ANESTHESIA EQUIPMENT

BY

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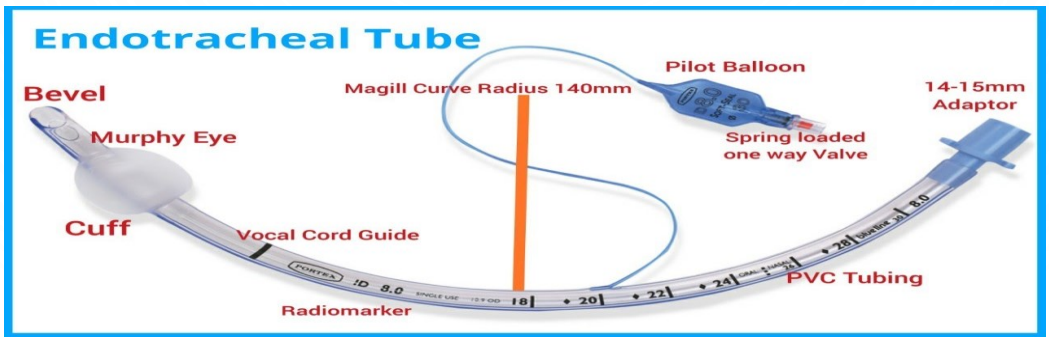
Tracheal tubes

Endotracheal tube is a flexible plastic tube that is placed through the mouth into the trachea (windpipe) to help a patient breathe. Tracheal tubes provide a means of securing the patient's airway. In the past, tracheal tubes used to be made of rubber allowing them to be reused after cleaning and autoclaving.



Endotracheal intubation:

➢**Surgical indications:**

- ❑ Patients for surgery who are full stomach
- ❑ Patients requiring IPPV
- ❑ All head and neck procedures with compromised airway
- ❑ Surgery for a long time also nonsupine position
- ❑ Abdominal, thoracic, neurosurgical procedures
- ❑ Double lumen tubes for intrathoracic surgery.

➢**Nonsurgical indications:**

- ❑ Cardiopulmonary-cerebral resuscitation
- ❑ Conscious or semiconscious patients unable to protect the airway
- ❑ Inadequate or gasping respiration
- ❑ Tracheobronchial toilet for retained secretions.

Contraindications:

No absolute contraindications, but difficult intubation in

- ❑Severe airway trauma
- ❑Cervical spine injury
- ❑Laryngeal edema.

Size

I. The size of a tracheal tube refers to its **internal diameter** which is marked on the outside of the tube in millimeters. Narrower tubes increase the resistance to gas flow. Usually, a size 8.5–9-mm internal diameter tube is selected for an average size adult male and a size 7.5- 8-mm internal diameter tube for an average size adult female. Paediatric sizes are determined on the basis of age and weight.

- the largest possible internal diameter should be used. This is especially important during spontaneous ventilation where the patient's own respiratory effort must overcome the tubes resistance. A size 4-mm tracheal tube has 16 times more resistance to gas flow than a size 8-mm tube.
- Tracheal tubes have both internal diameter (ID) and outside diameter (OD) markings. There are various methods or formulae used to determine the size of paediatric tracheal tubes. A commonly used formula is:

Alternatively, as a rough guide for normally nourished children aged > 2 years, use the following formula:

