The laryngeal mask airway (LMA) was invented by Dr. Archie Brain at the London Hospital, Whitechapel, in 1981. Dr. Brain's main objective for the LMA was that it would provide a better method of maintaining a patient's airway than by face mask. Also, the LMA would be less hemodynamically stressful than with insertion of an endotracheal tube.

The LMA consists of a silicone rubber tube connected to a miniature silicone mask. The perimeter of the mask consists of an inflatable elliptical cuff which forms a tip at the distal aspect of the LMA. The aperture bars in the dome of the mask lift the epiglottis away, so the lumen remains unobstructive.

The LMA forms a low pressure seal around the larynx. The LMA is contraindicated in any situation where the patient is at risk for pulmonary aspiration. The LMA is not a substitute for a properly placed endotracheal tube in this situation.

The American Society of Anesthesiologists' difficult airway algorithm recommends the insertion of an LMA when ventilation and/or intubation are difficult. The distal aperture of the LMA is in close approximation to the vocal cords, so a 6.0-mm internal diameter endotracheal tube can be passed over an intubating stylet or a pediatric fiberoptic bronchoscope to secure a patient's airway.

Key words: Aspiration, difficult airway, laryngeal mask airway.

Case presentation
The patient was a 45-year-old female ASA physical status I scheduled to have a right brow lift under general endotracheal anesthesia. Assessment of her airway revealed a Mallampati class 1. All laboratory values were within normal limits with a hemoglobin of 13 g and a hematocrit of 49%.

Upon arrival in the operating room, all routine monitors were applied. These included ECG, blood pressure cuff, pulse oximeter, precordial stethoscope, peripheral nerve stimulator, FiO₂ monitor, and end-tidal CO₂ monitor. This 55-kg patient was preoxygenated with 100% FiO₂ for 5 minutes. Curare, 3 mg, was given intravenously (IV), and then sufentanil, 20 μg, was slowly titrated for 2 minutes. Next, propofol, 2 mg/kg, was titrated for a total of 110 mg until loss of eyelid response. The patient was easily ventilated by mask. Suxcholine, 1.5 mg/kg or 90 mg, was given IV.

After loss of twitch demonstrated by the peripheral nerve stimulator, intubation was attempted with a Macintosh #3 blade. At this time, a small epiglottis was seen with no view of the vocal cords. This was a grade III laryngoscopic visualization. The patient's head was repositioned, and
Intubation was attempted using a Miller #2 blade. The vocal cords were not visualized, but a 7.0-mm internal diameter endotracheal tube was inserted anteriorly to the epiglottis. The capnometer revealed no end-tidal CO₂, and breath sounds were absent bilaterally. The endotracheal tube was removed. The patient was easily ventilated with FiO₂ 100% and isoflurane 1.5%. Glycopyrolate .2 mg, propofol 60 mg, and suxchylcholine, 40 mg, were given IV.

At no time during attempts at intubation did the oxygen saturation drop below 97%. Vital signs remained stable during this time. An additional folded sheet was placed under the patient's head to facilitate optimal sniffing position for intubation. Cricoid pressure provided no benefit in our attempts to visualize the vocal cords with a Macintosh #3 or a Miller #2 blade.

Next, a laryngeal mask airway size 3 was prepared for insertion by slightly overinflating the cuff with the prescribed volume of 20 mL and an additional 5 mL. No cuff leak was detected. After aspiration of the cuff, deflation was maintained by the one-way valve of the pilot tube. The cuff of the laryngeal mask airway (LMA) was everted by pressing the cuff against a firm surface during aspiration of air. Lubricant was applied to the dorsal tip. The patient's airway was opened, and the LMA was easily inserted. The capnometer showed CO₂ with each ventilation. Breath sounds were clear and equal bilaterally.

The external surface of a 6.0-mm internal diameter endotracheal tube was lubricated and inserted over a pediatric 3-French gauge fiberoptic bronchoscope. The fiberoptic bronchoscope was inserted down the LMA, and the vocal cords were clearly visualized. While keeping the vocal cords in view with the fiberoptic scope, the endotracheal tube was passed over the fiberoptic scope and through the vocal cords. After inflating the endotracheal tube cuff, the LMA cuff was deflated. The LMA was left in place and surgery proceeded without incident. The patient was fully awake at the end of surgery. The LMA and the endotracheal tube were removed over the endotracheal tube changer. The endotracheal tube changer was removed as the patient maintained stable vital signs and an oxygen saturation of 97-99%.

