chapter

# 9

# Laryngoscopes Endotracheal Tubes and Airways

## LARYNGOSCOPES

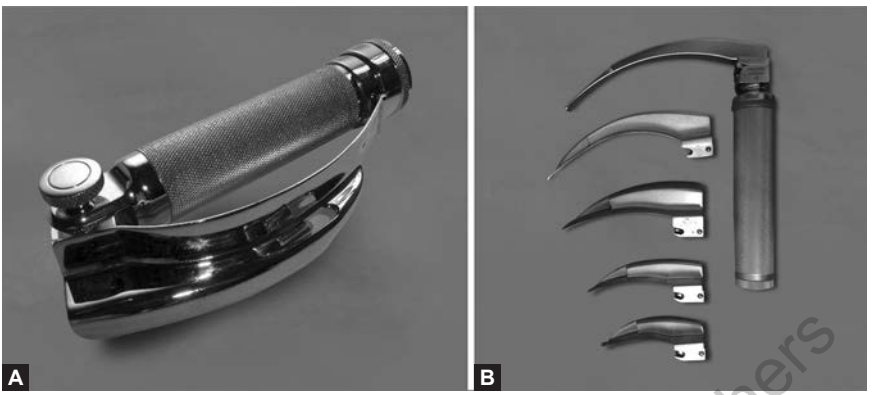
### History

*1854*: Manuel Garcia invented the first laryngoscope
*1895*: Alfred Kirstein made the direct vision laryngoscope
*1943*: Sir Robert Macintosh designed the first curved blade laryngoscope which is still in use worldwide for more than 7 decades.

- Laryngoscope is the instrument for visualizing the larynx. (Scope- visualizing instrument).
- Mainly used for visualizing the larynx (and adjacent structures) for the purpose of intubation of trachea with an endotracheal tube. Rarely used for removing a foreign body from the hypopharynx or larynx.
- It has two parts namely the 'handle' and the 'blade'.
- The handle contains the batteries for powering the bulb in the blade, which illuminate the larynx for intubation.
- The handle has rough surface for improved grip.
- The blade is hinged to the handle in such a way that when the handle is opened to right angle the light is switched on.
- The blade is used to lift the mandible and the tongue to visualize the larynx (after proper positioning of the head and neck)
- The handle is used for applying suitable leverage to the blade.
- There are two types of blades–straight blade and curved blade.
- *MacIntosh laryngoscope* has curved blades **(Fig. 9.1A)**
- Usually, it comes with four sizes of blades, infant size, child size, adult size and extra-large size for bigger adults. Sometimes there is a neonate size also included **(Fig. 9.1B)**.
- Straight blade laryngoscopes are available in various versions, but they are not commonly used.
- For pediatric patients, because of the anatomical difference, it is preferred to use a special design straight blade laryngoscope.
- *Miller straight blade pediatric laryngoscope* is the common type used. Sizes of blade 0–4 are available **(Fig. 9.2)**.
- Another model is *Sheila Anderson laryngoscope*. The blade is straight like Miller and has the tip as a spatula that lifts the epiglottis.

### Fiberoptic (Green Coded)

- These are different from the conventional laryngoscope in the mechanism of illuminating the larynx.
- The lamp is within the handle.




**Figs 9.1A and B:** (A) Traditional screw type laryngoscope with adult size blade illuminated by a bulb at the tip; (B) Hook on type fiber-optic laryngoscope with five blades; neonate, infant, child, adult and extra large sizes. The green band on the distal end of the handle indicates that it is fiber-optic instrument (Green coded)


**Fig. 9.2:** Miller straight blade laryngoscope



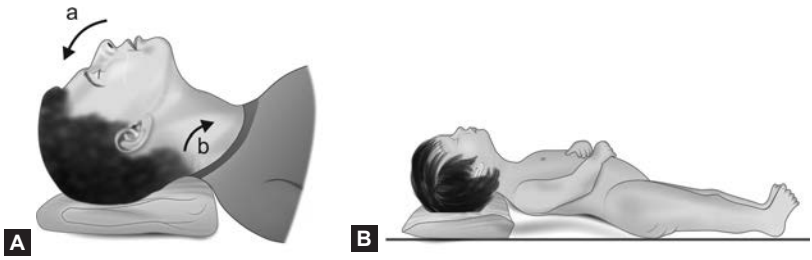
- The handle at the distal end has the bulb which is switched on once the blade is hinged on to the handle.
- From this source, fail proof light is transmitted to the tip of the blade through fiberoptic light bundle fixed in the blade.
- As there is no electrical circuit within the handle, failure of light during laryngoscopy does not occur.
- These laryngoscopes are identified by the green band on the distal end of the handle **(Figs 9.1B and 9.2)**.

## Technique of Laryngoscopy

The head and neck are positioned in such a way that oral cavity and the larynx are brought to lie in a straight line for the best possible view of larynx.

*Position:* Optimal position for most patients is *'sniffing position'* **(Figs 9.3A and B)**.

- Flexion of lower cervical spines 25 to 35°
- Extension of head at atlanto-occipital joint 85 to 90°




**Figs 9.3A and B:** Position of head and neck for intubation; adult and child

- Pillow to a height of 4" under the head.
- For children it may not be necessary to flex the lower cervical spines.
- For neonates a small pad is kept under the back (shoulder blades) to elevate the shoulder as the head is larger.

### *Steps*

- Laryngoscope is held in the left hand with the thumb at the junction of the handle and blade.
- Optimum opening of the mouth is done the right thumb and index finger.
- Introduce the tip of the blade into the mouth without engaging lips and teeth.
- As half of the blade enters the oral cavity, sweep the tongue to the left.
- Advance the blade along the side of the tongue till right tonsillar fossa is seen and then move the blade to the midline.
- Advance the blade behind the base of the tongue and pulling the handle along its axis will make the epiglottis visualized.

From now on there is a different technique for *curved blade* and *straight blade*.

*Curved blade* **(Fig. 9.4A)**

- Blade is advanced until the tip fits into the vallecula (glosso-epiglottic recess).
- Traction applied along the axis of the handle moves the base of the tongue and epiglottis forward and glottis will be visualized well.

*Straight blade* **(Fig. 9.4B)**

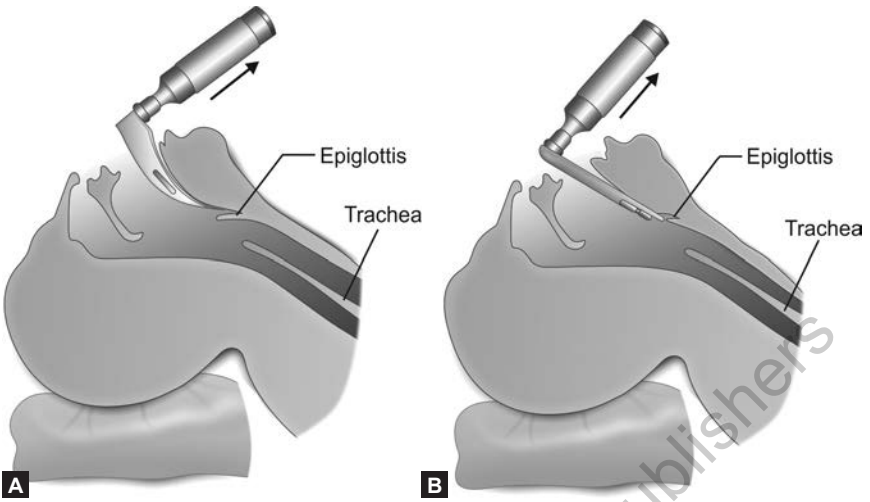
- The blade is advanced till epiglottis its identified.
- The tip of the blade is advanced posterior to the epiglottis.
- The blade is lifted anteriorly elevating the epiglottis directly and the glottis is visualized.

### *Anatomical Differences in Neonates and Infants*

- Large head, large tongue, small oral cavity, mandibular angle 140° (obtuse).
- Epiglottis is narrow, floppy, longer, 'U' shaped and angled backwards.
- Larynx is at the level of C3–C4 forms an acute angle with the base of the tongue.
- Straight blade (Miller) designed to pass beyond epiglottis and elevate it.

## Other Types of Laryngoscopes

Though numerous types of laryngoscopes were introduced over the past 7 decades, not all of them became popular or claimed superiority in performance. Some of the




**Figs 9.4A and B:** Position of laryngoscopy: (A) Macintosh blade (curved blade); the tip of the blade is at vallecula; (B) Miller blade (straight blade); the tip of the blade is posterior to epiglottis and lifts it

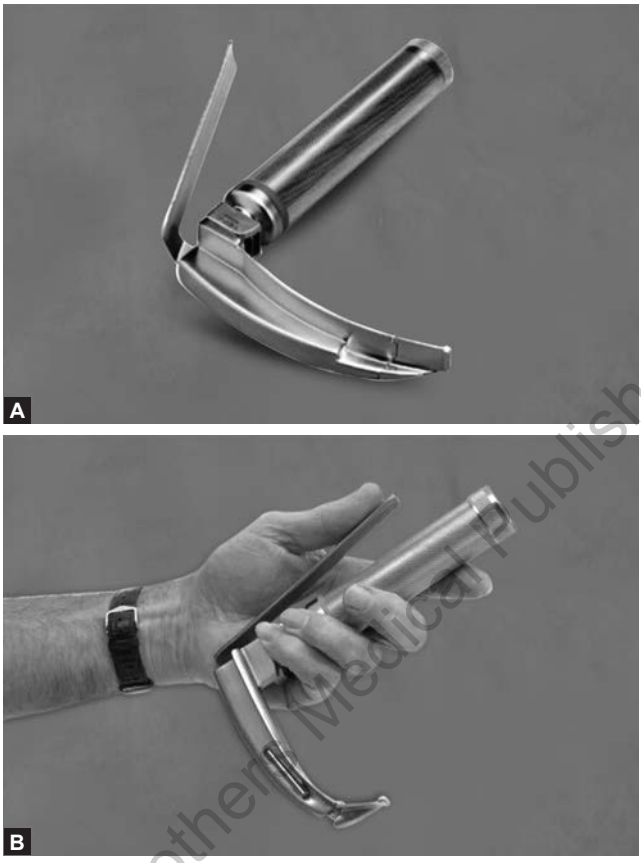
laryngoscopes were modifications in the existing one to overcome certain types of difficulties in intubation.

## McCoy Laryngoscope

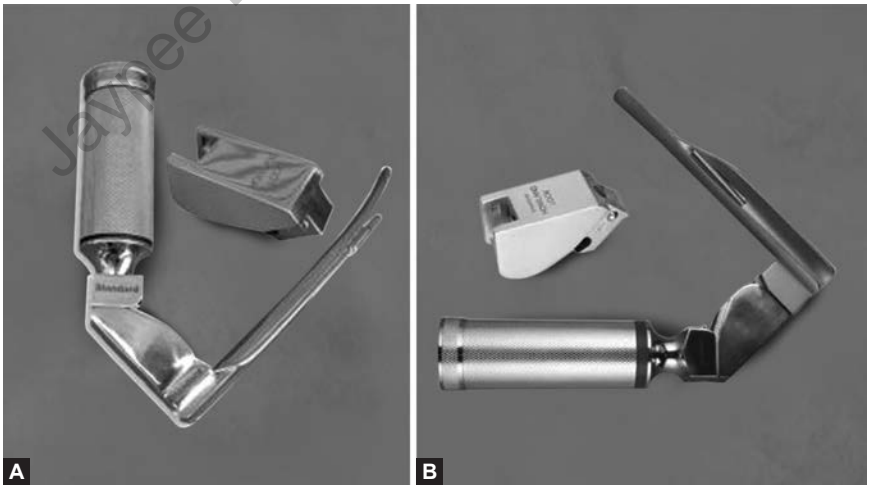
- The hinged tip of the blade is controlled by a lever attached to the proximal end of the blade **(Figs 9.5A and B)**.
- When the lever is pushed towards the handle, the tip is flexed to a maximum of 70°.
- This flexion of the tip further elevates the epiglottis and enhances the view of the larynx.
- Advantages; less force is required, less trauma and ideal for difficult intubation.

## Howland Lock

- The Howland lock is an additional block that has the provision for conducting the light and hooking on features.
- Howland lock is hooked on to the handle and the laryngoscope blade can in turn be hooked on to the lock and thus changes the angle of the handle allowing for a natural lifting action that simplifies visualization of larynx.
- By adding the Howland lock any conventional laryngoscope's angle can be reduced to 45° **(Fig. 9.6A)**.
- For conventional laryngoscope the lock has continuity of electrical circuit for the bulb **(Fig. 9.6A)**.
- For fiber-optic laryngoscopes, the block has continuity of optical conduction of light **(Fig. 9.6B)**.
- In 'difficult intubation' situations such as receding chin, anteriorly placed larynx, protruding teeth, 'Bull neck', facial contractures, decreased jaw mobility, etc. the use of Howland lock may make the procedure easier.