$$\text{Internal diameter of tube (mm)} = \frac{\text{Age (years)}}{4} + 4$$

Guide to the size and length of oral tracheal tubes used in pediatric practice

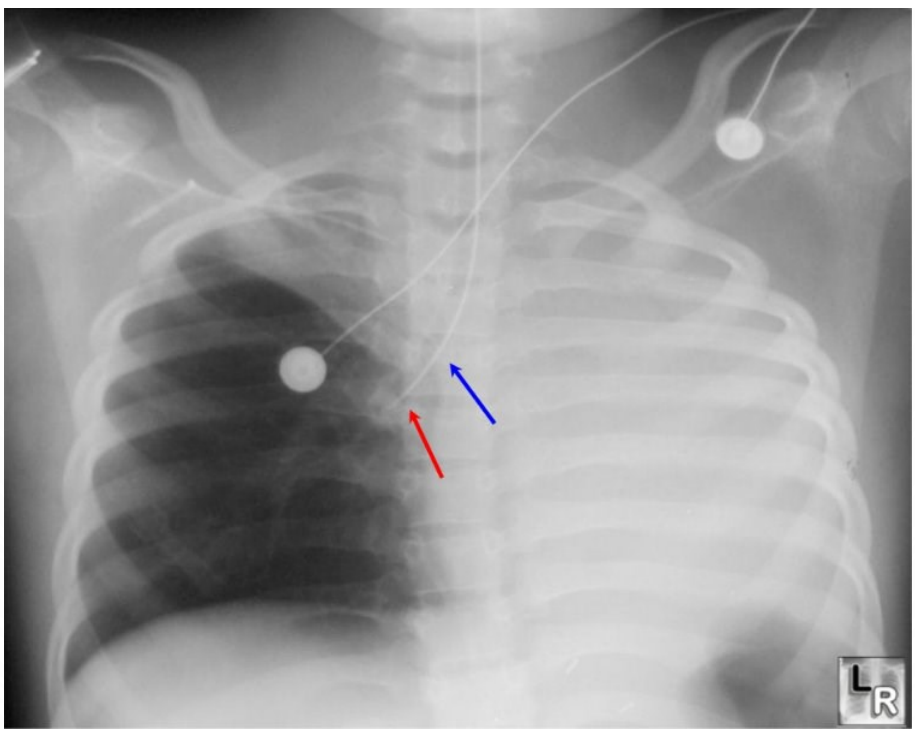
Age	Weight (kg)	Size (ID mm)	Length (cm)
Neonate	2–4	2.5–3.5	10–12
1–6 months	4–6	4.0–4.5	12–14
6–12 months	6–10	4.5–5.0	14–16
1–3 years	10–15	5.0–5.5	16–18
4–6 years	15–20	5.5–6.5	18–20
7–10 years	25–35	6.5–7.0	20–22
10–14 years	40–50	7.0–7.5	22–24

II. **The length (taken from the tip of the tube)** is marked in centimeters on the outside of the tube.

III. The tube is advanced until the mark at the proximal end of the cuff lies at the vocal cords

❖ The tube is fixed at the anterior incisors at 23 cm in adult males and at 21 cm in females. In nasaotracheal intubation, 5 cm more is added to this length.


A
B


L
R

III. Tracheal Tube Cuffs:

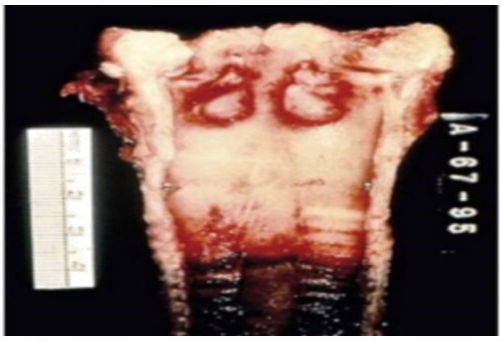
In order to achieve enough contact with the tracheal wall and a good seal, relative overinflation was required, with the result that the high pressure within the cuff was transmitted to the tracheal wall. This readily led to a reduction of mucosal pressure to critical levels (capillary perfusion pressure is usually about 35 mm Hg) could lead to mucosal ischemia, development of tracheal scarring and tracheal stenosis in case of prolonged use.

FIG. 5.7 Cuff pressure gauge. (Courtesy of Smiths Medical.)

High-pressure/low-volume cuffs

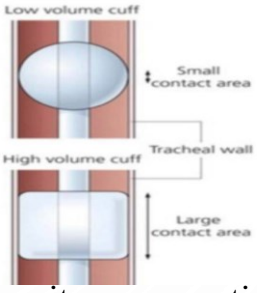
1. These can prevent the passing of vomitus, secretions or blood into the lungs.

