The Laryngeal Mask and Other Supraglottic Airways:

Application to Clinical Airway Management

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Introduction

For years the endotracheal tube (ETT) has served a pre-eminent role in airway management. Now, however, the laryngeal mask airway (LMA) and other forms of supraglottic airway are taking their place across the world in the repertoire of airway management techniques available to the clinician. These devices are especially popular in outpatient surgery, but have also proven to be life-saving in the management of airway crises.

The Laryngeal Mask Airway

At present, varieties of the LMA include seven sizes of the original (LMA-Classic), a single-use LMA (LMA-Unique) (also available in various sizes), a reinforced/flexible LMA (LMA-Flexible), an LMA specifically designed for tracheal intubation (LMA-Fastrach), the LMA-ProSeal, designed for applications where the patient is at increased risk of aspiration, and the LMA-CTrach, incorporating a display allowing one to see the glottic aperture.

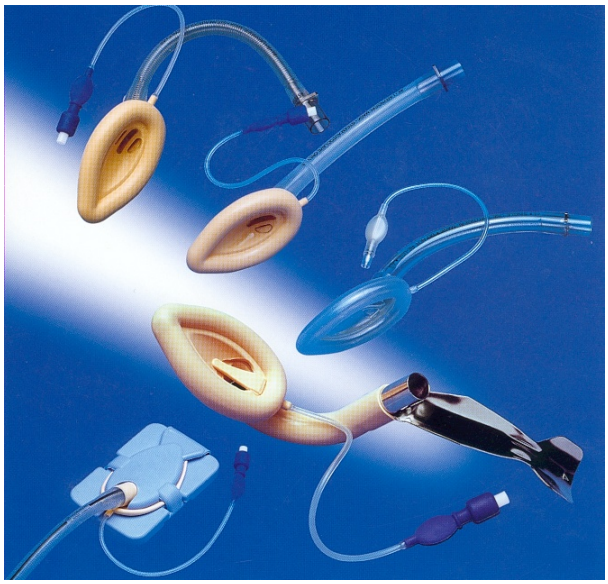


Figure 1. The laryngeal mask airway (LMA) comes in a variety of sizes and formats for use in a large variety of clinical situations.

While the standard LMA can usually be inserted by trial and error with relative ease, following officially recommended insertion technique transforms the process into a slick maneuver with minimal respiratory or hemodynamic consequences. Following successful insertion and cuff inflation, the LMA provides an oval seal around the laryngeal aperture (Figure 3). In many cases the seal is good enough to allow positive pressure ventilation, especially when the LMA-ProSeal is used (Figure 5).

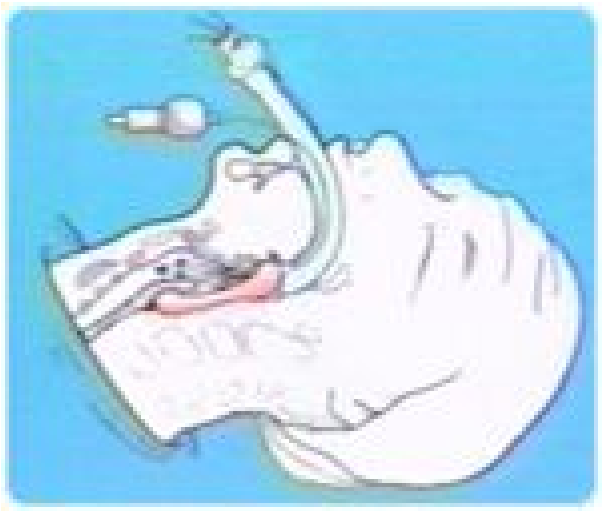


Figure 2. When correctly inserted, the tip of the LMA snuggles into the esophagus while the bowl of the LMA forms an oval seal around the laryngeal aperture.

The original LMA was invented in a development effort by Dr. Archie Brain spanning the years from 1981 to 1988. Much of the development was based on the study of laryngeal anatomy using cast models. Considerable clinical experience in the LMA has now been accumulated since the first production model in 1988, as evidenced by the many thousands of publications concerning its use, as well as by its world-wide adoption. Dr. Brain has published an interesting history of the development of the LMA which will be of interest to many readers [1]. The most recent addition to the LMA family is the LMA-CTrach (Figure 6).

