



Department of Anesthesia Techniques

Title of the lecture: - Tracheal Tubes

Mohammed AbdulZahra Al_Mosawi

PhD, MSc. Anesthesia and ICU medicine

TUMS, SUMS

Mohammed.abulzahra@mustaqbal-college.edu.iq



Tracheal Tubes''''

**** The gold standard for securing the airway is tracheal intubation.**

The endotracheal tube (intratracheal tube, tracheal catheter)

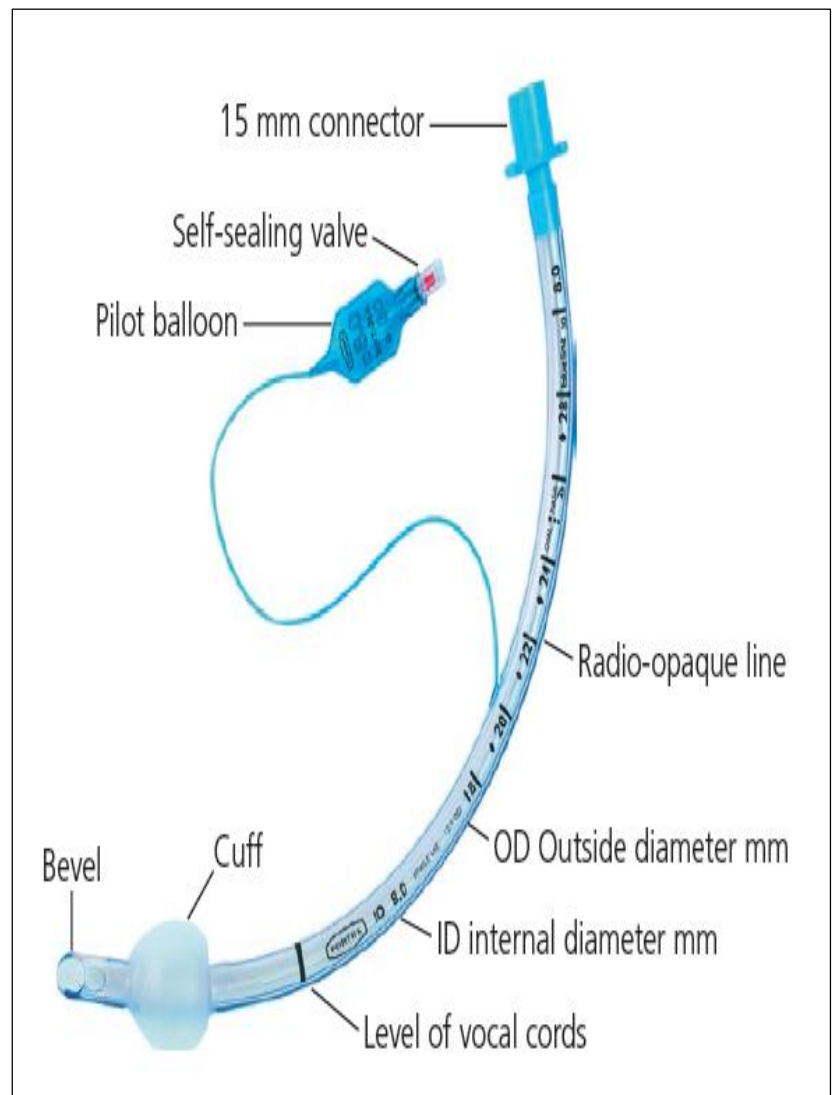
Is a device that is inserted through the larynx into the trachea to convey gases and vapors to and from the lungs

A cuffed endotracheal tube, isolates the trachea from esophagus and protects the lungs from inhalation of foreign material.

It permits surgical access during head and neck surgery.

Endotracheal tube components and design:

- Patient end
 - Bevel
 - Murphy eye
- Curve of tube
- Markings on the tube
- Tracheal tube material
- Tube size • Tube cuff
- Machine end.



Bevel:

**Bevel is a slanted portion at the distal end which faces to the left when the tube is held in anatomical position. This is because the tube is usually introduced from the right, and the larynx is easier to visualize with the bevel facing to the left.

**The bevel facilitates insertion and allows the tip of the tube to be seen passing between the vocal cords. Also, bevel reduces nasal morbidity during nasotracheal intubation.

Murphy Eye:

Murphy eye is a hole in the wall opposite the bevel

Advantages: In case of blockage of bevel, it provides a secondary port for gas movement in and out of the tube.