2. At the same time, they exert a high pressure on the tracheal wall. If left in position for long periods, they may cause necrosis of the tracheal mucosa .



Low-pressure/high-volume cuffs

1. These exert minimal pressure on the tracheal wall as the pressure equilibrates over a wider area .This allows the cuff to remain inflated for longer periods.



2. They are less capable of preventing the aspiration of vomitus or secretions. This is due to the possibility of wrinkles forming in the cuff.

Cuffed versus uncuffed tube

Cuffed tubes are routinely used in adults and uncuffed tracheal tubes are preferred in young children. In recent years, cuffed tracheal tubes have been used more often in small children.

Advantages of cuffed tubes include decreased risk of aspiration; ability to use high inflation pressures and low fresh gas flows, accurate monitoring of end-tidal gases, tidal volume.

Disadvantage of using a cuffed tube in children include the need to choose a slightly smaller tube. It will increase resistance and work of breathing; inadvertent over inflation of the cuff will result in excessive mucosal pressure and the risk of injury to the vocal cords. Relatively small amounts of inflated air lead to rapid increases in cuff pressure and volume.

Nasotracheal intubation:

- The tube should be thoroughly lubricated along its entire length with a sterile, water soluble lubricant.
- The cuff should be fully deflated. The patency of the nostril is checked.
- When the tube is inserted, the bevel opening should face laterally. It should be advanced along to the floor of the nose while slightly lifting the tip of the nose.
- After the tube is in the pharynx, laryngoscope is introduced. The position of the larynx is manipulated by flexing or extending the neck or external pressure on the larynx. Magill's forceps can be used to grasp the tip and direct it through cords avoiding damaging the cuff.

Indication for nasal intubation include:

1. Surgical procedures involving the oral cavity, oropharynx, and face where an oral tube would obstruct the view of the surgeon
2. Surgery for fractured mandible, temporomandibular joint ankylosis, intraoral pathology
3. Neck injury or cervical spine disease.

Contraindications:

1. Coagulopathy
2. Suspected fracture at the base of the skull
3. Nasal polyps, abscesses, foreign bodies, and possibly epiglottitis.

Problems in practice and safety features

1. Obstruction of the tracheal tube by kinking, herniation of the cuff, occlusion by secretions, foreign body or the bevel lying against the wall of the trachea

2. Esophageal or bronchial intubation

3.trauma and injury to the various tissues and structures during and after intubation

Advantages

- Securing the tube is easier
- Less of cervical spine movement hence useful in trauma cases
- No biting of tube.

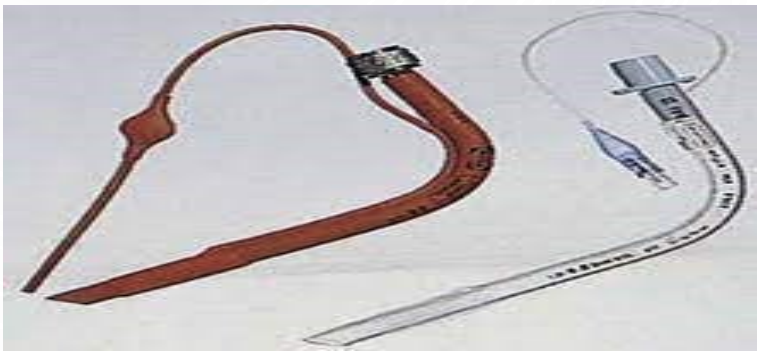
Disadvantages

- Intubation usually takes longer
- A size smaller than oral tracheal tube is accepted, resulting in increased resistance
- Severe bleeding may occur to injury to nasal septum
- High incidence of bacteremia, sinusitis, and otitis.

