow you to use the full-size suctioning fibrescope.

[12] A patient with a tracheostomy which does not have an inner-tube must be managed on HDU/ITU since this form of tracheostomy can easily get blocked by dried secretions.

[13] This has a very useful Luer connector and hence allows you to inject local anaesthetic down it directly into the trachea via even the smallest tracheal orifice. I have even used it in this way down a malpositioned tracheostomy tube (see Section 3.1.1).

[14] This is in the percutaneous tracheostomy pack, and can be used to further dilate the tracheal orifice if necessary.