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2nd Edition



Airway Management

Geetanjali S Verma

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CHAPTER 4

Instruments

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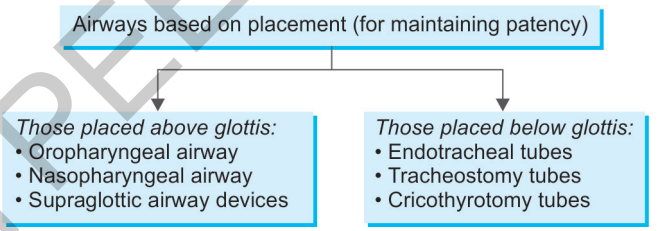
AIRWAY EQUIPMENT

Airway management is as old as medicine itself. The first references to airway treatment come from ancient Egypt, more than 3,500 years before Christ, with the description of a tracheostomy. Since then, the discipline has undergone a profound evolution, making available multiple devices and a considerable amount of knowledge based on the research and derived scientific evidence. The development of airway management techniques and devices has been influenced by the progress of medical knowledge and technological advancements. A wide range of airway devices and techniques have been created over the past century to enhance the safety of airway management. Thus, there are various advancements, beginning with the advent of the laryngoscopy in the 1940s, followed by fiberoptic laryngoscopy in the 1960s, the introduction of supraglottic airway devices in the 1980s, and, lastly, the emergence of modern video laryngoscopy in the 2000s.



Aids for assisting intubation include laryngoscope, bougie, introducers, and stylets.

OROPHARYNGEAL AIRWAY (FIG. 1)

Oropharyngeal airway (OPA) is a simple device used in maintaining patency of upper airway. Frederick Hewitt first used a metal tube through the mouth into hypopharynx. Guedel curved rubber airway was later described in 1935.

The Guedel airway is the most commonly used airway. It is either made of plastic or rubber. The central lumen may be used for suctioning.

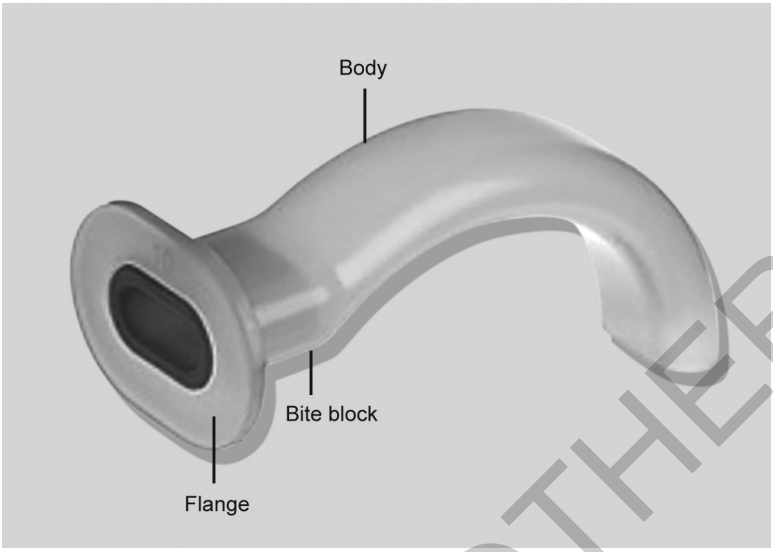


Fig. 1: Oropharyngeal airway (OPA).

The central lumen is reinforced by a harder inner plastic tube at the level of the teeth and by plastic ridges along the pharyngeal section. Oral and pharyngeal mucosae cannot occlude or narrow the lumen from the side. Its oval cross-section allows the four central incisors to make contact with it during masseter spasm. There is a flange at buccal end to prevent swallowing or over insertion.

The oropharyngeal airway (OPA) works by keeping the tongue anterior and thus prevents the tongue from falling back and obstructing the airway. The patient's pharyngeal and laryngeal reflexes should be depressed before insertion to avoid worsening obstruction due to airway reactivity.

The *Ovassapian airway* **(Fig. 2)** has a large anterior flange to control the tongue. There is a large opening at the level of the teeth to allow a flexible fiberoptic bronchoscope and endotracheal tube (ETT) to be passed through it and later disengaged from the airway. It is often employed during fiberoptic intubation to aid in maintaining upper airway patency.