**Figs 9.5A and B:** (A) Flexi-tip laryngoscope (McCoy); (B) The tip of McCoy laryngoscope during use




**Figs 9.6A and B:** Howland lock: (A) Howland lock on conventional laryngoscope; (B) Howland lock on fiber-optic laryngoscope

## Polio Laryngoscope

- Originally designed to incubate patients on iron lung negative pressure ventilation during polio epidemic.
- The blade is mounted at 135° to the handle **(Fig. 9.7)**.

## Patil-Syracuse Laryngoscope

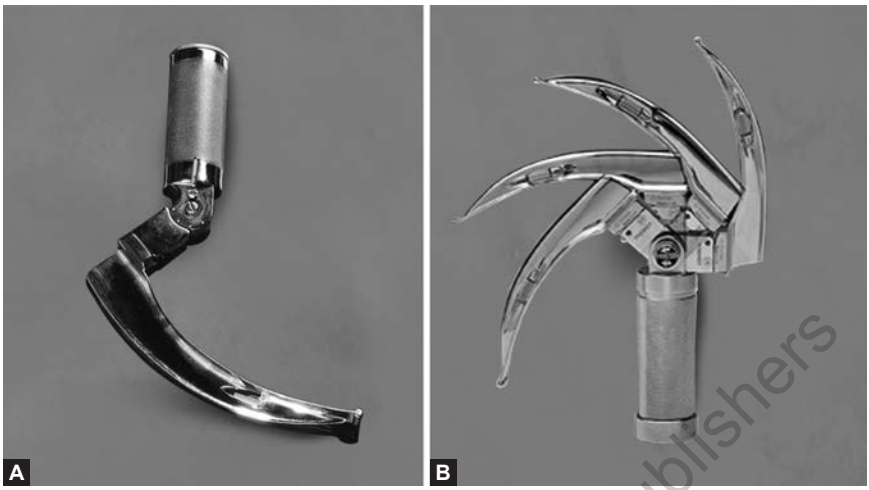
- Designed by Dr Vijayalakshmi Patil and colleagues in 1983 at the State University of New York at Syracuse.
- Has an adjustable handle which can be set and locked in 4 angles; 45°, 90°, 135° and 180°
- These positions mimic the Howland Lock and polio blade as well as the conventional arrangement **(Figs 9.8A and B)**.

## Bullard Fiberoptic Laryngoscope

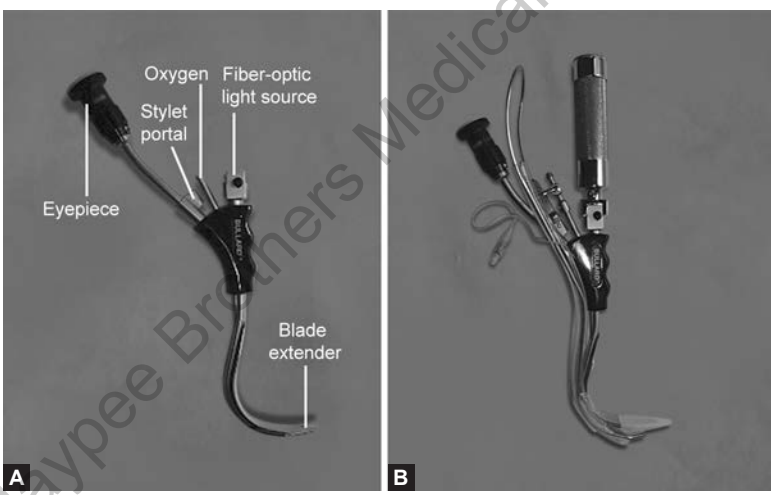
- It is an indirect fiberoptic laryngoscope designed by Dr Roger Bullard.
- Rigid metal fiberoptic laryngoscope that is shaped to fit the anatomical contour of the oropharynx and epiglottis **(Figs 9.9A and B)**
- This comes in three sizes; *pediatric, pediatric long* (8–10 yrs) and *adult (more than 10 years and adults)*.
- There are three channels; a *light bundle* on the left, *image bundle* on the right and the *working channel* on the center.
- The working channel extends from body of the cope to the point where the light bundle ends at the tip.
- Proximally the working channel divides into two; one with Luer-lock and the other for passing a stylet.
- This working channel can be used for suctioning, insufflation of oxygen, instillation of local anesthetic or saline.
- The light source may from an adaptor of cold light source **(Fig. 9.9A)** or a battery loaded handle which can be attached **(Fig. 9.9 B)**.
- It may be used as a passage for airway exchange or jet ventilation.
- *Advantages*: Difficult situations like cervical spine injury where movement of spine may be dangerous, Pierre Robin syndrome, upper body burns, etc.
- *Disadvantage*: The operator must have sufficient experience.



**Fig. 9. 7:** Polio laryngoscope




**Figs 9.8A and B:** (A) Patil-Syracuse laryngoscope; (B) Same blade shown in the 4 positions; 45°, 90°, 135° and 185°




**Figs 9.9A and B:** (A) Bullard laryngoscope; (B) Bullard laryngoscope with battery attached



## Video Laryngoscopes

- These are new generation laryngoscopy techniques.
- The image of the glottis is visualized in a clear better and magnified way that the intubation is done easily.
- The image from the end of the scope is carried directly to the attached screen or through optic cable to a distant screen **(Fig. 9.10)**.

### *Advantages*

- Better visualisation of the glottis is possible.
- Less mouth opening and extension of neck is needed for intubation.

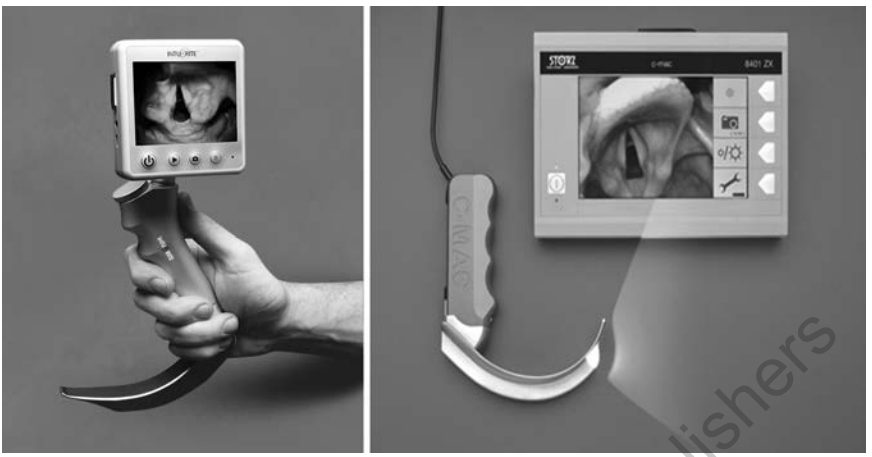


**Fig. 9.10:** Video laryngoscopes: Two versions; with an attached screen and a distant screen

- Ideal for difficult airway management.
- Assisting technician also can visualise the glottis and help easily.
- The two versions; with an attached screen and a distant screen.

## FIBER-OPTIC INTUBATING BRONCHOSCOPE

### History

In 1967, Dr P Murphy used a Choledochscope passed through an endotracheal tube to intubate the trachea.

The flexible bronchoscope is a device that can be used for direct laryngoscopy for endotracheal intubation. It is particularly useful when direct laryngoscopy is difficult or impossible, or would be dangerous. For awake intubation, flexible bronchoscopy is better tolerated than laryngoscopy with a standard laryngoscope.

While the term "flexible fiberoptic intubation" has been used for this technique in anesthesia, newer bronchoscopes no longer use fiberoptic technology.

This technique has become the gold standard for the management of difficult laryngoscopy.

### Principle and Design

- The fundamental principle in 'Fiberoptic" is "Total internal reflection".
- The pathway for carrying light and the image consists of thousands of very fine glass fibers of 10 microns diameter.
- Each fibere is made of a central glass core surrounded by a thin cladding of another type of glass with a different refractory index.
- As a result of the differences in the refractory indices, the light entering the glass fiber at one end undergoes 'total internal reflection' along the length of the fiber to be transmitted and emerge out of the other end.
- For image transmission, the arrangement of fibers must be identical in relation to each other at either ends of the bundle. This is essential as each fiber caries a tiny bit of the overall image and any fault in it will result in distortion of image. This is known as 'Coherent Bundle' **(Fig. 9.11)**.

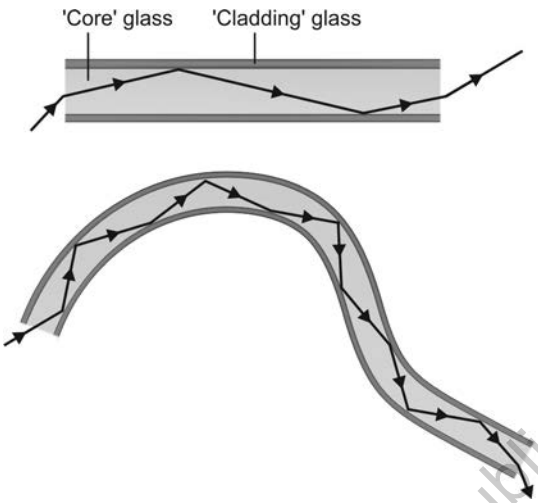



**Fig. 9.11:** Principle of fiber-optic—'Total internal reflection'

## Parts of the Fiberoptic Laryngoscope

- It has a powerful external light source—'Cold light source' which prevents tissue damage by radiant heat.
- The scope has two parts; A handle and a flexible insertion portion.

The insertion portion has the following components:

- Two light bundles
- One image bundle
- One working or biopsy channel
- Two angulation wires that control the flexible tip of the scope
- All these components are bound together by a spiral stainless steel wrap.
- This is further protected by a stainless steel 'braid' and covered with a water proof material.
- This gives a rigid cross section while permitting overall flexibility **(Fig. 9.12A)**.

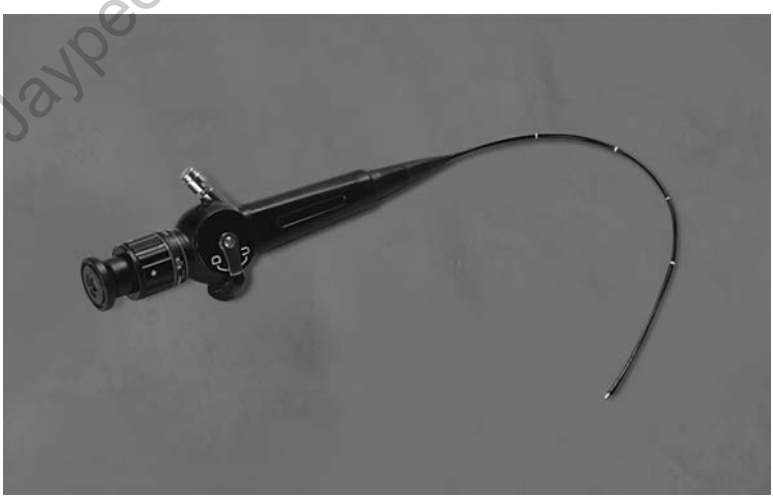


**Fig. 9.12A** Fiber-optic intubating laryngoscope

- Sizes ranging from 2.5 mm outer diameter to over 6 mm outer diameter scopes are available.
- Scopes with larger diameter have proportionately larger working channel.
- A laryngoscope with 3.5 mm outer diameter is suitable for use in adult patients.

## Technique of Intubation

- Intubation can be done either by oral or nasal route. Oral route is a little difficult than nasal route.
- The fiberoptic scope is introduced and advanced behind the tongue to reach larynx and further advanced into the larynx.
- Once inside the trachea, an endotracheal tube which has been previously loaded on to the scope is advanced into the trachea and the scope is withdrawn.

### *Advantages*

- Reliable technique in difficult airway situations
- Facility for recording and reviewing and also for documentation.
- Record review will help to improve the learning process.

### *Disadvantages*

- Expensive and fragile equipment
- Technically more difficult and time consuming than direct laryngoscopy
- Needs experience for operating.

## Single use Flexible Intubating Bronchoscope

- Now single use flexible intubating devices are available. It does not have fiberoptic cable, instead has a small camera at its tip illuminated by an LED. The image is transmitted through a slim cable in the device to a reusable screen. *Example*: Ambu a Scope **(Fig. 9.12B)**.
- Available in sterile pack, handy and is cheaper compared to the cost and maintenance of conventional fibreoptic equipment.