Specially designed tracheal tube:

Oxford tracheal tube

This anatomically L-shaped tracheal tube is used in anesthesia for head and neck surgery because it is non- kinking. The tube can be made of rubber or plastic and can be cuffed or uncuffed. The bevel is oval in shape and faces posteriorly and an introducing stylet is supplied to aid the insertion of the tube. Its thick wall adds to the tube's external diameter making it wider for a given internal diameter. This is undesirable especially in pediatric anesthesia



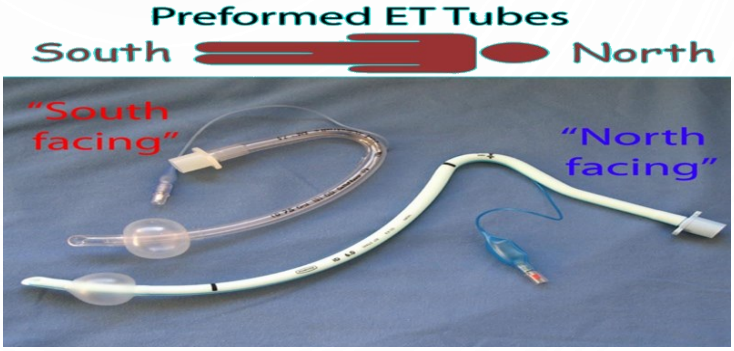
Armored tracheal tubes

Armored tracheal tubes are made of plastic or silicone rubber (fig. 5.12). The walls of the armoured tube are thicker than ordinary tracheal tubes because they contain an embedded spiral of metal wire or tough nylon. They are used in anaesthesia for head and neck surgery. The spiral helps to prevent the kinking and occlusion of the tracheal tube when the head and/or neck is rotated or flexed so giving it strength and flexibility at the same time. An introducer stylet is used to aid intubation.

Polar and RAE tracheal tubes

The polar tube is a north- or south-facing preformed nasal cuffed or uncuffed tracheal tube. It is used mainly during anaesthesia for maxillofacial surgery as it does not impede surgical access. Because of its design and shape, it lies over the nose and the forehead. It can be converted to an ordinary tracheal tube by cutting it at the scissors mark just proximal to the pilot tube and reconnecting the 15-mm connector. An oral version of the polar tube exists.

- **The Polar tube is used for nasal intubation and the RAE tube is used for oral intubation**

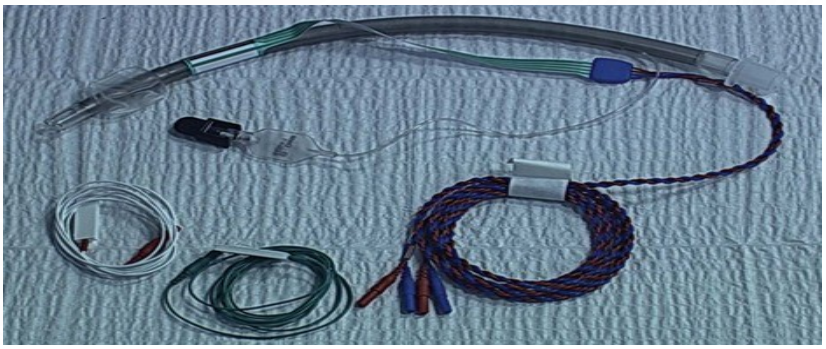


LASER RESISTANT TRACHEAL TUBES

These tubes are used in anesthesia for laser surgery on the larynx or trachea. They are designed to withstand the effect of laser beams, avoiding the risk of fire or damage to the tracheal tube. The cuff is filled with methylene blue colored saline. If the laser manages to damage the cuff, the coloring will help identify rupture and the saline will help prevent an airway fire.

Evoked Potentials Tracheal Tubes

These tubes are used in a number of surgical procedures that have the risks of damage to nerves, e.g thyroid surgery Bipolar stainless steel contact electrical electrodes are embebded in the tracheal tubes above the cuff where they are in contact with the vocal cords. These electrodes are connected to a nerve stimulator. An additional earth electrode is attached to the skin of the patient.