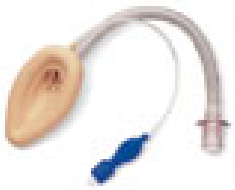
	LMA | Classic™ Reusable airway device made primarily of medical-grade silicone rubber. All LMAs are designed to conform to the contours of the hypopharynx with the LMA lumen facing the laryngeal opening.
	LMA | Unique™ Single-use disposable version of the LMA Classic™ Because it is disposable, it is well suited for areas where stocking a reusable device is not practical or economical.
	LMA | Flexible™ This LMA has a wire-reinforced, flexible shaft that is particularly useful when the surgeon and anesthesiologist are competing for access, such as procedures involving the head or neck.
	LMA | ProSeal™ Provides higher airway seal pressures for use with positive pressure ventilation (PPV). A “drain tube” separates the respiratory and GI tracts. The maximum airway seal is about10 cm H2O higher than the LMA Classic™ - up to 30 cm H2O.
	LMA | Fastrach™ The Fastrach™ is designed to allow blind or FOB assisted intubation while allowing the patient to be ventilated in the meantime. It is particularly useful in anticipated and unanticipated difficult airway situations. It is best used in conjunction with a special reusable silicone ETT.
	LMA | CTrach™ The CTrach™ is designed to increase intubation success in difficult airways. It enables ventilation during intubation attempts while built-in fiberoptics provide a direct view of the larynx and real time visualization of the ET tube passing through the vocal cords.

Figure 3. The laryngeal mask airway (LMA) comes in a seven specific formats for use in a large variety of clinical situations. Modified with permission from the LMA North America web site (www.lmana.com).