Sizing: Determined by measuring the distance between first incisor and angle of mandible.

Insertion: Ensure no foreign bodies in the mouth. Lubricate the oropharyngeal airway. Usually green used in adult females, orange/yellow in adult males and red in large adults **(Fig. 3)**.

There are two ways of inserting OPA:

1. Using a tongue blade. The mouth is opened, and a tongue blade is placed at the base of the tongue and drawn upward, lifting the tongue off

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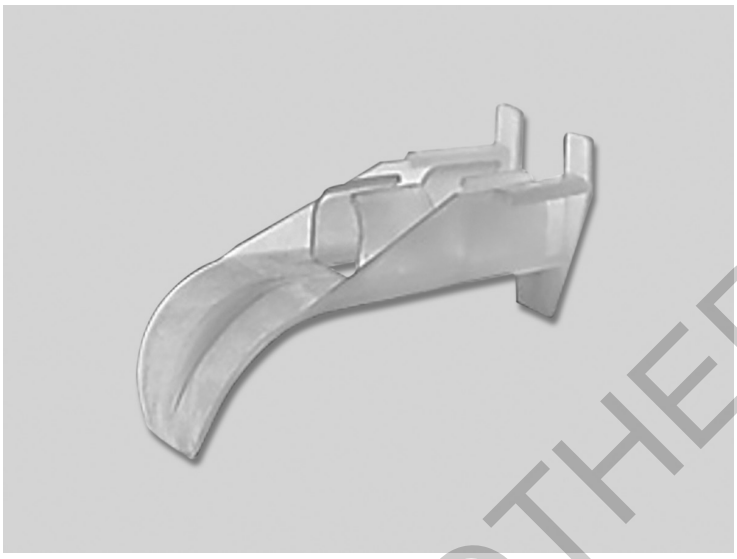

Fig. 2: Ovassapian airway.

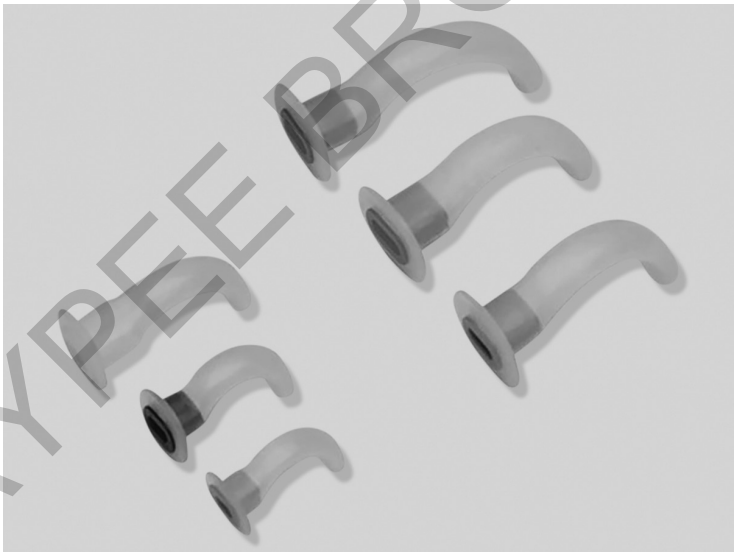

Fig 3: Oropharyngeal airways of different sizes. *(For color version, see Plate 1)*

of the posterior pharyngeal wall. The airway is then placed so that the OPA is just off the posterior wall of the oropharynx, with 1–2 cm protruding above the incisors. The mouth is inspected to ensure that neither the tongue nor the lips are caught between the teeth and the OPA.

2. Mouth is opened and the OPA is inserted with convex side toward the tongue until the tip is close to the pharyngeal wall of the oropharynx.

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It is then rotated 180° so that the tip rotates and settles behind the tongue base. There is a chance of dental trauma while insertion.

Complications: Even though the device is simple to use, it can cause complications such as trauma, airway reactivity (coughing, retching, emesis, laryngospasm, and bronchospasm), and obstruction. These responses are triggered by stimulating the epiglottis or the vocal cords. Management includes partially withdrawing the OPA, deepening the plane of anesthesia, mild positive airway pressure and a small dose of succinylcholine can be tried.