Postoperative complications of ETT

1. Sore throat

Sore throat is a common postoperative complication seen commonly in females, head and neck surgeries, prone position, prolonged ventilation and with use of larger tubes and with use of high pressure cuff. Preoperative inhalation of a steroid, inflating the cuff with a lidocaine or saline solution are some of the ways to reduce incidence of sore throat.15 lignocaine spray and cricoids pressure during intubation increase the incidence of sore throat

Postoperative complications of ETT

2. Hoarseness

Hoarseness may be decreased by using tubes with low pressure cuffs, smaller tubes, and lubrication with lidocaine jelly. Hoarseness increases with difficult and long intubation.

3. Neurologic Injuries

Trigeminal, lingual, buccal, and hypoglossal nerve palsies.

4. Tracheal Stenosis

Tracheal stenosis is more common with long-term intubation.

Postoperative complications of ETT

5. Latex Allergy

While most tracheal tubes are made from PVC, some laser tubes are made from latex-containing rubber.

6. Infection

A high incidence of sinusitis and otitis is seen. Pneumonia in case of prolonged intubation is fairly common.

Postoperative complications of ETT

7. Upper Airway Edema

Edema may occur anywhere along the path of the tube, including the tongue, uvula, epiglottis, aryepiglottic folds, vocal cords, and the retroarytenoid and subglottic spaces. It is most commonly seen after surgery involving the head and neck and with increased duration of intubation. It may manifest any time during the first 48 hours after extubation. The symptoms may range from hoarseness or croupy cough to respiratory obstruction.

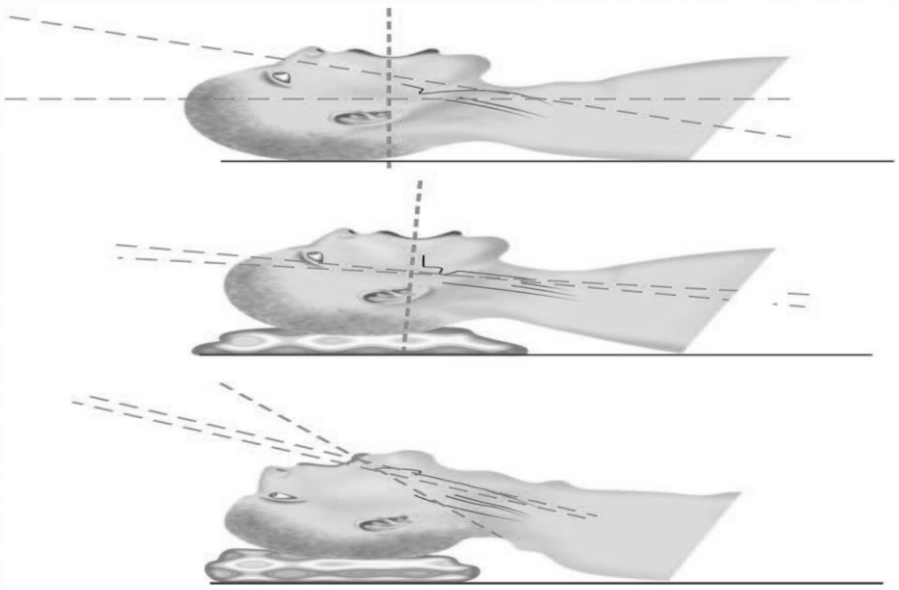
Techniques of endotracheal intubation

- Before insertion, the tube should be examined for defects such as cracks, holes and for obstructions.
- The cuff, if present, should be inflated and the syringe removed to check for leaks in the inflation valve.
- The cuff should be inspected to make certain that it inflates evenly and does not cause the tube lumen to be reduced.
- After the sterile wrapping is opened, the tube should be handled only at the connector end.

Techniques of endotracheal intubation

Orotracheal Intubation :

Patient is given "morning air sniffing" position (Chevalier Jackson position) i.e. extension at atlanto-occipital joint and flexion of neck (atlanto axial joint) by keeping a pillow below the neck. This position brings the oral, pharyngeal and laryngeal axis in one line thus facilitating the visualization of vocal cords on direct laryngoscopy.