**Fig. 9.12B** Disposable flexible intubating bronchoscope with reusable screen

# ENDOTRACHEAL TUBES

## History

- C. Kite of Gravesend described oral and nasal intubation for resuscitation of the apparently drowned in 1788.
- Historically, tracheostomy was preferred to intubation because it was believed that a laryngeal tube will not be tolerated.
- In 1871, Friedrich Trendelenburg developed a cuffed catheter for insertion though a tracheostomy to prevent soiling of lungs during operation in upper airway.
- In 1878, William Mac Evan, a surgeon of Glasgow, placed a metal tube into the trachea by manual palpation through mouth and administered chloroform anesthesia.
- Edgar Stanley Rowbotham and Ivan Whiteside Magill first used endotracheal anesthesia by passing a gum elastic tube in trachea.
- The first blind nasal intubation was performed by Stanley Rowbotham.
- Magill published his results of blind nasal intubation with a wide bore rubber tube in 1928.
- Inflatable cuffs were used even earlier, but reintroduced in 1928 by Ralph Milton Waters and Arthur E Guedel.
- Before the days of muscle relaxants, blind nasal intubation under deep inhalational anesthesia was in practice.
- Use of muscle relaxant to facilitate intubation was pioneered by Bourne.
- In 1950s, the use of cuffed endotracheal tube became the standard of anesthesia practice.

## Indications for Intubation of Trachea

- In situations where it may not advisable to administer anesthesia with a face mask.
- When there is a need for the use of muscle relaxant and positive pressure ventilation.
- For maintaining the airway in unconscious patients.
- Preventing aspiration of secretions or regurgitated gastric contents and protecting the respiratory tract with a cuffed tube.
- For sealing the respiratory tract and breathing circuit.
- For mechanically ventilating patients in ICU.

## Tubes

- Traditional tubes for either oral or nasal intubation were 'Magill endotracheal tubes'.
- These tubes were made of mineralized rubber to keep them retain their shape and lumen are relatively firm without collapsing.
- The tip of the tube is obliquely cut facing left side called 'bevel' that facilitates the insertion into the glottis.
- Oral tubes have thicker walls and are firm with a short bevel (35°).
- Nasal tubes are relatively softer with a long bevel (45°) for easy negotiation in the nasal cavity.
- Their size is mentioned in mm, 8 mm, 8.5 mm, etc. indicate the internal diameter of the tube.
- These specially designed tubes can be passed into the trachea for delivering anesthetic mixture into the respiratory tract.

- Laryngoscopy is done for visualizing larynx to be intubated.
- The tube may be passed, depending upon the necessity, either through the nose (Naso-tracheal intubation) or through the mouth (Orotracheal intubation).
- The procedure of passing an endotracheal tube into the trachea is called as "endotracheal intubation" shortly known as "intubation".

## Magill's Endotracheal Tube

### *Red Rubber Tube*

- Latex rubber is impregnated with minerals—'mineralized' rubber-to make it hard and retain the shape.
- It is colored red to indicate that as a medical product.
- There is a preformed (built in) curvature that helps in easy intubation
- Available as plain tubes (non-cuffed) or cuffed tubes **(Figs 9.13A and B)**.
- The cuff is made of soft latex rubber and is *small volume, high pressure* type.
- These 'low volume—high pressure' cuffs may cause pressure on the submucosal vessels leading to mucosal ischemia.
- There are different tubes meant for orotracheal and nasotracheal intubation.

Differences between *oral* and *nasal* tubes

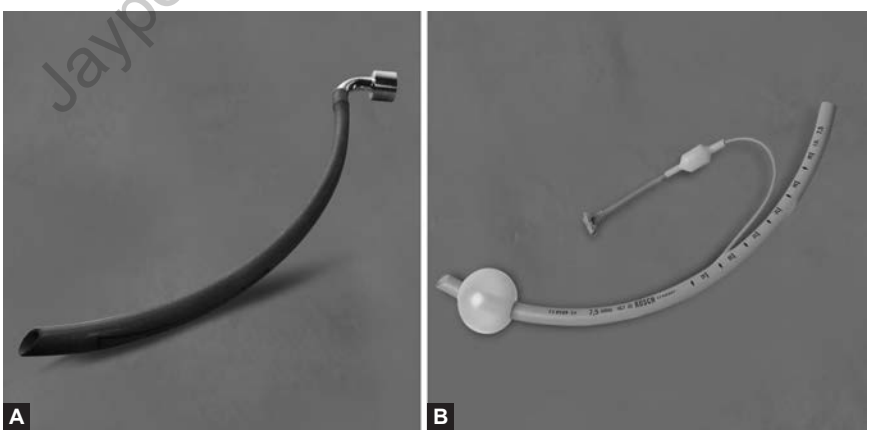
| | *Oral tubes* | *Nasal tubes* |
|---|---|---|
| • Curvature | 14 cm radius | 18 cm radius |
| • Bevel | 45° short bevel | 35° long bevel |
| • Texture | Relatively rigid | Relatively soft |

Nasal tubes are softer with long bevel for negotiating the nasal cavity without causing injury to turbinates. Red rubber tubes cause irritation to the mucosa and prolonged use may cause laryngeal granulomata.

## Plastic Endotracheal Tubes

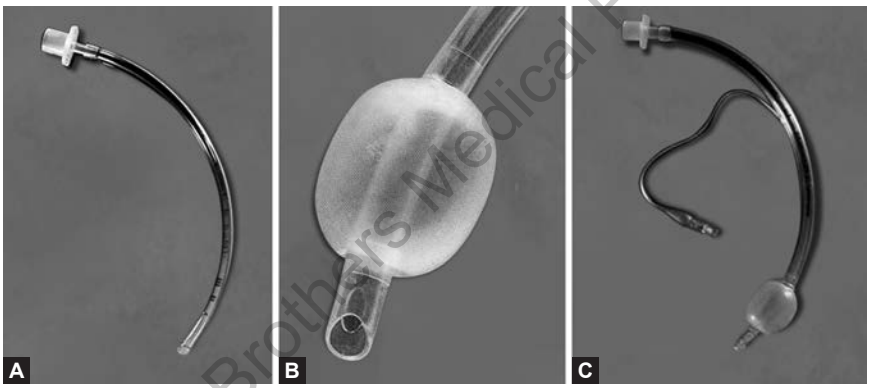
- These are transparent tubes are available as plain (noncuffed) and cuffed tubes.
- Available in sizes from 2 mm to 11 mm sizes.
- Most of the tubes come with 'Murphy's safety eye'. **(Figs 9.14A to C)**



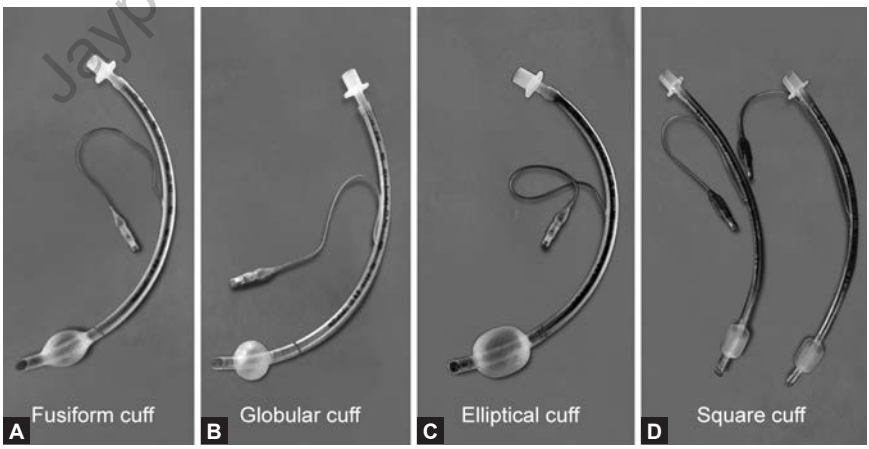



**Figs 9.13A and B:** Magill' red rubber endotracheal tube—noncuffed and cuffed (A) Oral tubes have the short bevel of 35° and arc of 18" radius; (B) Small volume high pressure cuff

- Murphy's eye is an oval hole on distal end of endotracheal tube on the opposite side of the bevel.
- This functions as a vent, and prevents the complete obstruction of the patient's airway, should the primary distal opening of an ETT become occluded.
- Relatively nonirritant and have large volume low pressure cuffs that give an airtight seal for normal airway pressures.
- The cuff can be inflated with air using a plastic syringe through a tube "cuff inflating tube with pilot balloon.
- Cuff inflating tube is embedded in the anterior wall of the tube and it extends out for a length and end in a pilot balloon with spring loaded self-sealing valve.
- The large volume low pressure cuffs do not cause pressure on the submucosal vessels to produce ischemia. Cuff pressure should not exceed 25 cm of $H_2O$.
- Different types are available depending upon the need. They are; fusiform, globular, elliptical, and square cuffs **(Figs 9.15A to D)**.
- For better seal with low pressure a square cuff is ideal.
- There is a radio-opaque blue line throughout the length on the posterior aspect of the tube for radiological confirmation of the position of the tube.




**Figs 9.14A to C:** (A) PVC endotracheal tube noncuffed; (B) High volume-low pressure cuff and Murphy' safety eye at the tip; (C) PVC cuffed tube




**Figs 9.15A to D:** Different types of high volume low pressure cuffs

*Information present on the tube:*

- Manufacturer's name
- Oral/nasal
- Internal diameter (ID)—large letters
- External diameter (ED)—small letters
- Z 79—Implantation test for tissue toxicity. As per ANSI standard.
- Length in cm—markings from the tip.
- Radio-opaque blue or black line on the posterior wall for radiological confirmation of the position of tube.
- A black ring proximal to the cuff—guides the position of the cuff just below the glottis.
- Pilot balloon has the size of the tube marked on it.

## Different Types of Cuffs

- Small volume, high pressure cuff (usually rubber cuffs)
- Large volume, low pressure cuff **(Figs 9.14 and 9.15)**
  - Fusiform
  - Elliptical cuff
  - Globular
  - Square cuff
- Square cuff ensures more airtight seal with less pressure
- For a tracheostomy tube, the cuff is shorter and square.

## Murphy's Safety Eye

Some tubes have an oval opening on the wall near the tip of the tube opposite to the bevel. It is an opening for an alternate passage for gas, if the tip of the tube is blocked **(Fig. 9.14B)**.

Modern endotracheal tubes are made of material other than rubber such as *plastic* (PVC), *polyurethane*, or *silicon rubber* and these tubes are less irritant. Silicon rubber stands heat sterilization.

## Cuff Pressure

- It is desirable that the cuff seals the airway without causing undue pressure on the tracheal mucosa.
- With a pressure of 30 cm $H_2O$, the perfusion in the vessels in the submucosa is compromised.
- With 50 cm $H_2O$ the perfusion completely ceases and leads to ischemic necrosis of tracheal mucosa.
- It is recommended that the intra cuff pressure is maintained between 25 and .30 cm $H_2O$ to prevent ischemic necrosis.
- Cuff pressure should be monitored with a cuff pressure gauge during prolonged anesthesia.

## Size of Endotracheal Tube

- The correct size of endotracheal tube needed for the patient must be used.
- Too small a tube needs very high pressure for seal and may lead to leaks.
- Too big tube may cause pressure on the glottis and lead to edema after extubation.

- Ideally three tubes must be ready. Expected size, one size bigger and one size smaller.
- Average adult male—8.5 mm ID size may be suitable.
- Average adult female—7.5 mm ID size may be suitable.
- For children age is the criterion for choosing the size of the tube.
  - 3 months and less - 3 mm ID
  - 3 to 9 months - 3.5 mm ID
  - 1 year and older - mm ID (16 + age in years/4)
  - Younger than 6 years - mm ID (age in years/3 + 3.5)
  - More than 6 years - mm ID (age in years/4 + 4.5)
- Infants
  - Below 1 kg - 2.5 mm
  - 1 to 2 kg - 3.0 mm
  - 2 to 3 kg - 3.5 mm
  - 3 kg - 3.5 or 4.0 mm
- The diameter of the tip of little finger of the patient roughly corresponds to the outer diameter of the endotracheal tube. It is an approximate estimate.

## Other Recommendations

| *Age of patient* | *Size in ID* |
|---|---|
| Premature neonate | 2.5 to 3.0 mm |
| Full term neonate | 3.0 to 3.5 mm |
| 3 months to 1 Year | 4.0 mm |
| 2 years | 4.5 mm |
| 4 years | 5.0 mm |
| 6 years | 5.5 mm |
| 8 years | 6.0 mm |
| 10 years | 6.5 mm |
| 12 years | 7.0 mm |

## Length of the Tube from Incisors

After intubation, the tube tip must be in the middle third of the trachea with the head in neutral position.

The calculation for assessing the length of the tube from the incisor teeth to the middle third of trachea:

- Age in years/2 + 12 cm
- Weight in kg/5 + 12 cm
- Height in cm/10 + 5 cm
- ID of the tube in mm × 3

In adults:

- The tube is passed until the cuff is 2.25 to 2.5 cm below the vocal cords.
- In average adults, 23 cm for male and 21 cm for female at the incisor level is correct.