### Laryngeal mask airway

The LMA was invented by Dr. Archie Brain at the London Hospital, Whitechapel, in 1981. Dr. Brain's purpose was to have a device that established a more secure airway than is provided when controlling the airway with a face mask. The LMA is an alternative to maintaining the airway with a mask or having to intubate the airway.¹²

The LMA consists of a silicone rubber tube connected to a miniature silicone mask. The elliptical spoon-shaped mask has an inflatable cuff around its perimeter, which forms a tip at the distal aspect of the mask. The cuff is inflated using a pilot balloon similar to that of an endotracheal tube. The cuff volume is determined by the size of the LMA (Table I). The lumen of the mask has two aperture bars which lift the epiglottis away (Figure 1). No latex is used in the construction of the LMA. When the LMA is properly inserted, the tip of the LMA cuff is at the base of the hypopharynx against the upper esophageal sphincter. The sides of the LMA lie in the pyriform fossae, and the upper border of the mask lies at the base of the tongue, pushing it forward.¹³

<table>
<thead>
<tr>
<th>Size</th>
<th>Patient's weight</th>
<th>Cuff volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Less than 6.5 kg</td>
<td>2-5</td>
</tr>
<tr>
<td>2</td>
<td>6.5 to 25 kg</td>
<td>7-10</td>
</tr>
<tr>
<td>3</td>
<td>25 to 70 kg</td>
<td>15-20</td>
</tr>
<tr>
<td>4</td>
<td>Greater than 70 kg</td>
<td>25-30</td>
</tr>
</tbody>
</table>

### Preparation and insertion of LMA

The LMA must first be checked for any leak by slightly overinflating the cuff with the prescribed volume and an additional 3-5 mL of air. Check the one-way valve of the pilot tube by deflating the cuff and verifying that deflation is main-
tained. Inspect the aperture bars of the mask for damage. The cuff is deflated while firmly pressing it against a hard surface to evert the cuff walls. Lubricate the dorsal tip, making sure the concave side is free of lubricant. This prevents any lubricant from dripping onto the vocal cords and causing laryngospasm during insertion.¹ ²

Propofol, 2.5 mg/kg, as the induction agent has been shown in previous studies to cause less gagging, coughing, and additional dosing than thiopental. Depth of anesthesia must be adequate for insertion of a laryngeal airway but not the anesthetic depth associated with laryngeal intubation.¹ Propofol, 2.5 mg/kg, blocks the gag reflex when inserting the LMA after loss of eyelid response. LMA insertion causes no direct laryngeal or tracheal stimulation, so the pressor response is of shorter duration compared to tracheal intubation.

During insertion of the LMA, it is held with the index finger at the junction of the tube and mask. The index finger and thumb are positioned similar to that of holding a pen or pencil. The patient’s neck is flexed and the head is extended (Figure 2). As you insert the LMA in the patient’s mouth, press the dorsal tip of the LMA against the hard palate (Figure 3). This enables the LMA to slide past the curvature of the pharynx. Inserting the LMA is one continuous motion until resistance is felt (Figure 4). This resistance signifies the LMA is positioned in the triangular base of the hypopharynx. Inflating the cuff with the prescribed volume of air (Table I) causes a slight retrograde movement of the LMA. After insertion, check for equal bilateral breath sounds and the presence of carbon dioxide on the end-tidal CO₂ monitor.

On proper insertion of the LMA, a longitudinal black line of the shaft of the LMA is facing the patient’s upper lip (Figure 5). Any deviation of this black line from being midline could indicate misplacement of the cuff and possible partial airway obstruction. The LMA is taped in place. A bite block is inserted to prevent biting and damage to the LMA on emergence.¹ ³ ⁵

**Advantages of the LMA**

Postoperative sore throat from the use of a LMA was found to average 6.8%. Similar data collected from patients who underwent tracheal intu-
The LMA is positioned in the triangular base of the hypopharynx. Properly placed, the distal aperture of the LMA is in front of the vocal cords.