- **Important note:** In case of suspected cervical spine injury, laryngoscopy is done with stabilization of spine in a neutral position, for oral intubation, only the cuff should be lubricated.

Techniques of endotracheal intubation

Advantages:

• it can be performed quickly and easily than nasal intubation.

• It allows use of a wider and shorter tube than for nasal intubation.

Disadvantages

• the possibility of oropharyngeal complications

• oral intubation is usually not well tolerated by the conscious patient

• significant cervical spine motion may be associated with direct laryngoscopy

• a bite block, rolled gauze, or oral airway should be placed between the teeth to prevent the patient from biting the tube.

Other techniques of orotracheal intubatioin are blind oral intubation and digital intubation.

Techniques of endotracheal intubation

Blind Oral Intubation

A blind oral technique is performed with the head flat, then tilted back in maximum extension. Pressure is applied to the cricoid cartilage with one hand while the tracheal tube with stylet in it is introduced into the mouth with the other, following the curve of the tube. The tube is advanced till the tube is felt advancing into the trachea. Manipulation of larynx is needed as this is a blind procedure. Capnography can be used in spontaneously breathing patient.

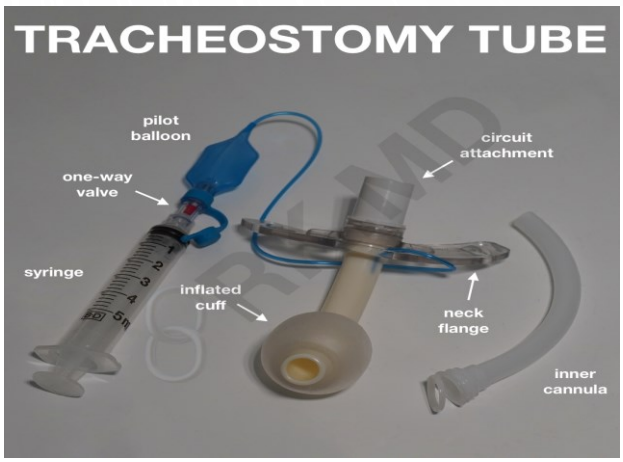
Techniques of endotracheal intubation

Digital Technique

In a digital technique, the mouth is opened, fingers of one hand are used to push the tongue away and the other hand is used to put the tube in the trachea. The intraoral hand is used to guide the tracheal tube tip.

Tracheostomy tracheal tubes:

These are curved plastic tubes usually inserted through the second, third and fourth tracheal cartilage rings.



Tracheostomy tubes are used for the following:

1. Long-term intermittent positive pressure ventilation.
2. Upper airway obstruction that cannot be bypassed with an oral/nasal tracheal tube.
3. Maintenance of an airway and to protect the lungs in patients with impaired pharyngeal or laryngeal reflexes and after major head and neck surgery (e.G. Laryngectomy).
4. Long-term control of excessive bronchial secretions especially in patients with a reduced level of consciousness.
5. To facilitate weaning from a ventilator. This is due to a reduction in the sedation required, as the patients tolerate tracheostomy tubes better than tracheal tubes. Also, there is a reduction in the anatomical dead space.

Problems in practice and safety features

Surgical tracheostomy has a mortality rate of <1% but has a total complications rate as high as 40%. The complications rate is higher in the intensive care unit and emergency patients.

The complications can be divided into:

1. Immediate:

A. Haemorrhage.
B. Tube misplacement (e.G. Into a main bronchus).
C. Occlusion of tube by cuff herniation.
D. Occlusion of the tube tip against carina or tracheal wall.
E. Pneumothorax.

2. Delayed:

A. Blockage of the tube by secretions which can be sudden or gradual; this is rare with adequate humidification and suction.

B. Infection of the stoma.

C. Overinflation of the cuff leads to ulceration and distension of the trachea.

3. Late:

A. Granulomata of the trachea may cause respiratory difficulty after extubation.

B. Persistent sinus at the tracheostomy site.

C. Tracheal dilatation.

D. Tracheal stenosis at the cuff site.

E. Scar formation.