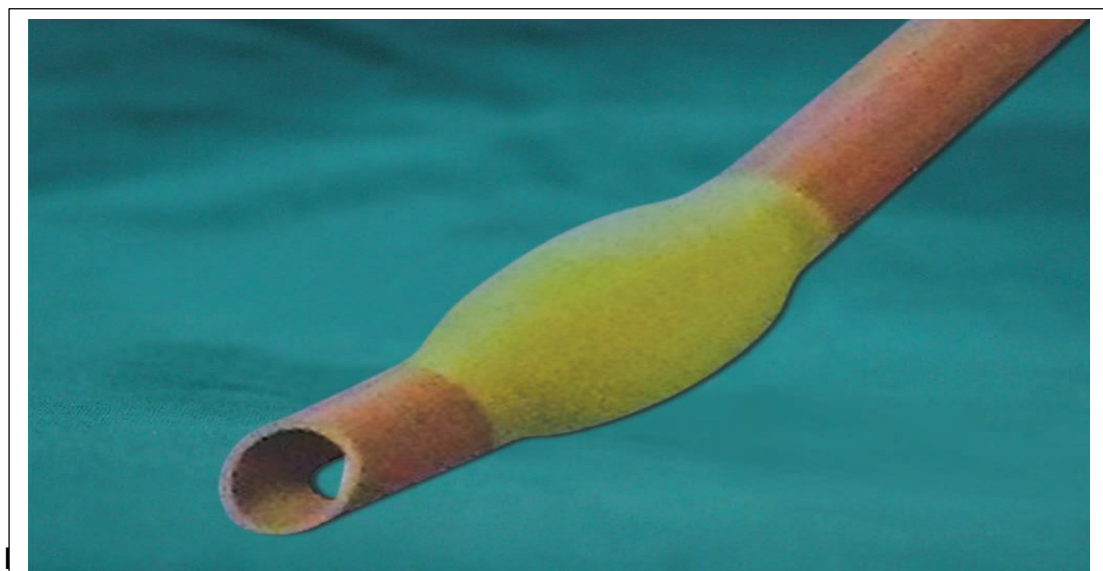
Disadvantages: Forceps, tube exchangers, and fiberscopes may get caught in it. Sometimes, secretions may accumulate in the eye.

**Tracheal tubes lacking the Murphy eye are known as Magill's type tubes, a tube with Murphy eye is known as Murphy type tube.

** If a Murphy eye is not present, the cuff is usually placed closer to the tip. This may decrease the risk of inadvertent bronchial intubation.

Curve:

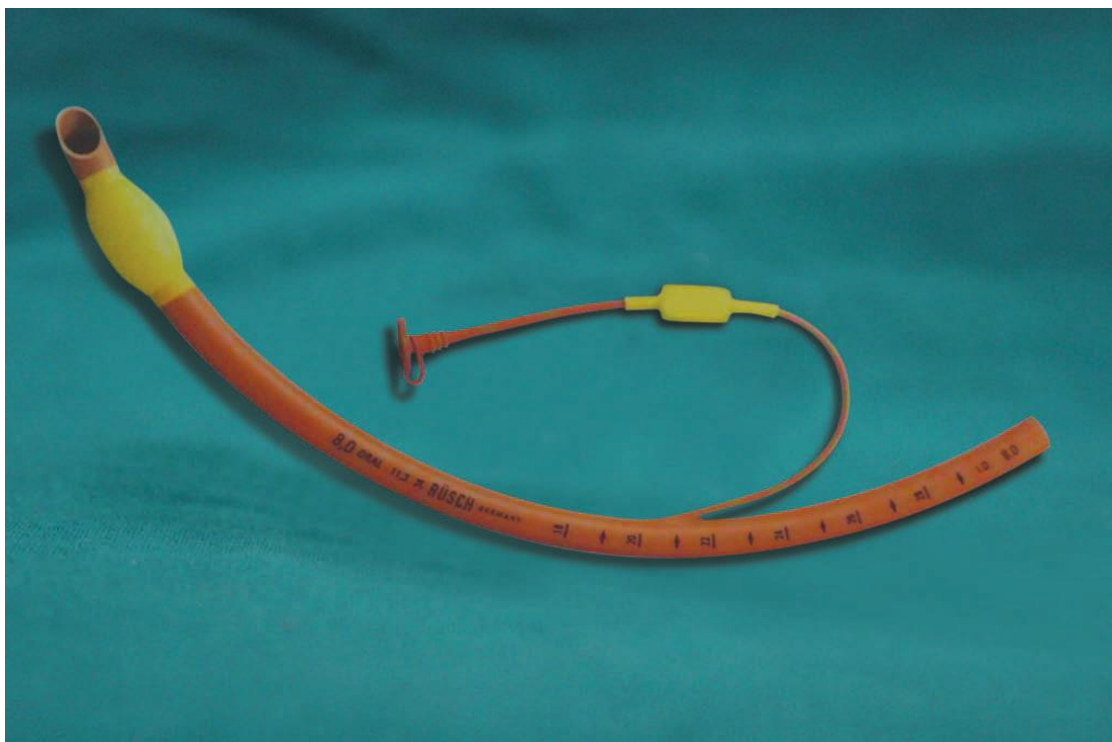
An orotracheal tube has a preformed curve approximately matching the anatomical curve of the airway. This preformed curve makes intubation easier.



