What’s New in Supraglottic Airways?
Three Decades of Evolution to Tract Separation

DARWIN C. VIERNES, MD
Chief Resident
Department of Anesthesiology
University of Washington
School of Medicine
Seattle, Washington

AARON M. JOFFE, DO
Assistant Professor
Department of Anesthesiology
University of Washington
School of Medicine
Seattle, Washington

ALLAN J. GOLDMAN, MD
Clinical Associate Professor
Department of Anesthesiology
University of Washington
School of Medicine
Honorary Medical Staff
Swedish Medical Center
Seattle, Washington

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Many newer supraglottic airways—such as the LMA ProSeal (LMA North America, Inc), LMA Supreme (LMA North America, Inc), i-gel (Intersurgical Inc), and King LTS-D (King Systems/VBM Medizintechnik GmbH)—include a gastric port in the design to overcome limitations of the LMA Classic (LMA North America, Inc). Although much emphasis is placed on the gastric port as potential protection against aspiration, there is far less emphasis on another advantage of the gastric port, that is, as a diagnostic tool in confirming proper positioning of the supraglottic airway (SGA).
Given that many previous mishaps with the laryngeal mask airway (LMA) were attributed to device malpositioning, the addition of a gastric drainage port offers a significant clinical advantage over devices without one. The original intent of Archie Brain, MD, inventor of the LMA, was to create an LMA with gastric access (Figure 1). “From the very beginning in 1981, I wanted to separate the respiratory and alimentary tracts. However, the prototypes were quite tricky for me to make and I, my eventual financial backers, and Dr. Nunn all thought that we should start with something relatively simple and easy to make” (personal correspondence, Dr. Brain, April 20, 2010).

Evolution of an Idea
When the LMA Classic (cLMA) was first introduced in 1988, its advantages compared with the tracheal tube were soon apparent (eg, avoidance of laryngoscopy, less bronchospasm, greater tolerance at lighter planes of anesthesia, and less coughing during emergence). However, a design limitation of the cLMA was a potential lack of protection of the respiratory tract from aspiration of gastric contents.

Brimacombe et al reported the incidence of pulmonary aspiration with the cLMA as 2.3 cases in 10,000 patients—comparable to the incidence of aspiration with general anesthesia without LMA.1 Others have reported an overall risk for aspiration ranging from 1 in 9,299 patients (elective, American Society of Anesthesiologists [ASA] physical status I) to a high rate of 1 in 1,401 patients (elective, ASA physical status IV and V). In cases in which aspiration occurred with use of a cLMA, many were attributed to device malpositioning.1

The LMA ProSeal (pLMA, Figure 2) was introduced in 2000 as an improvement to the design of the cLMA. An esophageal drain tube was added to separate the gastric and respiratory tracts. The cuff also was enlarged, which allowed approximately 50% higher seal pressures than with the cLMA.

Currently, there are no data from large studies with the pLMA that provide aspiration data comparable to the cLMA. However, data from case reports and cadaver studies have found the pLMA to be superior to the cLMA. Keller et al reported that a properly placed pLMA in cadaver studies was able to provide a more effective seal than the cLMA.3 They also demonstrated that a properly placed pLMA allowed fluid in the esophagus to bypass the pharynx and mouth via the drainage tube.

An added benefit of the drainage tube is the ability to rapidly determine correct placement of the pLMA. A combination of tests outlined below helps determine if proper placement has been achieved (Table).4,5 It is important to emphasize that the drain tube must be patent for the device to work properly.