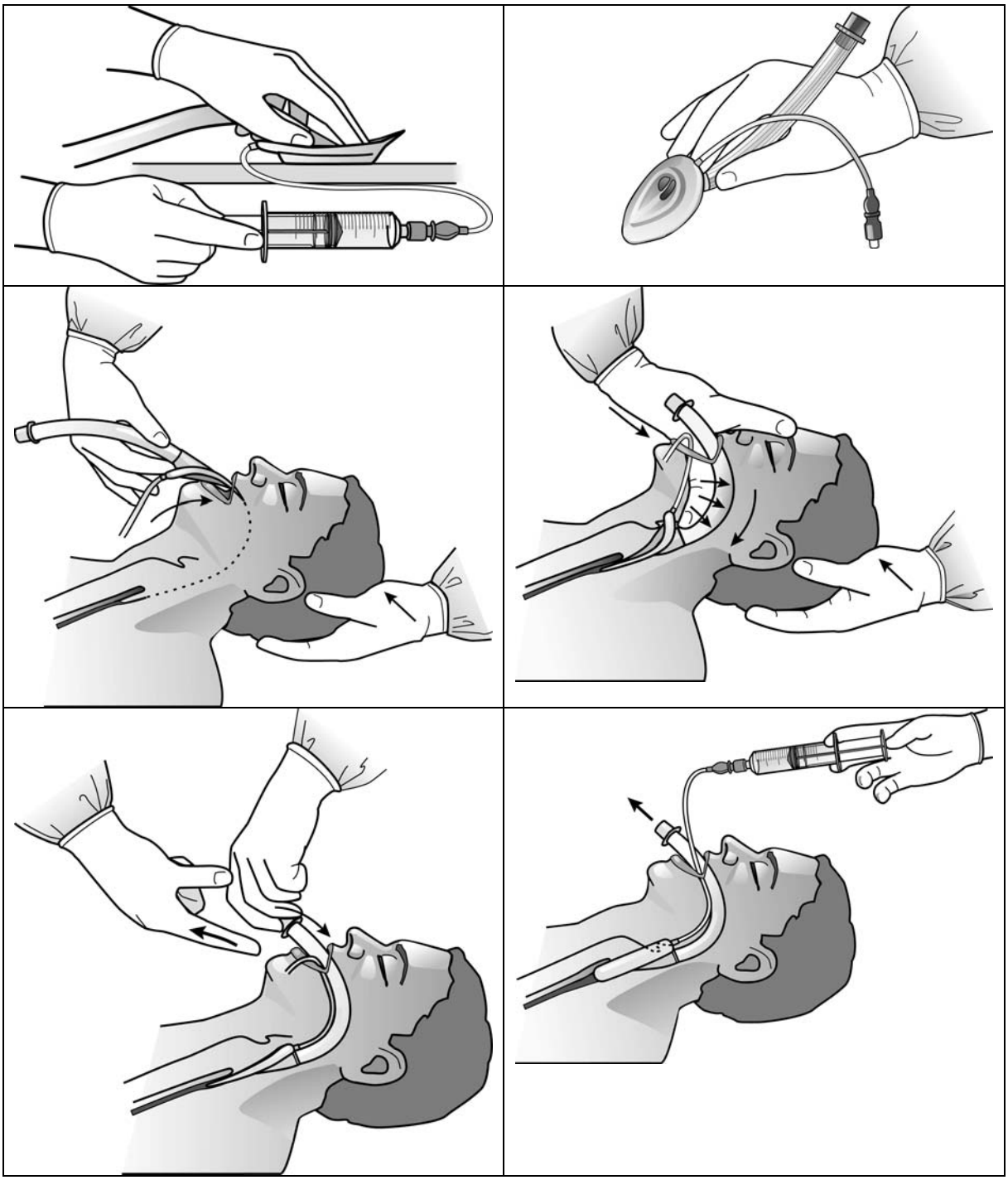


Figure 4. Steps in insertion of the LMA. Note how the right-hand index finger directs the LMA in the cephalo-posterior direction during the insertion process.

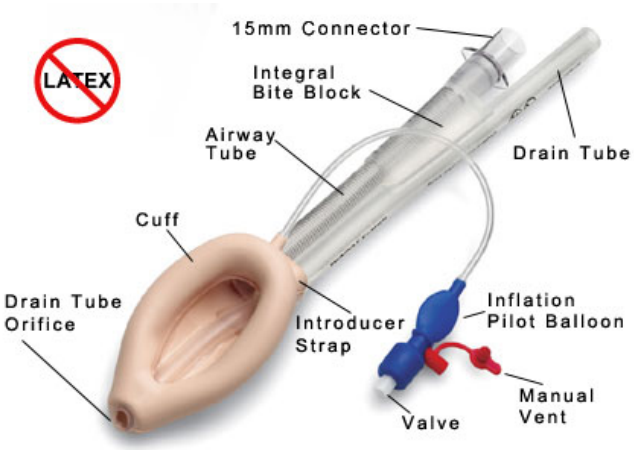


Figure 5 (left). The LMA ProSeal. Note the drainage tube designed to help reduce the risk of aspiration.
Figure 6 (right). The LMA CTrach with the viewer component attached.

The LMA is particularly useful where a face mask fit may be difficult, e.g., in bearded or edentulous patients or where both of the clinician's hands need to be free. When first gaining experience with the LMA, its use is recommended in simple cases such as short elective procedures in fasted nonobese ASA physical status 1 or 2 patients breathing spontaneously in the supine position. As experience is accumulated, the list of suitable indications can be greatly expanded as long as potential contraindications are borne in mind (Table 1).

The role of the LMA in patients who are expected to be difficult to intubate is controversial. While some airway authorities would emphasize awake intubation in such a case, in suitable cases some others would consider carrying out attempted intubation after induction of anesthesia, with LMA placement only if intubation is unsuccessful. Still others would recommend going directly with the LMA, avoiding laryngoscopy and attempted intubation.

Successful use of the LMA depends in part on appropriate size selection (Table 2), although clinical judgment should always since anatomical considerations can sometimes be more important than weight in size selection. It is also important to not exceed the maximum cuff inflation amounts; ordinarily cuff pressures should be kept under 60 cm H20. Finally, remember that it is usually better to use a large size with small inflation volumes than a small size excessively inflated.