For nasal intubation 5 cm should be added to the above lengths to fix the tube at the nares.

## Endotracheal Tubes for Special Purposes

Apart from the regular endotracheal tubes, there are several specially designed endotracheal tubes meant for certain special applications.

During certain surgical procedures (neurosurgical) or positions for surgery a (sitting position), it is possible that endotracheal tube is bent on itself and gets kinked resulting in partial or complete airway block.

In such situations a nonkinkable endotracheal tube is used, most common being the 'reinforced' or 'armoured' tubes':

- *Latex rubber tube* with metal spirals embedded—straight tube—reusable. (Flexo-metallic) highly flexible made of pure latex rubber.
- *Plastic tubes* with metal spirals embedded—with or without preformed curvature.

## Latex Rubber Armoured Tubes—Metal Spiral Reinforced Tubes (Nonkinkable Tubes)

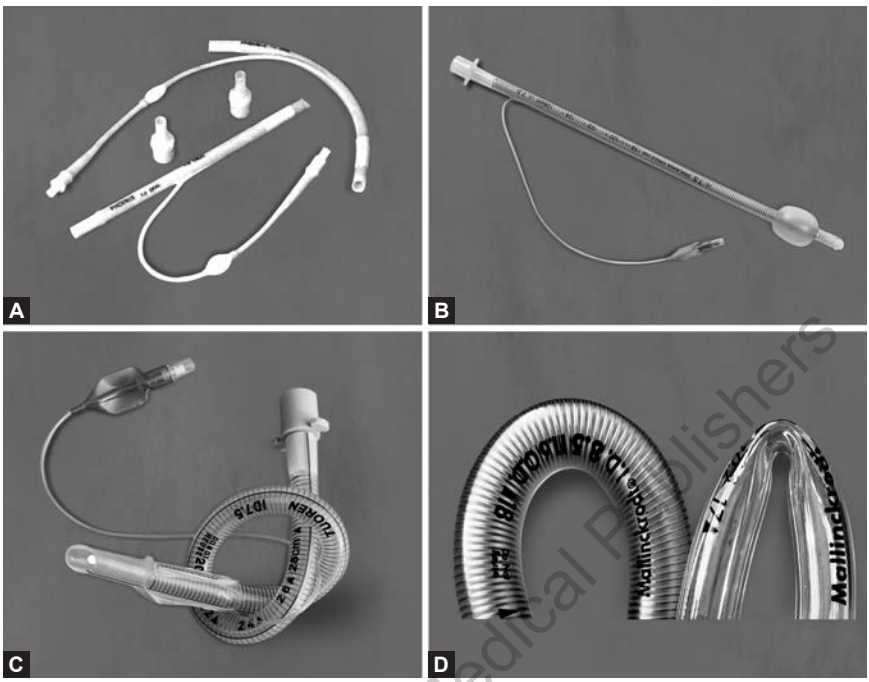
- These are the true nonkinkable endotracheal tubes, as it does not get kinked in any possible positions of the head and neck.
- Originally reinforced tubes were made of soft latex rubber, *reinforced with metal spiral* embedded in its wall, commonly known as flexo-metallic tubes **(Fig. 9.16A)**.
- The reinforcement spiral embedded in the wall may be either steel spiral or nylon spiral and is known as 'Armour'.
- This makes the tube virtually nonkinkable in spite of bending on itself or even making a knot. The lumen of the tube remains unaltered.
- The two layers of rubber are fused together in between the spirals to prevent sliding of spirals.
- The cuff inflating tube is not embedded in the wall. It enters the tube proximal to first spiral, runs through the side of the tube within the lumen of the tube and enters into the cuff. This prevents the tube getting caught in the spirals getting blocked.
- The distal end of the spiral is almost at the tip of the tube.
- The bevel is very short and small (less than 35º) to prevent the soft bevel folding inwards and causing obstruction of the tube.
- It is a soft rubber tube, does not retain preformed curvature as seen in red rubber or PVC tubes and is straight.
- It needs an introducer or malleable stylet for intubation.
- The spirals stop short of the proximal end leaving only latex rubber tube for inserting the connector.
- The connector must be inserted to touch the first spiral otherwise the soft tube may get kinked at this point
- These tubes are used for head and neck surgeries, mainly neurosurgeries.



## Plastic Armoured Tubes

Most of these problems have been solved in the modern reinforced tubes.

- Most of them are made of soft material that the tube is a straight tube **(Fig. 9.16B)**.
- Nonkinkable in any position, even with a knot on it or folded on itself **(Figs 9.16C and D)**.
- Need for a stylet for intubation and possibility of kinking at the connector level are still there.
- The tip is more firm provided with bevel and Murphy's eye.
- Some plastic tubes come with preformed curvature, does not require introducer.
- Disposable




**Figs 9.16A to D:** Reinforced or armoured endotrachal tubes: (A) Latex rubber 'Flexometallic' tube—a straight rube—needs stylet for intubation; (B) Silicon rubber armoured tube—this also needs a stylet for intubation; (C and D) A knot on it or bending it on itself does not kink the tube; The connector should be inserted well to touch the first spiral

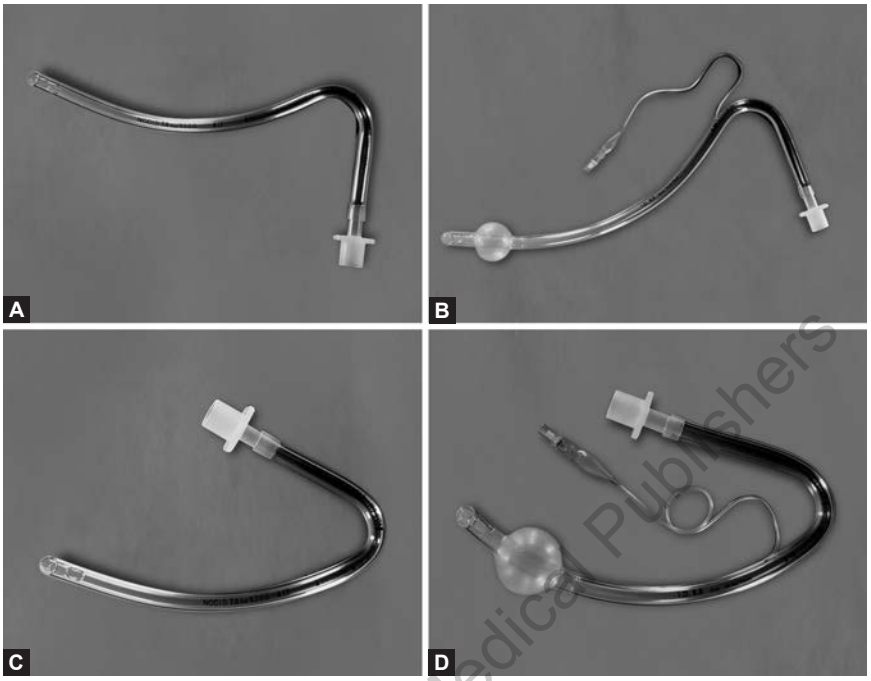


## RAE Tubes (Ring Adair and Elwyn) Preformed Tubes

- These tubes are specially designed for use in head and neck surgeries particularly for facial surgeries and plastic surgeries.
- Also called as "preformed tubes" because of the special fixed curvature they have conforming to the natural passage to suit the use **(Figs 9.17A to D)**
- They are relatively nonkinkable and available as cuffed as well as noncuffed versions.
- *North Pole*: Towards head end–*nasal*
- *South Pole*: Towards foot end away from the field of surgery—*oral*
- Suction may be a little difficult.
- Short bevel.
- The nasal tube is called "North Pole" and the oral tube is called "South Pole".
- Double 'Murphy's eyes on both sides of the bevel.

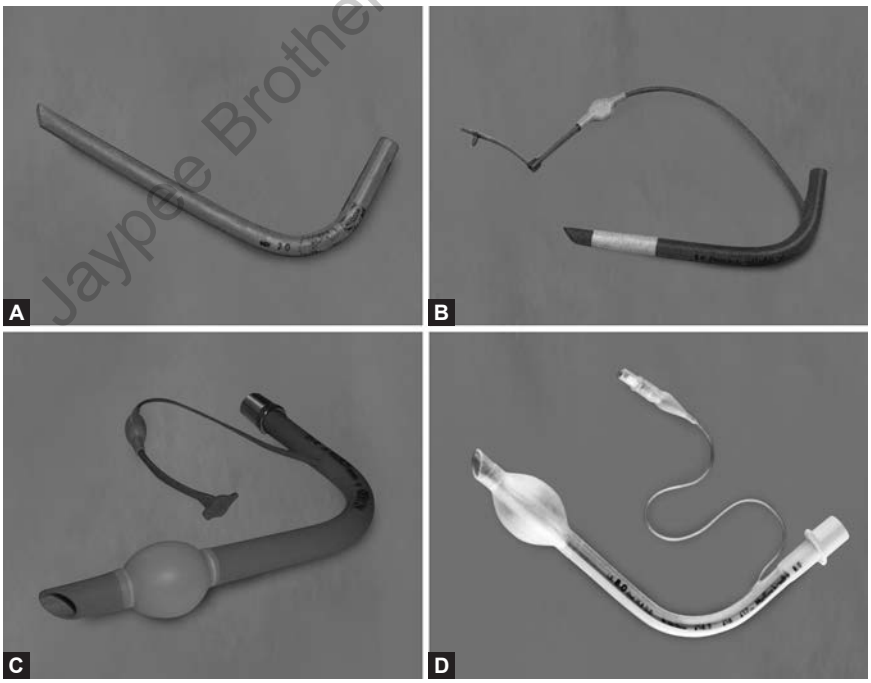
## Oxford Tubes

- These are right angled tubes specially designed for surgeries inside oral cavity.
- Very commonly used for "Cleft palate repair" surgeries and many other palate surgeries.
- These are relatively nonkinkable tubes because its preformed right angle portion fits well in the oropharynx **(Figs 9.18A to D)**.




**Figs 9.17A to D:** RAE tubes: Nasal–plain and cuffed; Oral–plain and cuffed. (A) Nasal tube plain; (B) Nasal tube cuffed (North Pole); (C) Oral tube plain; (D) Oral tube cuffed (South Pole). Double 'Murphy's eyes are seen on both sides of the bevel






**Figs 9.18A to D:** Oxford tubes: Red rubber—uncuffed, red rubber cuffed and PVC cuffed

- Proximal end of the tube has bigger outer diameter whereas the distal end has smaller outer diameter. But, the inner diameter uniform and outer diameter is tapering. This is for easy insertion of the tube **(Fig. 9.18A)**.
- The bevel is short and faces posteriorly; to prevent accidental occlusion of the tip by opposing the anterior tracheal wall.
- After intubation, the tube will not protrude out of mouth but stops at the incisor tooth level.
- Hence, a special metal connector is introduced used for preventing the patient biting the tube and blocking the airway.
- The connector must be usually kept tightly fixed to the tube before intubation as after intubation connector cannot be fixed to the tube without dislodging the tube.
- For small children a right angled metal connector is used.
- Available in red rubber (reusable) and plastic (disposable).
- Noncuffed and cuffed versions are available.

## Connectors for Oxford Tubes

- The right angled preformed curvature of the tube and the right angled connector form *"double right angle"* after application. This 'U' shaped passage will cause difficulty in passing suction catheter.
- Right angled connector—has hole or *fenestra (opening)* at the bend to facilitate suctioning which is covered with plaster.
- Connector must be sufficiently introduced into the tube so that when the mouth gag is applied, the tube is not compressed between incisor teeth and the tongue plate of mouth gag.

## Endotracheal Tubes for Laser Surgeries

For surgeries in airway and neck using laser beam, standard endotracheal tubes are unsuitable as the laser beam striking at the tube may perforate or sever the tube leading to catastrophe. In the presence of oxygen it may ignite combustible material resulting in 'Airway fire'.

To prevent such dangers there are many tubes designed with the aim of reflecting the laser beams. Some of the tubes used are:

*Norton:* Spiral wound stainless tube

*Bivona fome cuff:* Aluminum spiral tube with silicon polyurethane foam cuff

*Xomed Laser–Shield:* Silicon elastomer tube containing metallic powder

*Mallinckrodt Laser-Flex:* Airtight stainless steel spiral wound tube with two PVC cuffs.

Out of the many available types of tubes, *Laser-Flex tube* has many advantages.

### *Laser-flex Tube (Manufactured by Mallinckrodt Medical Inc.)*

- These are made of stainless steel spirals and are covered with PVC.
- The surface is rough for reflecting laser beam **(Fig. 9.19A)**.
- Non-cuffed tubes are available.

- The cuffed tube has two PVC cuffs and inflating lines which pass inside the lumen.
- The cuffs are filled with saline coloured with methylene blue.
- Proximal cuff is used first and if it is damaged by laser during work, the distal cuff can be inflated **(Fig. 9.19B)**.
- PVC tip with Murphy's Eye is provided.
- The laser beams strike at the metal will be reflected and will not damage the tube.
- The tubes are of thicker walls.