NASOPHARYNGEAL AIRWAY (FIG. 4)

Nasopharyngeal airway (NPA) is an alternative airway device for treating soft tissue upper airway obstruction. It is less stimulating compared to an OPA and therefore better tolerated in the awake, semicomatose patient or in light plane of anesthesia, preferential in oropharyngeal trauma. NPAs are pliable, bent cylinders made of soft plastic or rubber in variable lengths and widths. It has a flange which helps in controlling the depth of insertion by preventing the outer end crossing the nares. NPAs have beveled end which helps in easy insertion and minimizes mucosal trauma.

Insertion: Inspect the nares to determine their size and patency and look for presence of nasal polyps or marked septal deviation. Vasoconstriction of the mucous membranes can be accomplished with cocaine (which has the added benefit of providing topical anesthesia) or phenylephrine drops

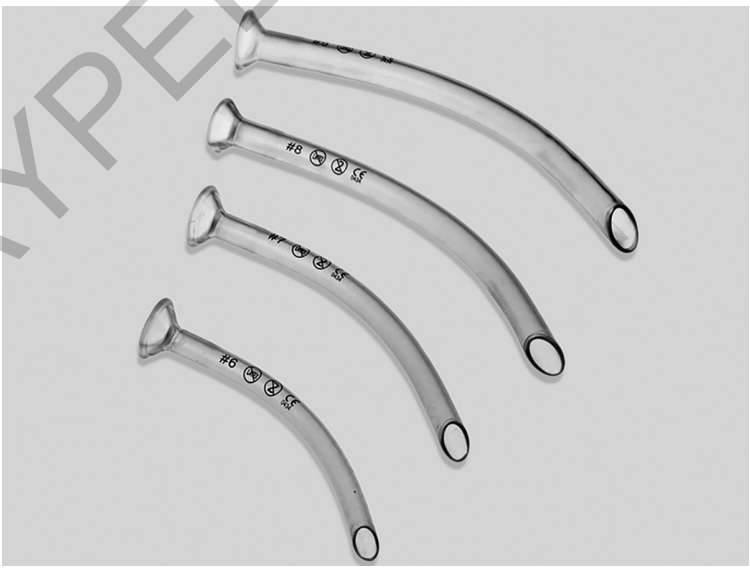

Fig. 4: Nasopharyngeal airway.

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or spray or cotton swabs soaked in either of these solutions. The NPA should be lubricated using water-soluble lubricant. Then pass the NPA with concave side parallel to the hard palate. Resistance is encountered at the nasopharynx. When there is resistance to passage, try and rotate the NPA 90° counterclockwise, bringing the open part of the bevel against the posterior nasopharyngeal mucosa. As the tube makes the bend (indicated by a relative loss of resistance to advancement), it should be rotated back to its original orientation.

If there is trouble passing NPA with moderate pressure, try a narrower tube, redilate the naris or try the other naris. If the tube does not pass into the oropharynx, then withdraw the tube 2 cm and then pass a suction catheter through the nasal airway as a guide for advancement of the NPA. Try and avoid stimulating epiglottis or vocal cords. If the patient's upper airway is still obstructed after insertion, then pass a small suction catheter to confirm the patency of the NPA. If patency of the NPA is confirmed, it is possible that the NPA is too short and the base of the tongue is occluding its tip. In this case, a 6.0 ETT can be cut at 18 cm to provide a longer airway.

Indications: Relief of upper airway obstruction in awake, semicomatose, or lightly anesthetized patients; in patients who are not adequately treated with OPAs; in patients undergoing dental procedures or with oropharyngeal trauma; and in patients requiring oropharyngeal or laryngopharyngeal suctioning.

Contraindications: Known nasal airway occlusion, nasal fractures, marked septal deviation, coagulopathy (risk of epistaxis), prior transsphenoidal hypophysectomy or Caldwell-Luc procedure, cerebrospinal fluid rhinorrhea, known or suspected basilar skull fractures, and adenoid hypertrophy.