The LMA North America Web site (www.lmana.com) has excellent didactic materials (including videos) to assist individuals who wish to learn more about the various LMA types and their clinical application. Note also that insertion of the reinforced variety of LMA can be very much less forgiving to deviations in insertion technique, and strict attention to recommended technique is essential.

It should be noted that failure to insert the LMA correctly may result in airway obstruction from the epiglottis being pushed down during insertion or from other malpositions. Obstruction can also occur if the cuff is deflated before protective reflexes return, or if laryngospasm occurs as a result of too light a plane of anesthesia coupled with irritation by secretions.

Before removing the LMA at the end of a case, remember the following suggestions: leave the patient undisturbed until protective reflexes have returned; look for swallowing as a sign of pending recovery from the anaesthetic; remove the LMA only when the patient can open his or her mouth on command; deflate the LMA cuff before removal; and understand that coughing is not necessarily an indication for removal, although it may be if the patient is also then able to open his mouth on command.

Table 1. Contraindications to Elective Use of the Laryngeal Mask Airway
(Note: Despite these contraindications, the LMA may still be quite acceptable as a rescue device. Furthermore, some absolute contraindications may be a bit on the relative side)

Absolute Contraindications

- Full stomach / significant aspiration risk (including hiatus hernia)
- Morbidly obese patients
- Oropharyngeal pathology very likely to result in a poor mask fit
- Glottic surgery

Relative Contraindications

- Positive pressure ventilation with airway pressures over 20 cm H_2O (stiff lungs, Trendelenburg position, laparoscopy)
- Very long cases
- Prone position
- Very limited experience in LMA use

Table 2

Laryngeal Mask Airway sizes.

Size	Weight	Maximum air in cuff
1	under 5 kg	4 ml
1.5	5 to 10 kg	7 ml
2	10 to 20 kg	10 ml
2.5	20 to 30 kg	14 ml
3	30 kg to small adult	20 ml
4	adult 50-70 kg	30 ml
5	big adult 70 - 100 kg	40 ml

Note: Keep LMA cuff pressures under 60 cm H_20

LMA and Aspiration

Because the LMA is not specifically designed to protect the airway against the entry of foreign materials, concerns about the risk of aspiration with the LMA have existed since its invention. However, clinical studies have demonstrated that the incidence of clinically detectable regurgitation into the pharynx with the LMA is extremely low [2, 3]. Still, it is prudent to take precautions against regurgitation and aspiration. The following are practical guidelines to minimize risk of aspiration: carefully select the patient and surgical procedure; avoid inadequate anesthesia upon insertion of the LMA and during surgery; ensure adequate neuromuscular reversal prior to terminating general anesthesia; and avoid anything that contributes to gastric distension.

LMA in Special and Unusual Situations

The anesthesia literature describes some special and unusual applications of the LMA, although some may be decidedly unsuitable for routine anesthesia practice in the USA. Brimacombe and Keller [4] have described a case of airway rescue in the prone position using the LMA ProSeal. Keller et al. [5] have described the use of the LMA ProSeal as a temporary ventilatory device in morbidly obese patients before laryngoscope-guided tracheal intubation. Han et al. [6] conducted a prospective study of 1067 cases of elective Cesarean section using the LMA and concluded that the technique was “probably safe”. Ng et al. [7] describe a prospective audit of 73 patients where anesthesia was induced in the prone position and a laryngeal mask airway (LMA) was used to maintain the airway. They concluded that “with experience and appropriate patient selection, it is possible to induce and maintain anesthesia using a laryngeal mask airway in patients in the prone position for ambulatory surgery.”

A final comment that should be made concerns the special role that the LMA now plays in the new (2003) edition of the ASA difficult airway algorithm [8]. This is illustrated in Figure 7.