Markings on the Tube:

- The word oral or nasal or oral/nasal
- Tube size: Tracheal tube size is in millimetres internal diameter (ID).
- The name or trademark of the manufacturer or supplier
- A longitudinal line of radio-opaque material runs throughout the length of tube for confirmation of the correct placement from an X-ray.
- A transverse black line is made few centimeters proximal to the cuff. It indicates the distance that the tube should be placed in trachea so that the mark is just visible above the larynx. This is to prevent the tube remaining too out or the tube going too in inside the larynx.
- The distance from the tip of the bevel is marked in centimeters on the tube.

Tracheal Tube Material Tracheal tubes are mainly made up of **red rubber** or **polyvinyl chloride (PVC)**. Some are made up of **natural latex** or **silicone rubber**.



Cuffed red rubber tube

Polyvinyl Chloride:

Advantages: It is relatively inexpensive. It is compatible with tissues, less kinkable and nonirritant. They are disposable hence allow single patient use thus preventing transmission of infection. They are presterilized. As the material is usually clear, foreign bodies and blockages are seen and can be cleaned.

Disadvantages: PVC tubes do not have the elasticity of rubber and are relatively rigid. Hence, they can be difficult to insert sometimes and can be traumatic.

Tube Size:

Adults: Ideal tube in the average adult is a 7.5 mm ID tube for females and an 8.5 mm ID tube for males. However, there is great variation in sizes and shapes of trachea in adults.

Age	Tube size ID in mm
10-14 years	7.0-7.5
7-10 years	6.5-7.0
4-6 years	5.5-6.5
1-4years	4.5-5.5
6-12 months	4.5-5
1-6 month	4-4.5
Neonate	2.5-3.5
Premature	2.2-5

Children:

Pediatric tracheal tubes have been uncuffed and use of a tube small enough to leave an audible leak between the tube and the wall of the trachea at high peak airway pressures (20–25 cm H₂O) is still standard.

In children, the narrowest part of the airway is the cricoid ring. A small degree of edema in the pediatric airway will reduce the lumen of the trachea considerably (1 mm of circumferential swelling reduces the diameter of the adult airway by less than 10% and that of an infant by as much as 30%) and may lead to respiratory compromise.

Uncuffed Tubes:

- For children below 6 years: $\text{Age in years}/3 + 3.5$
- For children older than 6 years: $\text{Age in years}/4 + 4.5$
- $\text{ID} = \text{Age in years}/4 + 4$ (modified Cole formula) for children above 2 years
- $\text{ID} = 3 \text{ mm}$ for those 3 months of age and younger
- $\text{ID} = 3.5 \text{ mm}$ for those from 3 months to 9 months of age
- $\text{ID} = (\text{Age in years} + 16)/4$ over 9 months of age
- External diameter is the same width as the distal phalanx of the little finger approximately.