Complications: Failure of successful placement, epistaxis due to mucosal tears or avulsion of the turbinates, submucosal tunneling, and pressure sores.

Epistaxis is the most common complication. Anterior plexus bleeding can be treated by applying pressure to the nares. If the posterior plexus is bleeding (with blood pooling into the pharynx), leave the NPA in place, suction the pharynx, and consider intubating the trachea if the bleeding does not stop promptly. The patient may be positioned on his or her side to minimize the aspiration of blood.

SUPRAGLOTTIC AIRWAY DEVICES (SADs/SGAs)

Laryngeal mask airway (LMA) was introduced by Archie Brain and brought into clinical practice in 1988. In the first paper on the LMA he described it as "*an alternative to either the endotracheal tube (ETT) or the face-mask with either spontaneous or positive-pressure ventilation (PPV)*". Brain modified Goldman dental nose piece to become cuff and it was glued with diagonally

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cut ETT. Over the years of research and experience it was realized that no single LMA can fulfill all requirements. This led to developing various types of LMAs.

FIRST-GENERATION SUPRAGLOTTIC AIRWAY DEVICES

These are supraglottic airway devices (SADs) which fit the description "simple airway device". They include the classic laryngeal mask airway (cLMA), flexible LMA, and all LMs. In addition, they include the laryngeal tube (LT) and cobra perilaryngeal airway. They may or may not protect against aspiration in the event of regurgitation, but have no specific design features that lessen this risk.

SECOND-GENERATION SUPRAGLOTTIC AIRWAY DEVICES

The SADs have been designed for safety and have design features to reduce the risk of aspiration. These include: PLMA and I-gel.

CLASSIC LARYNGEAL MASK AIRWAY (FIG. 5)

It was the simple device first introduced. It was extensively studied and compared with tracheal tubes and mask ventilation. Brimacombe published a meta-analysis in 1995 which highlighted advantages of cLMA over ventilation using tracheal tubes and mask.

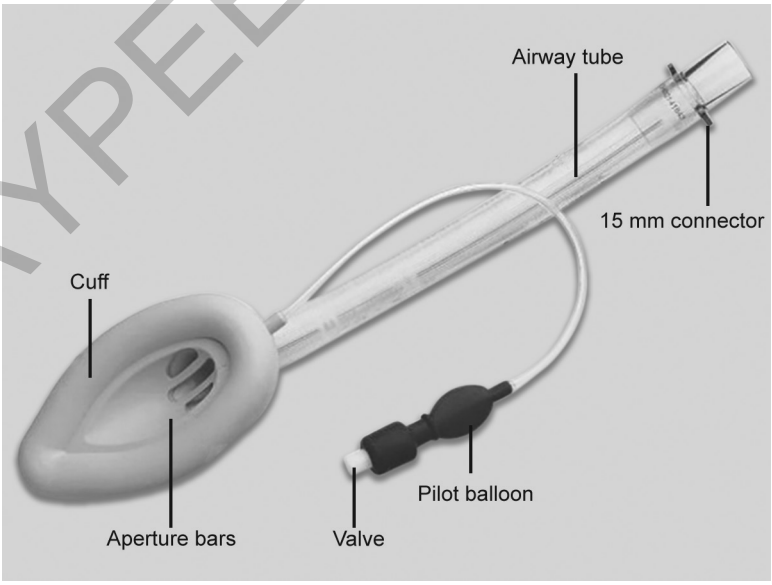

Fig. 5: Classic laryngeal mask airway (LMA).

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Advantages of Classic Laryngeal Mask Airway

- Lesser hemodynamic and intraocular changes with placement and removal of LMA compared to intubation and extubation. There was significant difference in coughing, bucking while awakening the patient.
- Classic laryngeal mask airway was better in preserving mucociliary function, laryngeal competence, and also has the advantage of minimal laryngeal trauma.
- No need for muscle paralysis or laryngoscopy during placement.
- Speed and ease of insertion in inexperienced hands is increased.
- Easy to train. Thus, becomes an important tool during resuscitation in inexperienced hands.
- Better hemodynamic stability at induction and emergence.
- Seems to be tolerated well under lighter plane of anesthesia with lesser laryngospasm, bronchospasm, and sore throat.