## Double Lumen Endotracheal Tube

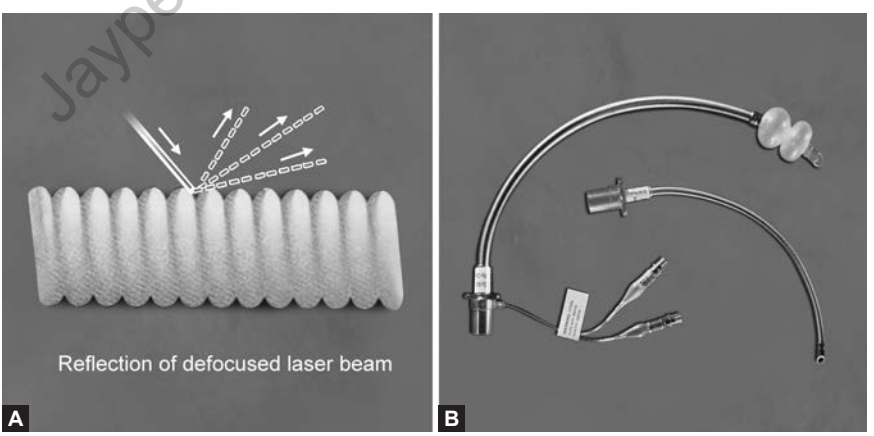
These are special tubes designed for one lung anesthesia, commonly employed for lung surgeries and any other thoracotomies to keep the lung down at will during surgery.

- There are two different lumens in the same tube for ventilating each lung separately.
- The lumens are 'D' shaped, proximally have two connecting pieces.
- For isolating the lungs, there are two cuffs, one in the bronchial portion (Bronchial cuff) and the other on the tracheal portion (Tracheal cuff).
- The pilot tubes and the balloons for inflating the cuffs are differently colored for easy identification.
- Right sided and left sided versions are available.

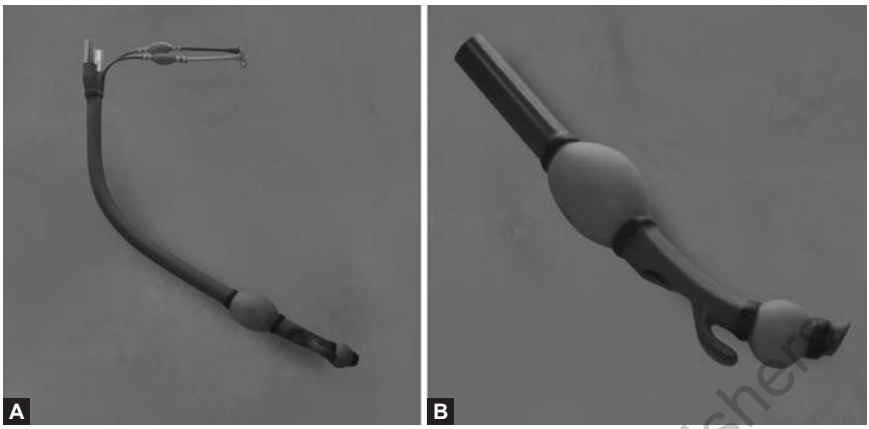
## Carlen's Double Lumen Tube

- Originally double lumen tube was designed for bronchospirometry – was known as 'Carlen's catheter' and later only it was used for one lung anesthesia.
- *Carlen in* 1949 *designed this* for bronchospirometry to assess individual lung function.
- It is a left sided tube with left bronchial tube **(Fig. 9.20A)**
- It has a carinal hook that will rest on carina for proper positioning the tube **(Fig. 9.20B)**






**Figs 9.19A and B:** Laser-Flex tube (Mallinckrodt Medical Inc). (A) Laser beam getting defocused and reflected on the surface; (B) Laser-Flex tube; Plain and cuffed




**Figs 9.20A and B:** (A) Carlen's double lumen tube; (B) The cuffs and 'carinal hook' are shown. The 'carinal hook' helps to position the tube in the right place



## Green and Gordon's Right Endobronchial Tube

- Designed by Gordon and Green in 1955
- The problem of intubating the right bronchus without obstructing its upper lobe branch was solved.
- This tube has a right bronchial tube that lies in the right main bronchus.
- The tube with a slot on the bronchial cuff opposite the orifice of the right upper lobe bronchus ventilates the right upper lobe **(Fig. 9.21)**
- This is actually a right sided modified version of Carlen's tube with a 'carinal hook'.

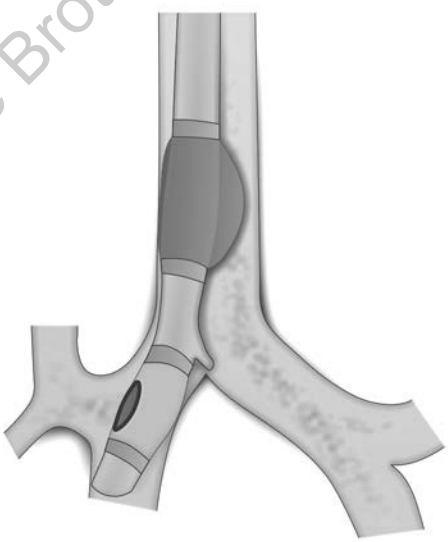


**Fig. 9.21:** Green and Gordon double lumen tube. • The bronchial cuff is in the right main bronchus; • The cuff has a opening opposite to upper lobe for ventilating the upper lobe

### Robert Shaw Double Lumen Tubes for One Lung Anesthesia

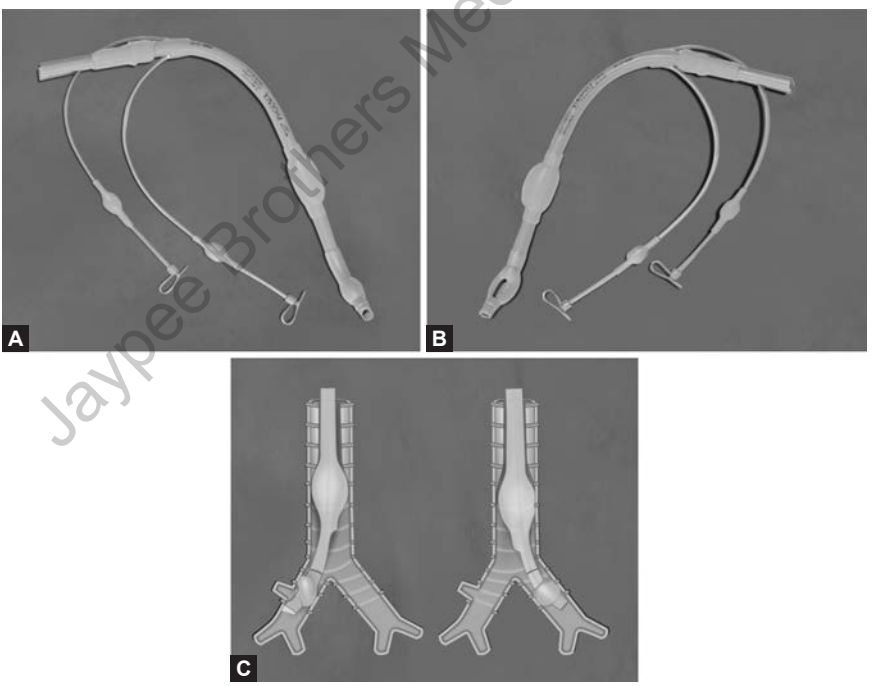
- A modified Carlen's double lumen tube.
- Lumen is D shaped on cross section.
- Right and left side versions are available. No carinal hook.
- Right side version will have a slit on lateral aspect of bronchial cuff for ventilating the right upper lobe **(Figs 9.22A and C)**.
- This is the most commonly used tube.
- *Bronchial* cuff is *blue* and *tracheal* cuff is *red* with pilot balloons of corresponding colours
- Small, medium, large sizes were available. Now one more size extra small is added.

## OTHER LESS COMMONLY USED TUBES

### Cole's Tube

- Introduced for the purpose of preventing endobronchial intubation in neonates.
- Internal diameter is same throughout.
- Outer diameter is narrow near the tip to form a shoulder.
- When the tube is introduced, the shoulder rests on vocal cords so that only the narrow portion of the tube is inside the trachea and can't be introduced further.
- Distal portion measures 1.5 to 2 cm **(Fig. 9.23)**.






**Figs 9.22A to C:** Robert shaw double lumen tube for one lung anesthesia. • The two cuffs (bronchial and tracheal) have different colored pilot balloons. The bronchial cuff and pilot balloon are blue colored and the tracheal cuff and pilot balloon are red colored. (A) Left-sided version; (B) Right-sided version—which has a opening in the bronchial cuff for ventilating right upper lobe; (C) The position of the tubes in trachea and bronchus

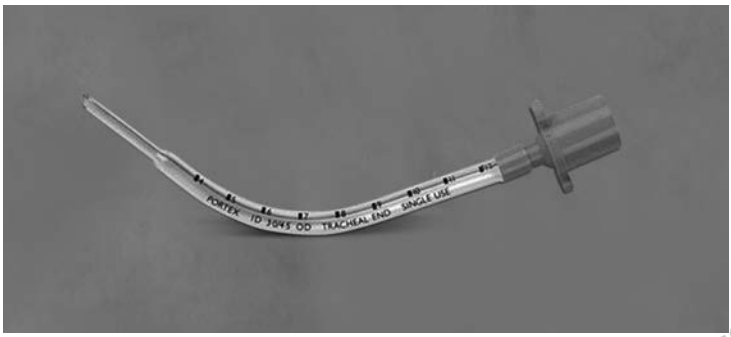



**Fig. 9.23:** Cole's tube

## Laryngectomy Tube

- If the tumor is not obstructing the airway, general anesthesia with oral intubation is managed for the major part of the surgery. When the trachea is severed, surgeon inserts a sterile tube into the trachea and secures it.
- When there is any doubt regarding the maintenance of airway, ideally tracheostomy is done under local infiltration anesthesia and a laryngectomy tube which has performed 'J' shaped curvature is inserted for safe anesthetic management **(Fig. 9.24)**
- Laryngectomy tubes are cuffed tubes available in red rubber as well as reinforced plastic tubes.
- The armoured plastic tubes have a short square cuff.

## Endotracheal Connectors

- Different connectors are used to connect the endotracheal tube to the anesthetic breathing system or a resuscitator bag.
- Modern equipment use only the "Universal 15 mm connectors" available in all sizes starting from 2.2 mm tube meant for a premature neonate.
- These connectors fit in almost all adapters used in equipment for anesthesia as well as resuscitation.

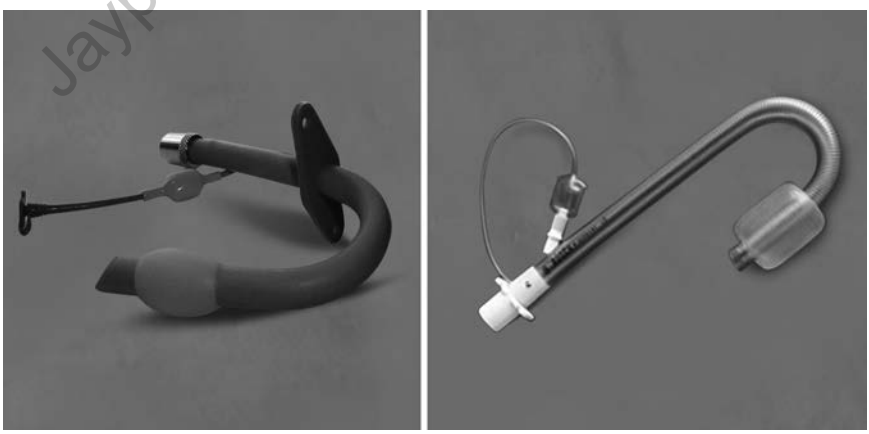


**Fig. 9.24:** Laryngectomy tube

## Magill's Connectors

- In 1930 Sir Ivan Magill designed these curved metal connectors to be used with Magill's red rubber endotracheal tube he invented.
- *Smooth curved* connectors–16 connectors **(Fig. 9.25)**
- Funnel shaped proximal end (flanged) and corrugations on the tip for tight fit to the tube.
- 8 oral connectors and 8 nasal connectors
- 1, 2, 3, 4, 5, 6, 6A and 6B: *Oral*—angle of curvature: obtuse and smooth curve
- 7, 8, 9, 10, 11, 12, 12A, 12B: *Nasal*—very acute curve and nearly right angle
- *Oral*: Less than 90°; nasal—more than 90°.
- Turbulence in flow of gases and increase in resistance with nasal connectors.
- A catheter mount is necessary for using these connectors.
- In both these relatively good laminar flow is maintained, because these are curved connectors.