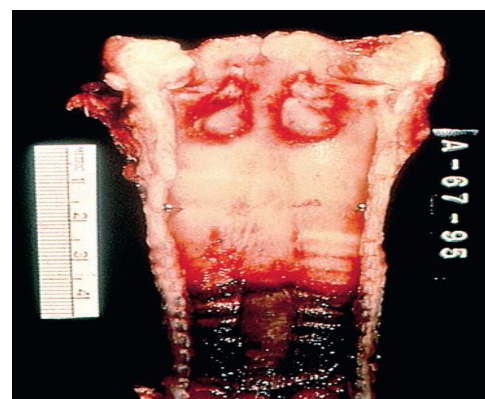
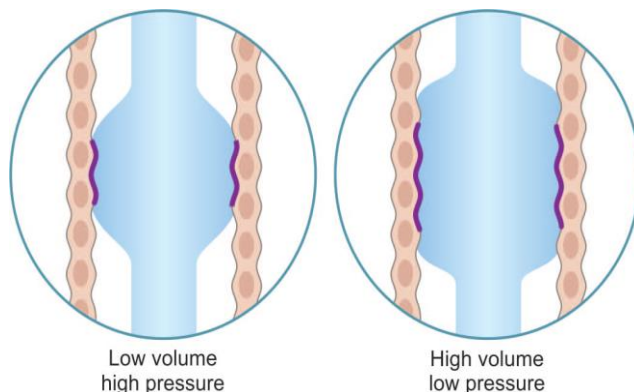
*Cuffed Tubes

- $\text{ID in mm} = \text{Age}/4 + 3$ (Khine formula)
- A tube 0.5–1 mm smaller than that calculated for an uncuffed tube.

xv n v

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.



Advantages:

- Better protection against aspiration
- Better visibility during intubation than low pressure cuffs
- Lower incidence of sore throat
- They are less expensive.

Disadvantages:

Ischemic damage to the tracheal wall mucosa following prolonged use.

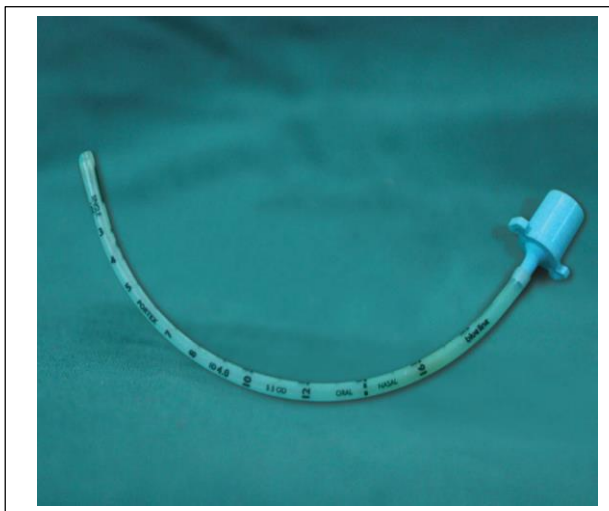
Cuffed Versus Uncuffed Tube

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.



Uncuffed endotracheal tube



Cuff pressure manometer

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
- Aneurysm of arch of aorta
- Laryngeal edema.

"TECHNIQUES OF ENDOTRACHEAL INTUBATION"

Before insertion, the tube should be examined for defects such as **cracks, holes and for obstructions.**

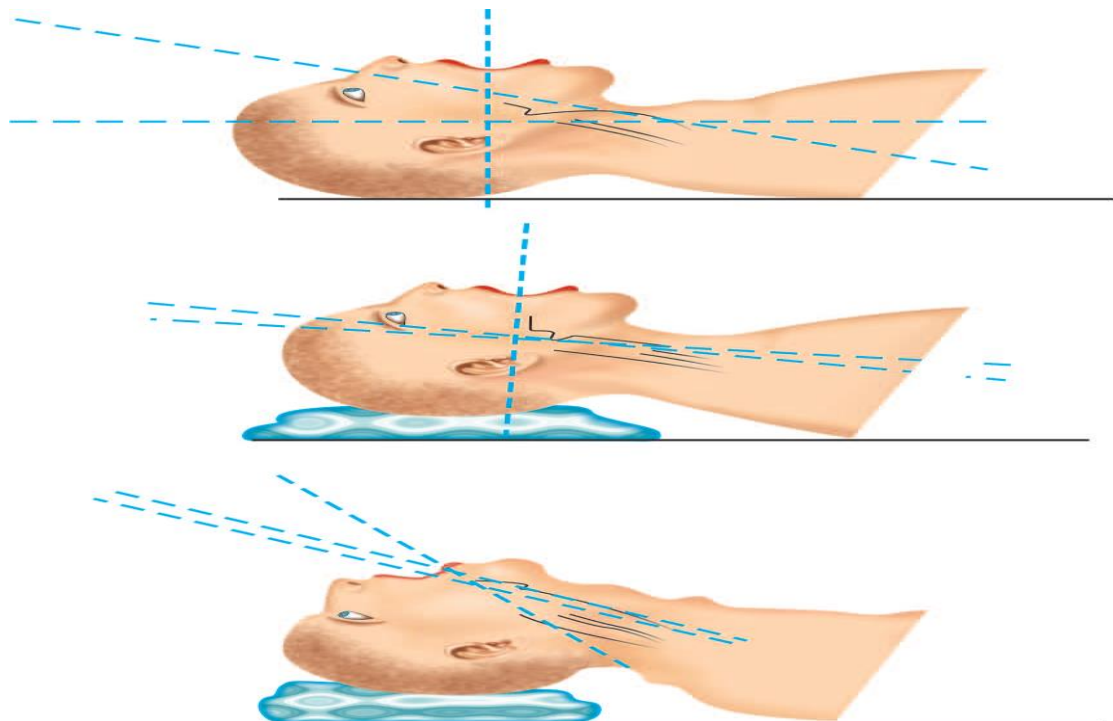
The **cuff**, if present, should be inflated and the syringe removed to check for leaks in the inflation valve.