Limitations of Classic Laryngeal Mask Airway

- Increased frequency of failed placements.
- Increased risk of gastric aspiration.
- Controlled ventilation is not always possible in view of moderate pharyngeal seal. The median seal pressure reached is around 20 cmH_2O. Occasionally it reaches 30 cmH_2O.
- Does not aid in tracheal intubation.

These limitations led to making of second-generation SADs which were concentrating mainly on improving controlled ventilation and preventing aspiration of gastric contents.

INSERTION TECHNIQUE

There are various insertion techniques described for insertion of cLMA. The LMA insertion originally described was to mimic deglutition. Initially deflate the cuff completely to make it appear like spoon. Lubricate the back of the cuff using water-soluble lubricant like KY jelly. Do not lubricate the front of the cuff as it may block the aperture bar and aspiration of lubricant. Avoid using silicone-based lubricants as they may damage the cuff.

Standard Insertion Technique

- Ensure adequate anesthesia.
- Position the head and neck as for normal intubation.
- During insertion the LMA to be held like a pen with the index finger placed anteriorly at the junction of the cuff and tube. Press the tip up against the hard palate and verify it lies flat against the palate and that the tip is not folded over.

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TABLE 1: Deciding size of laryngeal mask airway (LMA) for the patient *(please check on LMA as well)*.

Size of the LMA	*Patients weight (kg)*	*Maximum inflation volume (mL)*
1	Up to 5	4
1½	5–10	7
2	10–20	10
2½	20–30	14
3	30–50	20
4	50–70	30
5	70–100	40
6	>100	50

- By using the index finger, push the mask backward while maintaining pressure against the palate. As the mask progresses down, the index finger should keep the mask pressed against the posterior pharyngeal wall as to avoid collision with the epiglottis. Insert the index finger fully into the mouth to complete insertion. Keep moving down until resistance is felt. At this point index finger can be removed while the other hand is stabilizing the LMA. Avoid jerky movements during insertion.

Check that the black line on the tube is in midline. Inflate the cuff without holding the tube, allowing it to position itself correctly. Soon after this the device should be connected to fresh gas flow. Intracuff pressure should not exceed 60 cmH_2O under any circumstance. Overinflation of cuff can weaken the seal.

Thumb Insertion Technique

This technique is favored when the access to the head from behind is difficult or impossible. The steps and principle of insertion are almost same except for the fact that thumb is used instead of index finger. Toward the end the non-dominant hand helps in pushing the LMA to its final position.

The information on choosing appropriate size and maximum inflation volumes are highlighted in **Table 1**.

FLEXIBLE LARYNGEAL MASK AIRWAY (FIG. 6)

This LMA was introduced in 1994 mainly for head and neck procedures. Spiral coil was incorporated into shaft to make it kink resistant and more flexible. This helps with better surgical access mainly in head and neck procedure.

FASTRACH INTUBATING LARYNGEAL MASK AIRWAY (FIG. 7)

In 1983, while developing the LMA, Brain conducted a fiberoptic investigation that revealed the LMA's potential as a guide for endotracheal intubation.

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Fig. 6: Flexible laryngeal mask airway (LMA).