## Rowbotham Connector

- Metal connector
- Right angled with a tapering end with horizontal or transverse ribs for better hold **(9.26)**.



**Fig. 9.25:** Magill's endotracheal tube connectors—oral and nasal

**Fig. 9.26:** Rowbotham's connector

- *Advantages :* Same connector can be used for a few sizes of ETT, maintains good grip.
- *Disadvantage:* Enormous turbulence and resistance because it is right angled.
- Resistance during inspiration cause more problems in spontaneous breathing. But in controlled ventilation, it is not dangerous.
- Expiratory resistance is dangerous because $CO_2$ elimination is affected.

## Noseworthy Connector

- Curved connector made of chromium plated brass metal.
- Has three pieces of very wide bore **(Fig. 9.27)**.
- Maintains good laminar flow.

## Cobb's Suction Union

- Right angle connector, with an extension of a suction port at the angle covered with a metal stopper **(Fig. 9.28A)**
- Metal stopper linked by a chain to the angle.
- These connectors are used for anesthetizing patients with suppurative long diseases posted for lobectomy where purulent secretions from the affected lobe may flow into the proximal bronchial tree during handling necessitating frequent suctioning.

## Magill's Suction Union

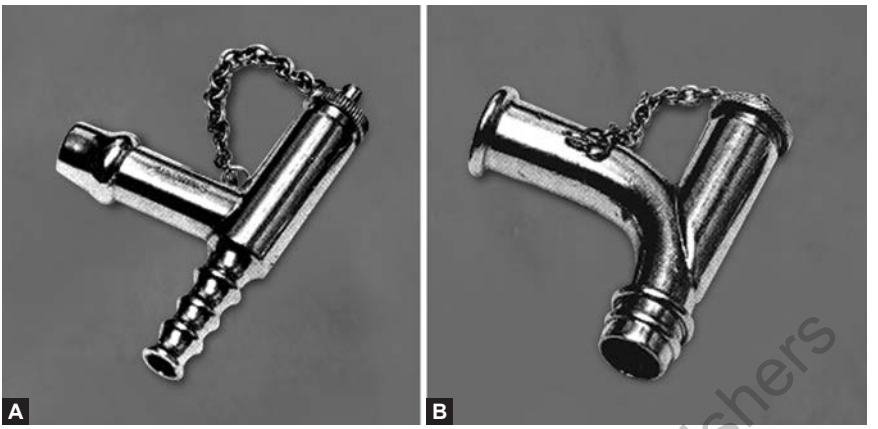
- Similar to the Cobb's suction union but, the suction port is wide and funnel shaped to facilitate the introduction of catheter easily **(Fig. 9.28B)**.
- Suction port is covered with a metal cap or rubber cap, which fits the outside of suction port.
- These two suction unions are commonly used for *wet lung cases*, which facilitates *frequent suctioning during surgery*.

## 15 mm Universal Endotracheal Tube Adapter

A set of connectors from 2.5 mm size to 12 mm size are available with a swivel mount adapter **(Fig. 9.29)**.



**Fig. 9.27:** Noseworthy's connector




**Figs 9.28A and B:** Cobb's suction Union and Magills suction Union


**Fig. 9.29:** Set of 15 mm Universal connectors with a swivel mount



## Swivel Mount with Suction Port

- Permits 360° movement of catheter mount without causing leak
- This is for use with 15 mm universal connectors
- *One way* swivel mount permits 360° movement around the connector
- *Two ways* swivel mount—*axial swivel* and *circular swivel mount* combined. I can be rotated 360° in its axis without leak. Similarly it can be rotated 360° at right angle to the axis. So, no drag on the endotracheal tube is caused during positioning **(Fig. 9.30)**.
- It is provided with a suction port covered with a rubber stopper that helps suctioning without disconnecting the tube.

## Stylet

- An endotracheal tube *stylet*, useful in facilitating orotracheal *intubation*.
- An intubating *stylet* is a malleable metal (copper or brass) wire with the tip is rounded up like a globe to prevent injury to any soft structure **(Fig. 9.31A)**.
- Stylets made of aluminium metal covered with PVC are also available **(Fig. 9.31B)**.

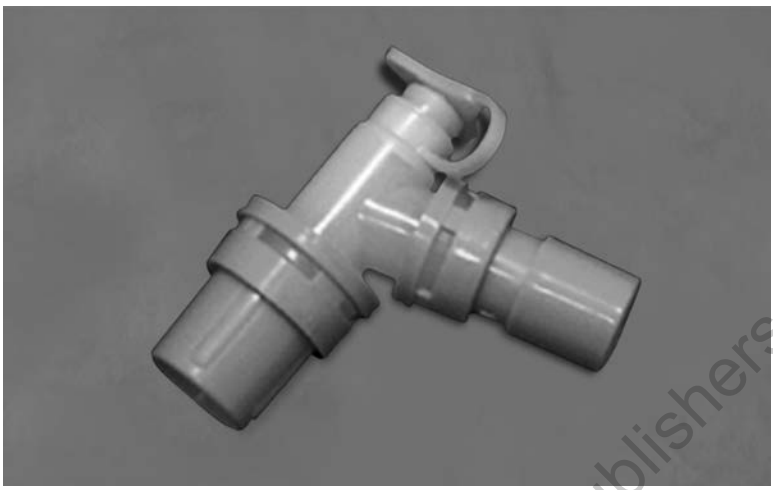
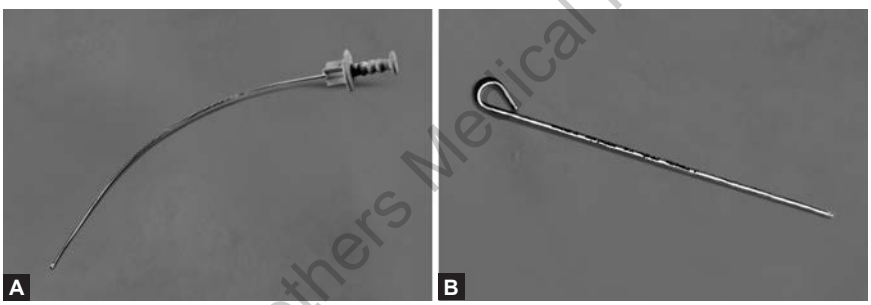


**Fig. 9.30:** Two way swivel mount for endotracheal connectors




**Figs 9.31A and B:** Two types of stylet



- Designed to be inserted into the endotracheal tube to make the tube conform better to the upper airway anatomy of the particular individual.
- It is placed into the tube prior to laryngoscopy.
- Then the tube with the stylet in it is bent to resemble a hockey stick.
- It can be used for difficult intubation when the tip of the tube is not reaching the glottic opening when the glottis is very anteriorly placed.
- After insertion of the tube into the trachea, the stylet is removed.

## Bougie (Gum elastic Bougie)

- The bougie is also known as 'Endotracheal tube introducer' or 'Intubation Catheter'.
- The bougie is a straight, semi-rigid stylet-like device with a bent tip that can be used when intubation is (or is predicted to be) difficult **(Fig. 9. 32)**.
- It is important to have "the epiglottis only view" during laryngoscopy in the first attempt for using a bougie.
- As an aid to in difficult intubation, Bougie is considered superior to a 'Stylet' especially with limited mouth opening, anteriorly placed glottis.
- During laryngoscopy, the bougie is carefully advanced into the larynx and through the vocal cords until the tip enters a main bronchus.

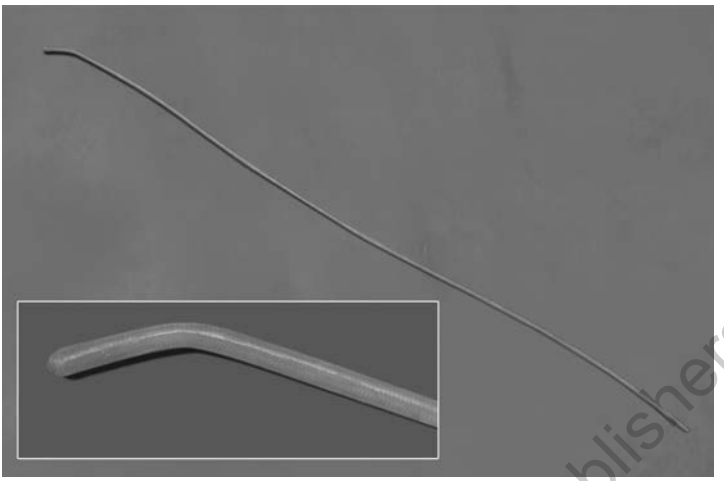


**Fig. 9.32:** Bougie used for aiding difficult intubation

- While maintaining the laryngoscope and bougie in position, an assistant threads an ETT over the end of the bougie, into the larynx. Once the ETT is in place, the bougie is removed.

*Other Uses*

- For exchanging ETT. Insert a Bougie through the existing tube. The existing tube is then removed and a new tube is inserted over the bougie.
- It can be used to direct an LMA or for changing an existing LMA.

## Magill's Intubating Forceps

- It was introduced by Sir Ivan Magill in 1920.
- The instrument is to guide the tip of endotracheal tube to be introduced into the glottis particularly in nasotracheal intubation.
- Specially designed handle makes it possible to use it without obstructing the view of the operator **(Fig. 9.33)**.
- This instrument is essential for nasotracheal intubation.
- Three sizes are available; small, medium and large.
- Small size for children and medium for normal adults. The large size is for large adults with long neck.
- It has a uniquely designed tip that can hold the tip of endotracheal tube firmly for introducing into the trachea even in the presence of slippery secretions.
- This can be used for packing the throat around the endotracheal tube for preventing aspiration of blood during oral surgery and occasionally for removing a foreign body in oral cavity.

## Artificial Airways

Artificial airway is a device that aims to maintain oral or nasal air passages patent. It is to be remembered that the term *'Artificial airway'* includes:

- *Simple supraglottic airway:* Oropharyngeal airway, nasopharyngeal airway
- *Augmented supraglottic airaway:* Laryngeal mask airway
- *Infraglottic airway:* Endotracheal tube, tracheostomy tube

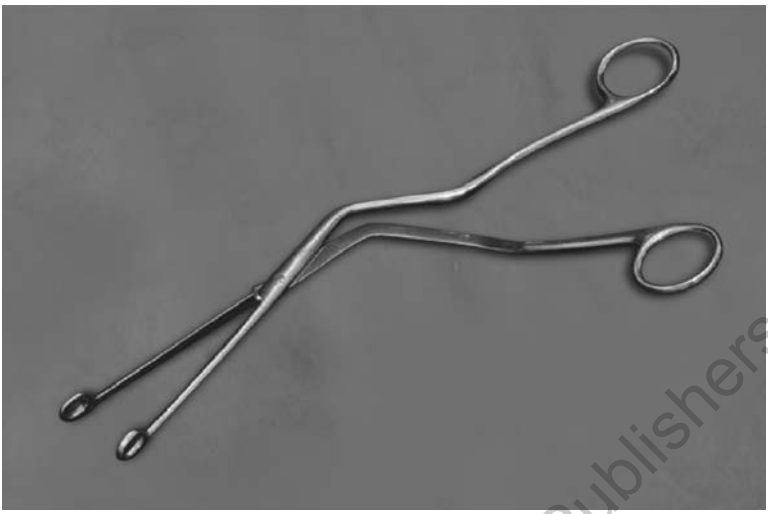


**Fig. 9.33:** Magill's intubating forceps

Conventionally the term *'Airway'* is used to mention about oropharyngeal airways and nasopharyngeal airways.

These are devices that could be used to maintain the patency of the patient's air passage when there is a need.

## Airway Obstruction

- In an unconscious patient the muscles that support the mandible are relaxed.
- The *mandible sags behind and the base of the tongue and epiglottis fall backwards and press on the posterior pharyngeal wall causing airway obstruction* **(Fig. 9.34A)**
- The maneuver of lifting the mandible (Jaw thrust), extending the head and supporting the chin is shown in Figure 9.34B
- At this point, an artificial airway when properly placed displaces the base of the tongue and epiglottis from the posterior pharyngeal wall. The lumen of the device maintains a patent airway.