Mechanical ventilation has been used with a gas leak occurring at 20 cm H₂O pressure. Higher airway pressure during mechanical ventilation could cause gastric distention and potential aspiration. The LMA is removed when the patient's protective airway mechanisms have recovered, and the patient can open his or her mouth on command.

**Contraindications and side effects of the LMA**

The LMA does not prevent pulmonary aspiration. Any patient with a history of gastroesophageal reflux, hiatal hernia, or any other condition that puts him or her at risk of aspiration or delayed gastric emptying such as obesity, pregnancy, and upper abdominal surgery, should avoid the routine use of an LMA. The LMA forms a low pressure seal around the larynx. The LMA should never be a substitute for a properly placed cuffed endotracheal tube, when a patient is at risk for regurgitation.

The risk of aspiration, when using the LMA, can be diminished by following these manufacturer's recommendations.

1. Test the cuff for defects before use.
2. Do not lubricate the anterior surface of the mask, because the lubricant can be aspirated.
3. Obtain adequate anesthetic depth before inserting the LMA.
4. Maintain an adequate anesthetic depth throughout the surgery.
5. Avoid any stimulation on emergence.
6. Deflate the cuff only when the patient is fully awake and opens his or her mouth on command.

When the LMA is properly inserted, aspiration of regurgitant fluid should not occur because the esophagus is not included in the bowl of the mask with the glottis. One study showed the glottis and the upper esophageal sphincter to be enclosed.
by the LMA in 6-9% of patients examined during fiberoptic bronchoscopy. In this situation, aspiration is a possibility.²

Other contraindications to the use of the LMA are:

1. Inability to open the mouth or extend the neck more than 1.5 cm, making insertion of the LMA difficult (e.g., ankylosing spondylitis, severe rheumatoid arthritis, cervical spine instability).
2. Low pulmonary compliance or conditions causing high airway resistance (morbid obesity, bronchospasm, pulmonary fibrosis, pulmonary edema, thoracic trauma).
3. Airway obstruction below or at the larynx.
4. Pharyngeal pathology (e.g., abscess, hematoma, tissue injury).
5. One-lung anesthesia.²

Recently, two cases of pulmonary edema due to upper airway obstruction were reported. It is not clear if the pulmonary edema was caused by the LMA, difficulty with insertion, or light anesthesia during insertion.¹²⁻¹⁵ Other problems occurring with insertion of the LMA include:

1. The tip of the LMA folding up on itself.
2. The epiglottis can become lodged in the aperture bars of the mask causing swelling and airway obstruction.
3. The epiglottis can fold on itself or the aryepiglottic folds can be forced inward causing airway obstruction.
4. Trauma to the uvula and posterior pharyngeal wall.
5. Increased cuff inflation due to prolonged use of nitrous oxide may cause airway obstruction.¹²

LMA in the management of a difficult airway

The American Society of Anesthesiologists Task Force algorithm for difficult airway management recommends insertion of an LMA when it is not possible to ventilate or intubate the trachea.¹⁶ In other case scenarios of difficult airway, the LMA has been inserted and used as a guide to pass a 6.0-mm internal diameter endotracheal tube over a pediatric fiberoptic bronchoscope (Figure 6).¹⁰⁻¹⁶

The author has had the experience of being unable to intubate a patient but was able to maintain the airway by mask. An intubating stylet was inserted through the LMA, followed by removal of the LMA, and insertion of the endotracheal tube over the tracheal tube introducer (Figure 7). Other studies have shown when a blind tracheal intubation is attempted through an LMA in a patient with normal anatomy, intubation was successful in 90% of patients.¹⁷,¹⁸ The overall failure rate for an intubating stylet is 12%, while intubating over a fiberoptic scope has a success rate of practically 100%.¹⁹ There have been numerous case reports documenting expected and unexpected difficult airways being secured with an LMA.

The LMA can provide an airway for a patient and then act as a guide to facilitate tracheal intubation by means of a fiberoptic scope or an intubating stylet. The LMA, used under the proper conditions, can be a valuable adjunct to anesthetic practice.

REFERENCES


AUTHOR

LCDR Jeffrey R. Jones, CRNA, BSN, BSN, USN, NC, is a staff nurse anesthetist at Medical Center, Oakland, California. He received his BSN degree from San Diego State University, San Diego, California. In 1989, he graduated from George Washington University with a bachelor of science in Nurse Anesthesia.

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