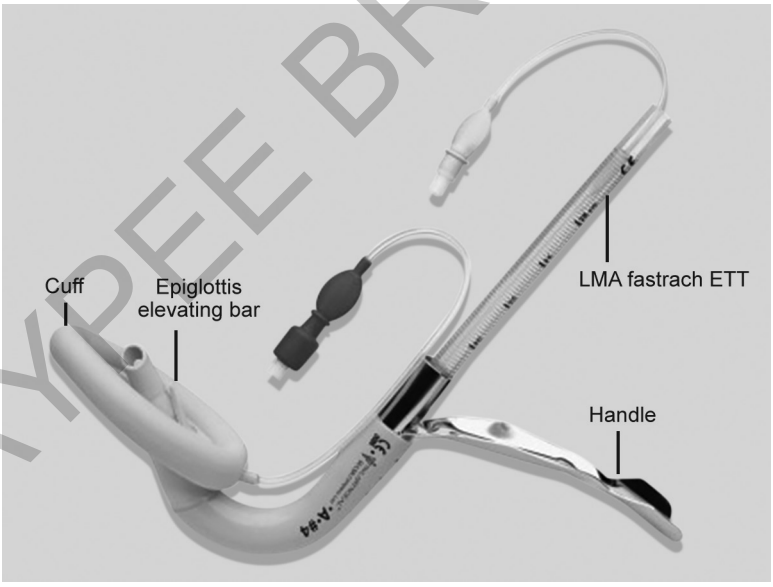

Fig. 7: Fastrach intubating laryngeal mask airway (LMA).

The same year, he blindly intubated three patients. However, the intubating LMA was introduced in 1994 after the cLMA gained popularity. There was demand among clinicians for a device which could serve to ventilate as well as act as a conduit for intubation.

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The intubating laryngeal mask airway (ILMA) consists of an anatomically curved, stainless steel tube with a 13-mm internal diameter that is connected firmly at its distal end to the laryngeal mask. The preformed angle was designed based on the data collected from sagittal magnetic resonance imaging (MRI) images with head in neutral position. The two bars at the aperture of the cLMA have been replaced in the ILMA by a single, movable epiglottic elevating bar that pushes the epiglottis out of the way and allows smooth and unobstructed passage of the ETT as it emerges from the distal end of the ILMA's metal shaft. It allows ETT up to 8.5 mm size. The shaft is also kept short so as to avoid need for longer tube.

Many researches were undertaken to improve the rate of blind intubation through the ILMA. However, Chandy's maneuver seems to be the only one which was more consistent. It involves two steps.

1. Rotate the ILMA in sagittal plane till least resistance to ventilation is achieved.
2. Lift the ILMA slightly (not tilt) from the posterior pharyngeal wall just before blind intubation.

Both maneuvers were done holding the handle. The overall success rates for blind and fiberoptic guided intubations were 97 and 100%, respectively.

PROSEAL LARYNGEAL MASK AIRWAY (FIG. 8)

Proseal is a second-generation SAD with a better seal pressure and a drain tube for draining gastric contents. It is a reuse device recommended for

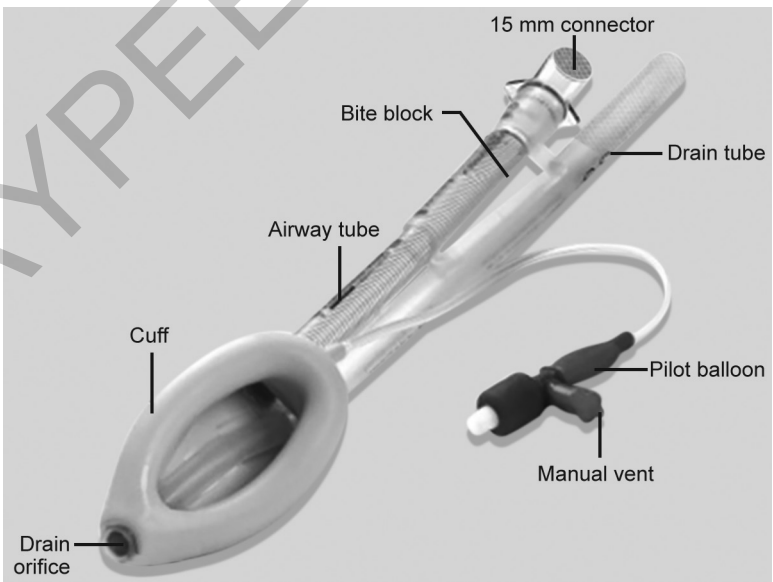

Fig. 8: Proseal laryngeal mask airway (LMA).

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about 40 uses. The main advantage over the cLMA is the fact it has double the seal pressure compared to cLMA at intracuff pressure of 60 cmH_2O. Drain tube does not only act as a conduit for draining the gastric contents but also allows passing of gastric tube through it.