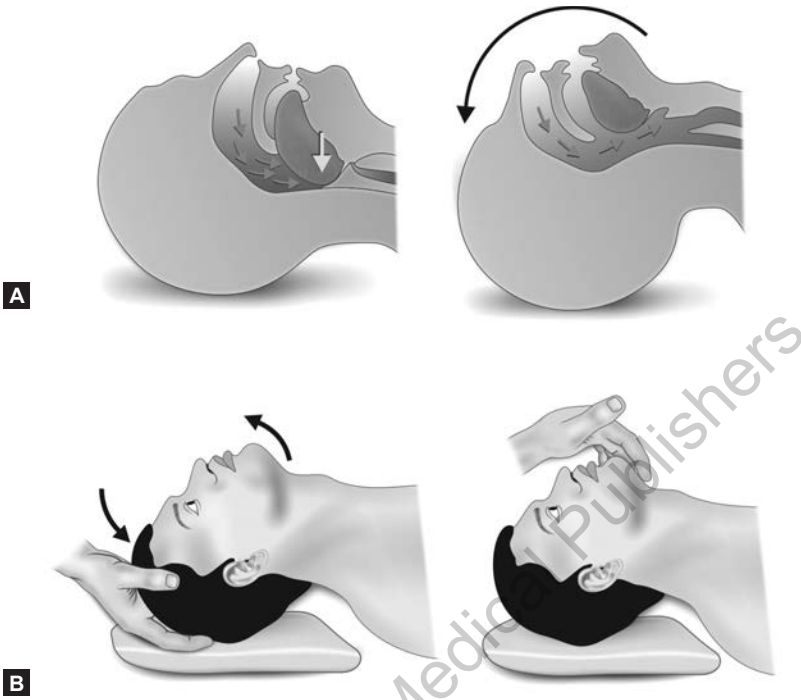
## Types of Airways

There are two types of airways:

1. Oropharyngeal airways.
2. Nasopharyngeal airways.

## Oropharyngeal Airways

- These are designed in a shape that fits well in the contour of mouth and pharynx.
- It extends from lips to pharynx fitting in the oropharynx between tongue and posterior pharyngeal wall.
- Introducing this airway will keep the tongue away from posterior pharyngeal wall.
- The lumen in the airway is so good that the patency is well-maintained without much resistance.




**Figs 9.34A and B:** (A) Mechanism of airway obstruction in an unconscious patient. • Falling back of tongue causes airway obstruction. • 'Jaw thrust' and extension of the head relieves the obstruction. (B) The maneuver of Jaw thrust, extension of head and supporting the jaw.



- When the patient is unconscious and pharyngeal reflexes are absent, these airways can be tolerated well to maintain a good patency.
- If the patient is conscious, has pharyngeal reflexes, this may induce gagging and vomiting and cannot be tolerated by the patient.
- There are different types of oropharyngeal airways **(***See* **Fig. 9.35A to D)**.

They are:

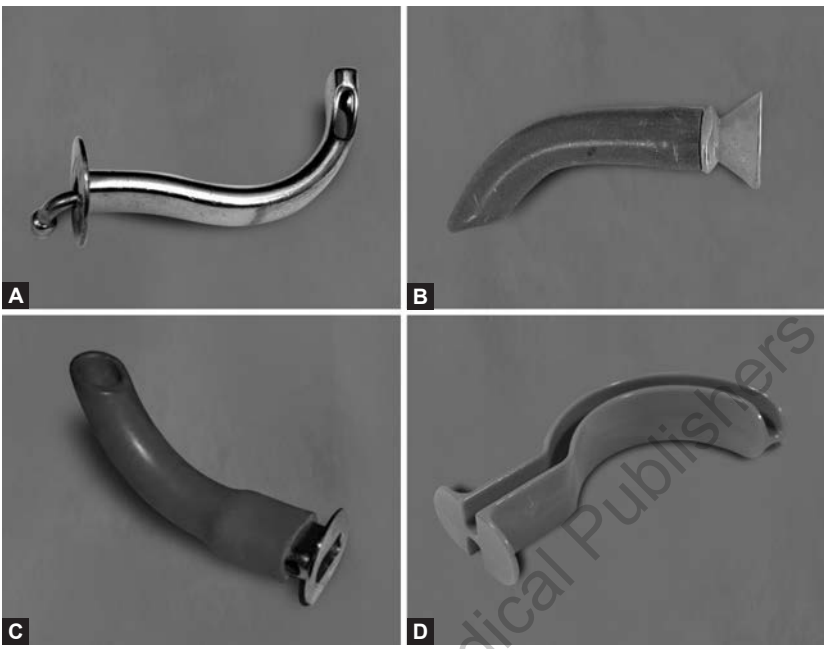
- *Water's airway*: 1930 (Metal airway)—Ralph M Waters (1883–1980)
- *Guedel's airway*: 1933—Arthur Ernest Guedel (1883–1956)
- *Phillips airway*: 1920
- *Hewitt's airway*: Sir Frederic William Hewitt (1856–1916)
- *Berman's airway*: Dr Robert A Berman (1914–1999).

Among these, Guedel's airway and Berman's airway are in common use. Parts of the oropharyngeal airway are; *Flange, Bite block* and *Body* **(Fig. 9.36)**.

*Flange*: It is at the proximal end that prevents the airway slipping deep into hypopharynx.

*Bite block*: This is the short straight portion of the airway that lies between the incisor teeth. This part is reinforced with a metal insert (sleeve) or hard plastic to prevent the lumen getting blocked if patient bites the airway.

*Body*: This is the curved portion of the airway that lies in the oropharynx behind the tongue to reach just above the glottis. Usually, it corresponds to the anatomical curvature of the tongue and palate.




**Figs 9.35A to D:** Different oral airways; Water's, Hewitt's, Phillips and Berman's


**Fig. 9.36:** Parts of an airway shown in Guedel's airway



## Guedel's Airway

- The most commonly used airway more anatomically shaped, body more deeply curved to accommodate the bulge of the base of tongue **(Fig. 9.36)**.
- Less traumatic introduce
- The flange and the bite black are the same as Water's airway
- Be sure not to push the 'airway' forcefully over the tongue. This may push and move the tongue backward and cause airway obstruction rather than clearing airway obstruction.

- An anatomically curved pharyngeal section and an oval flange at the proximal end prevent over insertion.
- The flattened cross-section made it easy to insert the airway between partially clenched teeth, sometimes an important feature during inhalational anesthesia induction in those times.
- Now Guedel's airways are available in silicon rubber and plastic also **(Fig. 9.37A)**.
- The bite block is reinforced with hard plastic which is color coded.
- This prevents the airway-collapsing if the patient bites it.
- The flange prevents the airway slipping into the mouth.
- Available in sizes from 000,00,0,1, 2, 3, 4. Size 000 being the smallest for a neonate.

## Types of Guedel's Airway Available

- Black rubber (natural rubber) airway reusable.
- Silicon rubber transparent airway with different color bite blocks to identify the size. It can be sterilized by autoclaving.
- Plastic airways with different color bite blocks to identify the size (disposable).

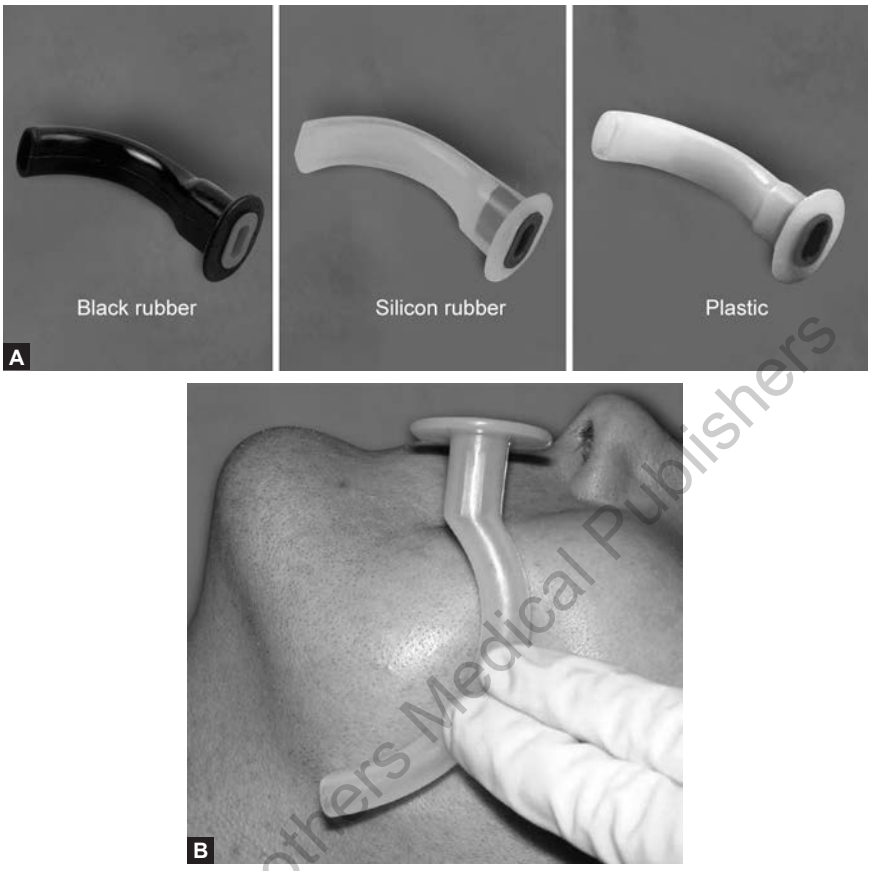
## Technique of Introduction

- When the tongue falls back against the posterior pharynx in anesthetized or unconscious patients obstructing the flow of air, it is inserted over the tongue that creates an air passage between the mouth and the posterior pharyngeal wall.
- The correct size of the airway must be used otherwise it may be blocked.
- The size of the airway to be used is assessed by keeping it on the side of the face. *It must extend from the lips to the angle of mandible* **(Fig. 9.37B)**.
- The preferred technique is to use a tongue blade to depress the tongue and then insert the airway posterior to the blade.
- A laryngoscope blade also can be used.
- An alternate technique is to insert the oral airway upside down until the soft palate is reached.
- Then the device is rotated 180° and allowed to slip over the tongue **(Figs 9.38A and B)**.
- Be sure not to use the airway to push the tongue backward and block, rather than clear, the airway.

## Sizes of Airways

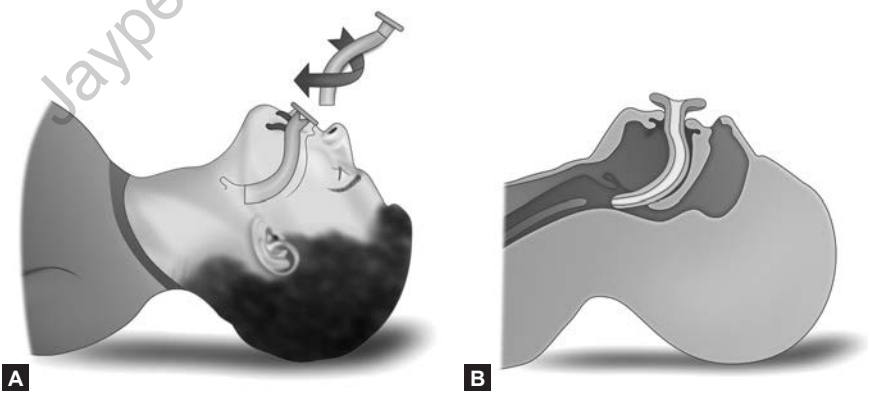
As per American National Standards' specifications 8 sizes of airway are available.

| *Size* | *Color* | *Length* |
|---|---|---|
| 000 | Violet | 3.5 cm |
| 00 | Blue | 4.5 cm |
| 0 | Black | 5.5 cm |
| 1 | White | 6.5 cm |
| 2 | Green | 7.5 cm |
| 3 | Orange | 8.5 cm |
| 4 | Red | 9.5 cm |
| 5 | Yellow | 10.5 cm |




**Figs 9.37A and B:** (A) Guedel's oropharyngeal airways; (B) The method of assessing the correct size for a patient






**Figs 9.38A and B:** The correct technique of inserting the airway (A) It is passed with the tip facing upwards and then gently rotated 180° to make it occupy the normal curvature of tongue. (B) Properly positioned airway maintains the patency

## Water's Airway

- Dr Ralph Milton Waters (1883–1980) introduced this *metal oral airway* in 1930.
- It has three parts, *flange*, *bite piece* and *body*.
- It has a side port or "nipple" to which a tube can be attached to deliver air or oxygen. Its metal construction prevents patients accidentally biting on the airway and blocking the patency of the airway **(Fig. 9.35A)**.
- This airway has flattened cross section and opens at the tip.
- Near the tip there are three alternate pathways for air. Two on either side or one on the posterior aspect. If the tip gets blocked, air will pass through the alternate passages.
- However, metal airways including the Water's airway are prone to cause cut or bruises of lips and dental damage.
- It can be sterilized by autoclaving.
- Three years later, his friend and fellow-inventor, Dr Arthur Guedel, introduced an airway of similar shape but made of rubber with a metal insert at the level of the teeth.

## Hewitt's Airway

- A straight and relatively short beveled rubber oropharyngeal airway with a metal mouthpiece **(Fig. 9.35B).**
- The body is made of red rubber tube with distal curved portion and bevel.
- This is not very anatomically designed airway.
- The metal mouth piece (bite block) has a grove that fits in-between the incisor teeth has a round opening that facilitates suctioning.
- The lumen is round throughout and provides wider airway.
- May stimulate posterior pharyngeal wall and induce vomiting.
- Widest air channel and relatively straight tube which facilitates easy suctioning.
- This airway device was the forerunner of many oropharyngeal airway designs.
- Not commonly used.