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.

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.

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 intubation are blind oral intubation and digital 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.

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.

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.

Indications

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

Contraindications

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

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 or turbinates
- High incidence of bacteremia, sinusitis, and otitis.

Blind Nasal Intubation:

This technique is useful in patients where intubation is difficult or mouth opening is not adequate. It may be performed under general or local anesthesia. In a spontaneously breathing patient, the tube is inserted through the nostril.

Capnometer can be attached to the tube and end-tidal CO₂ is used as a guide.

Blind nasal intubation needs flexion or extension of the head or manipulation of the larynx by external pressure. It does require some experience and expertise.

Sometimes, partial inflation of the cuff helps to elevate the tip from the posterior pharyngeal wall and center it. The cuff is deflated before the tube is advanced into the trachea. The blind technique may be useful when direct laryngoscopy or fiberoptic intubation would be difficult.

Depth of Insertion:

- The tube is advanced until the mark at the proximal end of the cuff lies at the vocal cords
- The tube tip should be inserted not more than 1 cm past the cords in children under 6 months, not more than 2 cm past the cords for patients up to 1 year, and not more than 3–4 cm past the cords in larger patients

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

A number of formulae have been developed in children, including the following:

For Oral Intubation

- According to Lau et al, 2006¹²
 - Above 1 year, length in centimeters = $\text{Age}/2 + 13 \text{ cm}$
 - Below 1 year, length in centimeters = $\text{Weight (in kg)}/2 + 8 \text{ cm}$
- Rule of 7-8-9: Infants weighing 1 kg are intubated to a depth of 7 cm at the lips, 2 kg infants to a depth of 8 cm, and 3 kg infants to a length of 9 cm. For Nasotracheal Intubation
- $L = (S \times 3) + 2$, where L is the length in centimeters, and S is the ID of the tube in millimetres

- According to Lau et al, 2006¹²

- Above 1 year, length in centimeters = $\text{Age}/2 + 15 \text{ cm}$
- Below 1 year, length in centimeters = $\text{Weight (in kg)}/2 + 9 \text{ cm}$.

Confirmation of Correct Placement of Tube:

1. Clinical confirmation (primary confirmation)

- Direct visualization of tube passing through vocal cords
- Moisture of exhaled gases in the lumen of tube if tube is transparent
- Palpation of tube over trachea
- Bilateral chest movement – Bilateral air entry on auscultation of chest
- Feel of the reservoir bag: Movement of the reservoir bag with the patient's spontaneous respiratory efforts

2. Confirmation with equipment (secondary confirmation)

- Pulse oximeter
- *Capnometer*
- Chest X-ray
- Fiberscopic view

COMPLICATIONS OF INTUBATION:

Trauma

Esophageal Intubation

Bronchial Intubation

Foreign Body Aspiration

Tracheal Tube Obstruction

Aspiration

Difficult Extubation

****Postoperative Complications**

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

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.

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.

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. Even mild degree of laryngeal edema (postintubation croup or inflammation, acute edematous stenosis, stridor, and subglottic edema), especially in the young child, may produce a significant reduction in the internal cross-sectional area. 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. Intubation should be atraumatic, and adequate anesthetic depth and/or good muscle relaxation should be maintained to prevent tube movement. Head movement should be kept to a minimum.

Best wishes