Insertion Technique

The pre-insertion preparation and the principle behind insertion technique is somewhat similar to that of cLMA. The insertion can be successfully made either using the standard technique using index finger or by the thumb insertion technique. In addition to the abovementioned techniques, a technique using an introducer has been added. The principle of insertion using a dedicated introducer is same as that of the finger techniques. The introducer seems to better while using 1–2½ size LMA. However, at the bigger sizes, there is no significant difference between these three techniques.

Tips to Diagnose Correct Position of the Cuff

- Observe for the anterior displacement of cricoid while insertion and at inflation.
- The correct position will produce perfect seal by the cuff against the glottis with no leak (seal 1). The mask tip should be wedged against the upper esophageal sphincter (seal 2). And the bite block should be at position. The correct mask placement can be checked by placing a small bolus (1–2 mL) of lubricant gel in the proximal end of the drain tube. In a properly placed mask, there should be a slight up-down meniscus movement of the lubricant. No movement or the bolus of lubricant is ejected suggests incorrect placement.
- In case of incomplete insertion, the bite block will be more proximal, there will be leak on ventilation and a leak felt through the proximal end of drain tube (DT). The LMA must be repositioned.
- Sometimes, due to improper deflation of the cuff, the tip of the cuff enters the laryngeal vestibule. This leads to obstruction during ventilation (in spite of deep plane of anesthesia) and leak through the proximal end of DT. The LMA should be removed and reinserted.
- Another malposition is when the tip of the cuff folds back and obstructs the DT. The up-down meniscus movement of lubricating gel is absent. Confirmed by passing a gastric tube through the DT. If the gastric tube does not go past the distal tip, it suggests folding over of the tip. The LMA should be removed and reinserted.

The main advantage of proseal LMA is to prevent aspiration of gastric content. This advantage will be lost in case of malposition. So, it is important to make sure that the cuff is in right position and also that the drain tube is not obstructed.

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TABLE 2: Deciding size of proseal laryngeal mask airway (LMA).

Size of the LMA	*Patient weight (kg)*	*Maximum inflation volume (mL)*	*Maximum diameter of orogastric tube (Fr)*	*Introducer size*
1	Up to 5	4	8	1–2½
1½	5–10	7	10	1–2½
2	10–20	10	10	1–2½
2½	20–30	14	14	1–2½
3	30–50	20	16	3–5
4	50–70	30	16	3–5
5	70–100	40	18	3–5

Table 2 describes the maximum inflation volume, maximum diameter of orogastric tube and introducer sizes for various sizes of proseal LMA.

LARYNGEAL MASK AIRWAY SUPREME (FIG. 9)

This is a single-use LMA made by combining the useful features of ILMA and proseal laryngeal mask airway (PLMA) together. It is basically an LMA with ease of insertion requiring no finger to be inserted into the oral cavity, head need not be extended with better seal and drain tube for gastric contents.

Salient Features of Laryngeal Mask Airway Supreme

- It is a single-use LMA.
- The LMA supreme has a manifold with an integral bite block, an anatomically shaped airway tube enclosing a drain tube, a redesigned inflatable cuff (through which the drain tube passes), and a cuff inflation line with pilot balloon.
- There is a fixation tab that is molded at right angles to the manifold which helps in easy insertion and fixation after insertion.
- The airway tube is elliptical in shape aiding easy insertion. The airway tube is much stiffer than that of PLMA. However, it is intended to bend with head movement unlike the rigid metal tube of ILMA.
- It has a patented lateral groove on the airway tube which prevents it from kinking.
- The gastric drain tube serves to equalize the upper esophageal sphincter (UES) pressure with atmospheric pressure, drains the gastric contents and acts as a conduit to pass gastric tube.
- The modified shape and enlarged surface area of the inflatable cuff enhances the anatomic fit of the device into the pharynx, permitting higher glottic seal pressures than the LMA classic and LMA unique.

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This book is a definitive guide to airway management, designed for healthcare professionals at all levels of expertise. It combines foundational knowledge with cutting-edge practices, offering evidence-based approaches, practical tips, and real-world case studies. Whether you are a trainee, a practicing clinician, or an educator, this book provides the tools and insights needed to navigate airway challenges with confidence and precision. With its focus on the latest guidelines and practical applications, this book is an indispensable resource for anyone dedicated to mastering the art of airway management.



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