## Phillips Airway

- The Phillips airway was developed by George Ramsay Phillips. There is no known original description of the airway and the earliest known reference to it is from 1919.
- The airway with its modifications is known now.
- It is a red rubber oropharyngeal airway with a shaped pharyngeal curve section and a metal mouthpiece.
- Bite piece and flange are made of metal. Bite piece has holes on either side which accommodates an oxygen catheter **(Fig. 9.35C)**.
- Less anatomically shaped.
- Further modification of this by *Hirsch* has an additional side feed tube on the metal mouthpiece.

## Berman's Airway

- The design of this 'dual-channel' airway was one of Dr Robert A Berman's (1914–1999) earliest innovations.
- The open channel on each side, with a central support, was very different from previous oral airways, which had central tubes **(Fig. 9.35D)**.

- Oral airways with a central tube may contain mucous or other matter that is not easily visible.
- Dr Berman viewed this as a safety concern and designed this airway to prevent unseen occlusion.
- The shape is similar to that of Guedel's airway and fits well in the anatomical space.
- Advantage is airway block by secretions is less and it is easy to clean it.

## Nasopharyngeal Airways

- A nasopharyngeal airway is a soft tube designed to be inserted into the nasal passage to secure an open airway.
- Made of mineralized red rubber, silicon rubber or plastic. Various sizes are available.
- When the patient is not tolerating an oral airway, nasopharyngeal airway can be used and is tolerated.
- This airway helps in maintaining the patency of airway in a semiconscious or conscious patient with *active oropharyngeal reflexes* where an oral airway will not be tolerated.
- It is introduced through the *widest patent nostril* and when the tip is just near the glottis opening, it is fixed in that position by *the adjustable flange*.
- If an adjustable flange is not provided it can be fixed by passing a safety pin across the tube that prevents the tube moving further into the nose.
- Position is confirmed by listening to the breath sound through proximal end of airway.
- It extends from nose to pharynx; the pharyngeal end must be below the base of tongue but above epiglottis **(Figs 9.40C and D)**
- The size noted is the inner diameter of the tube.
- The size required for a particular patient is the same size of a nasal tracheal tube; 0.5 to 1 mm smaller than oral tube.

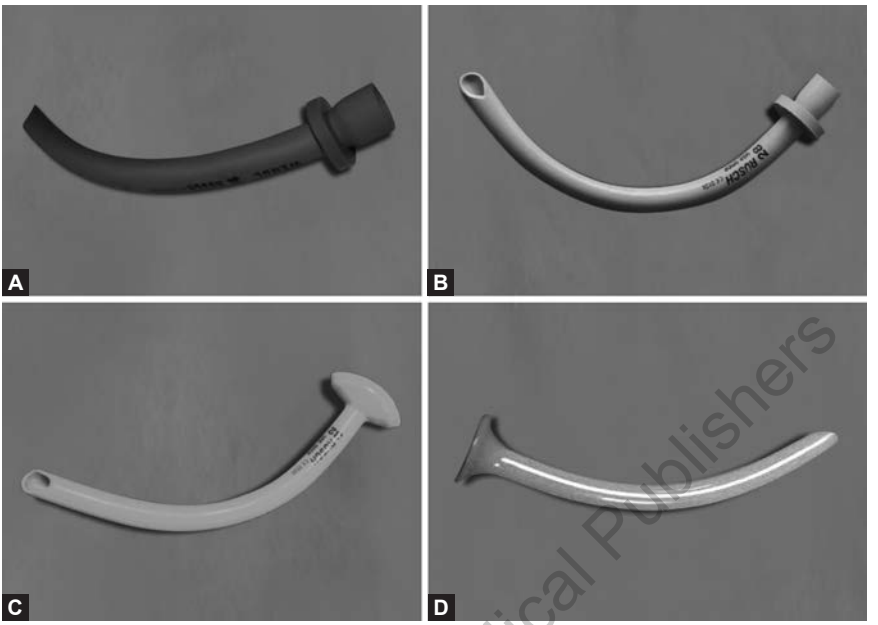
Two types of nasopharyngeal airways are available.

## Airway with an Adjustable Flange

- The adjustable flange is to keep it in position without slipping in or out.
- After passing the tube to the suitable distance, the flange is adjusted to maintain that position.
- Red rubber nasopharyngeal airway with adjustable flange. It is reusable **(Fig. 9.39A)**.
- Silicon rubber nasopharyngeal airway with adjustable flange.
- It causes less irritation to nasal mucosa.
- It is available in different colors. It can be autoclaved **(Fig. 9.39B)**

## Airway with a Widely Flared End

- This is also known as a 'nasal trumpet' because of its flared end and shape.
- Silicon rubber nasopharyngeal airway with a flared end.
- The flared end prevents the airway slipping into the nose **(Fig. 9.39C)**.




**Figs 9.39A to D:** Different types of nasopharyngeal airways. (A) Red rubber airway with adjustable flange; (B) Silicon rubber airway with adjustable flange; (C) Silicon rubber airway with flared end; (D) PVC airway with flared end

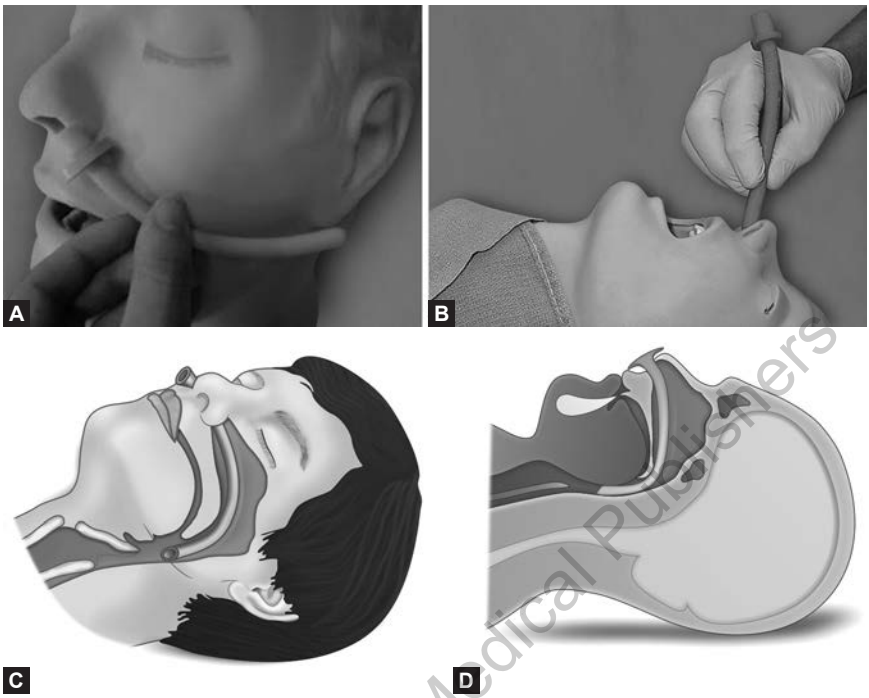
- A safety pin is used instead of flange to fix the airway in position (passed across the airway)
- It can be autoclaved.
- PVC nasopharyngeal airway with flared end is disposable **(Fig. 9.39D)**.

Choosing the size and inserting the airway:

- The correct size (length) airway is chosen by measuring the device on the patient.
- The device should reach from the patient's nostril to the earlobe or the angle of the jaw is usually 2–4 cm longer than the oral airway **(Fig. 9.40A)**.

## Insertion

- Use a nostril that is unobstructed. The widest nasal cavity is identified by feeling the air throw from individual nostril.
- The outside of the tube is lubricated thoroughly with a water-based lubricant jelly along its entire length so that it enters the nose more easily.
- The airway is advanced at an angle perpendicular to the face with the bevel facing the septum **(Fig. 9.40B)**
- The airway is advanced carefully listening to the breath sound and when it is maximally heard, the airway is fixed with the adjustable flange.
- For airways with flared end, a big safety pin is passed through the tube at the appropriate level to fix the tube from slipping into the nose.
- *Remember*: The floor of the nose is the roof of the mouth, and it is the widest portion of nasal cavity.




**Figs 9.40A to D:** Assessing the size and insertion of an nasopharyngeal airway. (A) The size that extends from the nose to the ear lobe is correct; (B) Inserted perpendicular to the face near the floor of the nose and gently advanced posteriorly; (C) The position of the tip is just proximal to epiglottis; (D) The position of the tip just beyond the base of tongue and above epiglottis



*Complications*

- Epistaxis
- Ulceration and necrosis of nasal mucosa
- Laryngospasm and cough if epiglottis is irritated
- Aspiration or swallowing of part or entire airway
- Latex allergy a rubber airway is used.

## London Hospital Mouth Prop

- Though it is not in use now, it has historical importance and was a very useful device during the ether era.
- It is made of aluminum metal and has the shape of a bobbin with one end wider and the other end narrower.
- Assorted sizes linked with a chain to a ring **(Fig. 9.41)**.
- Appropriate size is chosen and passed over the endotracheal tube and kept at the level of incisor teeth. In light plane of anesthesia if the patient clinches the teeth this protects the tube from getting blocked.
- This can be used as a mouth prop in unconscious patient which maintains the patency of airway as well as facilitates suctioning through the wide funnel shaped proximal portion.

**Fig. 9.41:** London hospital mouth props



## Special Airways Used in CPR

Using an oropharyngeal airway is aesthetically not ideal for mouth-to-mouth ventilation. Hence special airways were developed for the purpose of resuscitation that are more hygienically and esthetically acceptable.

## Expired Air Ventilation

Expired air ventilation could be done in the following methods:

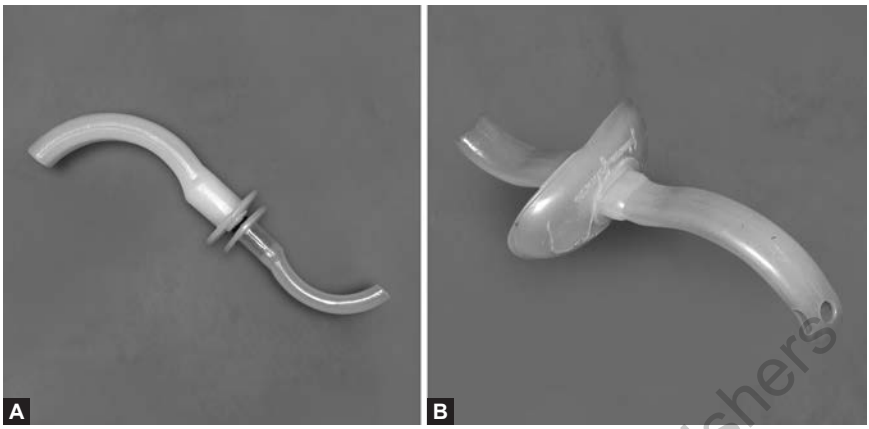
- Mouth-to-mouth
- Mouth to nose
- Mouth to airway—using
  - Guedel's airway
  - Resusci airway
  - Safar's airway
  - Brook's airway
  - Mouth to rescue mask.

## Resusci Airway

- Simply fixing two Guedel's airways at their flanges with their curvatures facing opposite direction **(Fig. 9.42A)**.
- One is small child size and the other is adult size.
- Used for expired air ventilation during cardiopulmonary resuscitation.

## Safar's Airway (Designed by Peter Safar)

- In 1957, *Peter Safar* (Baltimore, Maryland, USA) designed this oropharyngeal airway for mouth-to-mouth ventilation and popularized this device for resuscitation **(Fig. 9.42B)**
- It is a combination of two Guedel's airways fixed together at the flanges, but in the reverse direction, so that it forms an 'S' shaped double airway.




**Figs 9.42A and B:** (A) Resuci airway; (B) Safar's airway

- One airway is small size for children. The other one large for the adults, which can be used according to the necessity.
- This has a *reversible lip guard* which covers the lip and prevents the leak of air when mouth to airway resuscitation is done.

## Brook's Airway

- It is similar to Safar's airway with lip guard.
- But, it has only one airway with a corrugated flexible neck connected to a mouthpiece through which the resuscitator blows into the patient's lung.
- In between the mouthpiece and corrugated tube there is a *unidirectional valve* which diverts the exhaled gases from the victim to the atmosphere without bouncing on the rescuer's face **(Fig. 9.43)**.
- More aesthetically designed and hygienic to use.



**Fig. 9.43:** Brook's airway

## FURTHER READING

1. Dorsch JA, Dorsch SE. Understanding Anaesthesia Equipment, 5th edn. London: Lippincott Williams and Wilkins, 2008.
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