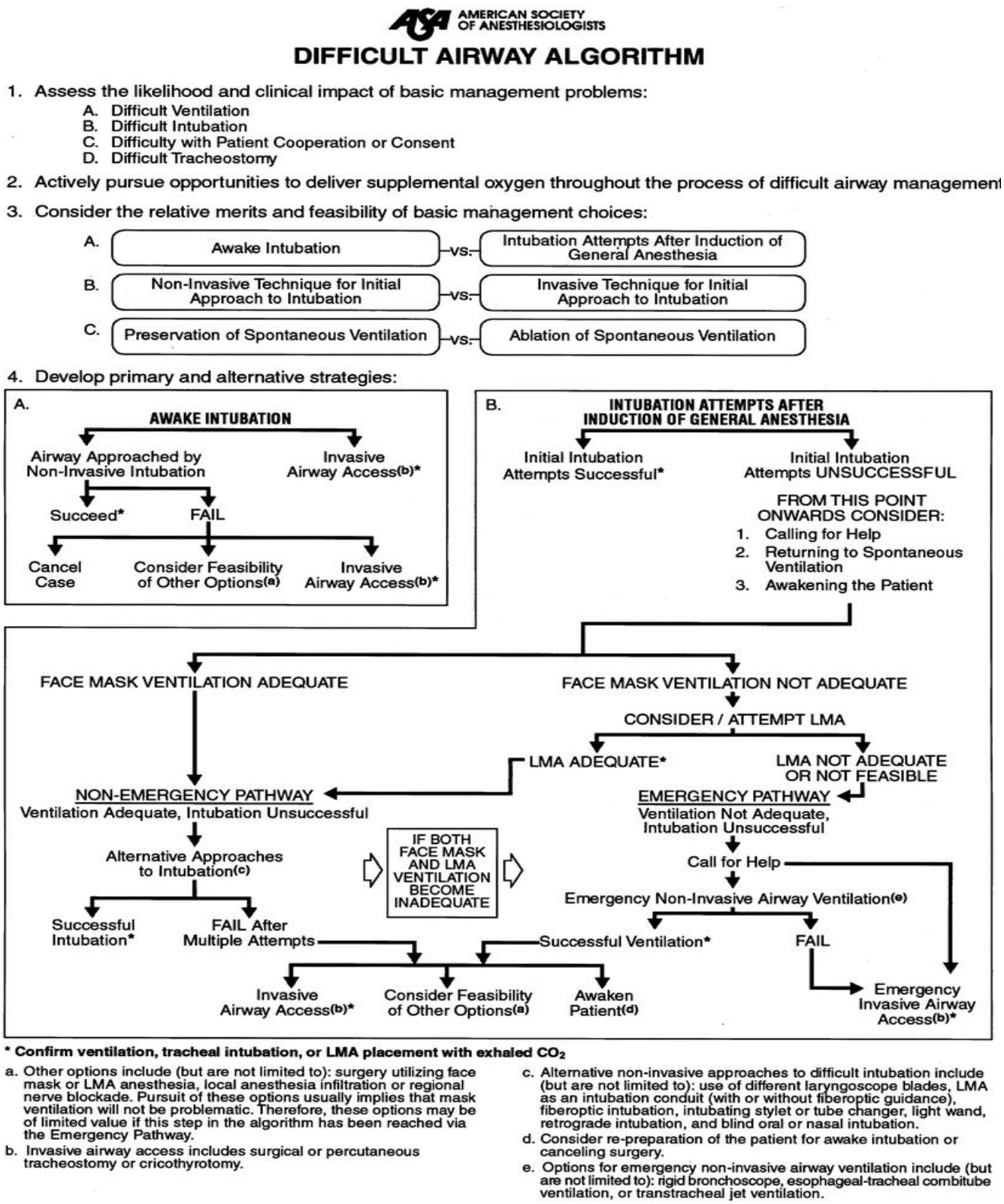


Figure 7. The 2003 edition of the ASA difficult airway algorithm. Note the role of the LMA.

Other Supraglottic Airway Devices

While the LMA is the best known supraglottic airway device, a variety of other devices are also available. These are illustrated in Figures 8 to 10.

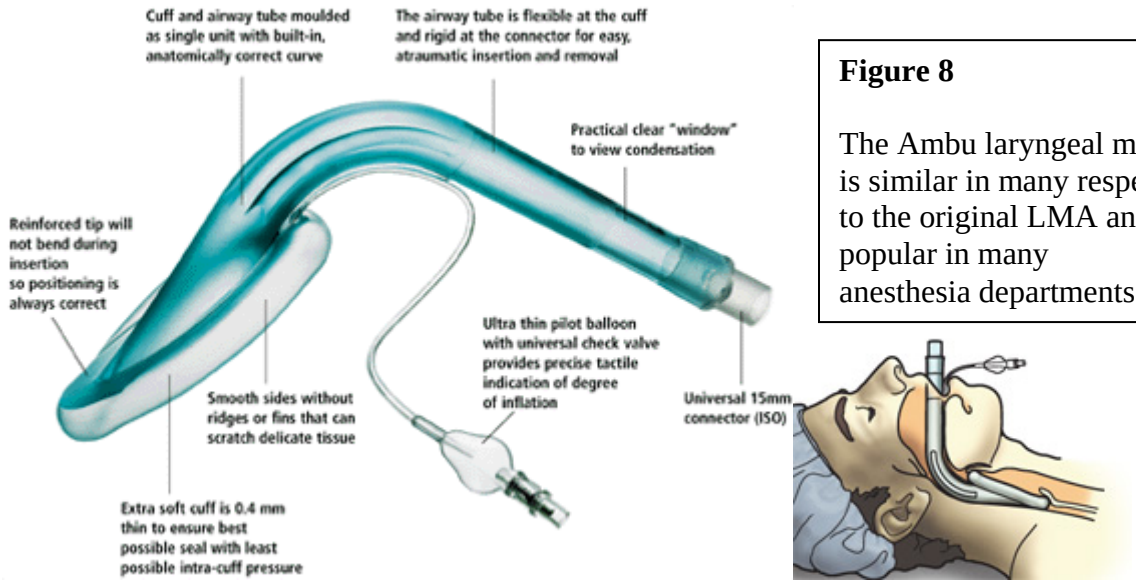


Figure 8

The Ambu laryngeal mask is similar in many respects to the original LMA and is popular in many anesthesia departments.

Figure 9

The Combitube is a well-known supraglottic airway device that is popular in prehospital airway management and in many hospital emergency departments.

Figure 10

The Laryngeal Tube is similar to the Combitube but has only one lumen, making it simpler to use. More information is available online at www.kingsystems.org

References

[1] Brain AI. The development of the Laryngeal Mask--a brief history of the invention, early clinical studies and experimental work from which the Laryngeal Mask evolved. Eur J Anaesthesiol Suppl. 1991;4:5-17.

[2] Bapat PP, Verghese C. Laryngeal mask airway and the incidence of regurgitation during gynecological laparoscopies. Anesth Analg. 1997; 85:139-43.

[3] Verghese C, Brimacombe JR. Survey of laryngeal mask airway usage in 11,910 patients: safety and efficacy for conventional and nonconventional usage. Anesth Analg. 1996; 82:129-33.

[4] Brimacombe J, Keller C. An unusual case of airway rescue in the prone position with the ProSeal laryngeal mask airway. Can J Anesth, 2005; 52: 884.

[5] Keller C, Brimacombe J, Kleinsasser A, Brimacombe L. The laryngeal mask airway ProSeal as a temporary ventilatory device in grossly and morbidly obese patients before laryngoscope-guided tracheal intubation. Anesth Analg 2002; 94: 737–40.

[6] Han TH, Brimacombe J, Lee EJ, Yang HS. The laryngeal mask airway for elective Caesarean section in healthy patients. A prospective study of 1,067 cases. Can J Anesth 2001; 48: 1117–21

[7] Ng A, Raitt DG, Smith G. Induction of anesthesia and insertion of a laryngeal mask airway in the prone position for minor surgery. Anesth Analg 2002; 94: 1194–8.

[8] American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2003;98:1269-7.

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