Diagnostic Tests To Confirm Placement

**Oropharyngeal Leak Pressure Test**
After adequate ventilation has been determined, the oropharyngeal leak pressure test is performed. The test is conducted by closing the adjustable pressure-limiting valve of the circle system at a fixed rate of gas flow (usually 3 L/min) and then observing the airway pressure at which a gas leak occurs.6 A gas leak can be detected by listening to air escape from the mouth, by using a stethoscope over the neck, or by sampling end-tidal carbon dioxide in the oropharynx.7

**Gastric Leak Test/Bubble Test**
The bubble test helps determine separation of the alimentary and respiratory tracts. Just enough water-soluble lubricant is placed in the proximal end of the gastric port to occlude it.7,8 While applying moderate positive...
pressure ventilation, a well-placed pLMA, i-gel, or LMA Supreme (sLMA) will not eject the lubricant, indicating isolation of the respiratory and alimentary tracts. If air or lubricant escapes from the drain tube during positive pressure ventilation, the device usually needs to be inserted a bit deeper for the gastric port to form a seal with the upper esophageal sphincter.7

**Suprasternal Notch Test**

The suprasternal notch test indirectly demonstrates continuity of the upper esophageal sphincter with the gastric port of the pLMA, sLMA, and i-gel. First, the same occluding lubricant described previously is placed. A gentle tapping on the patient’s suprasternal notch causes the lubricant membrane to pulsate. This pulsation indicates that the device tip is behind the cricoid cartilage, patent and not folded over.5

**Gastric Tube Test**

Passing a gastric tube through the drain tube is recommended if any uncertainty exists about the validity of the suprasternal notch test. Easy passage of the gastric tube into the stomach directly shows that the device tip is not folded over. The gastric tube also can be used to decompress the stomach.

**Newer Disposable SGAs: Tract Separation**

Three new single-use SGAs separate the alimentary and respiratory tracts, and include a gastric port that allows passage of a gastric tube. Manufacturers of the devices claim easy insertion with high oropharyngeal leak pressures. These airways have many of the advantages of the pLMA, with several additional key features. The tips are reinforced to prevent folding and the bodies are more rigid to prevent rotation and allow easier insertion, especially by novices. These features make possible a high rate of first-pass insertion. In addition, correct device positioning can be rapidly determined, which should offer a greater margin of safety for routine cases compared with SGAs without a drain tube.

These single-use SGAs also may be preferable for use in high-risk cases, including patients with delayed gastric emptying (ie, patients with diabetes), obese patients, or those who require positive pressure ventilation. In these cases, aspiration pneumonia—although rare—may have dire consequences. Future studies comparing these devices are indicated.

**LMA Supreme**

The sLMA (Figure 3) combines features of the LMA Fastrach (a fixed-curve shaft for easy insertion) and the pLMA (gastric access, separation of the alimentary and respiratory tracts, high oropharyngeal leak pressure, and an integral bite block).8 The clinician does not have to place fingers in the patient’s mouth, and an introducer is not required.9 The sLMA comes in 3 sizes. Initial studies have demonstrated that leak pressures are similar between the sLMA and pLMA, whereas the rate of first-pass insertion is higher in the sLMA.9,10

**Table. Steps to Facilitate and Assess Positioning of an LMA With Gastric Access**

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<tr>
<td>Infl ate the cuff to no more than 60 cm H₂O.</td>
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<tr>
<td>Assess depth of insertion by visually inspecting position of the bite block.</td>
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<tr>
<td>Connect to anesthesia circuit and ensure adequate gas exchange.</td>
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<tr>
<td>Determine oropharyngeal leak pressure.</td>
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<tr>
<td>Perform gastric leak test/bubble test.</td>
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<tr>
<td>Perform suprasternal notch test.</td>
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<td>Verify patency of the drain tube by passing the orogastric tube.</td>
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**INTERSURGICAL I-GEL**

The i-gel (Figure 4) is manufactured from medical-grade thermoplastic elastomer. It is designed to create a noninflatable, anatomical seal of the pharyngeal, laryngeal, and perilaryngeal structures, and avoid compression trauma. Initial studies have demonstrated that the i-gel can be placed more quickly than conventional LMAs, which might play a role in prehospital settings. Preliminary data from cadaver studies have found that the pLMA to be superior to the i-gel in achieving seal pressures. However, the ability for complete and fast drainage of gastric fluid through the esophageal lumens was comparable. The device is available in 3 adult and 4 pediatric sizes.
Catheter with a larger internal diameter (4.7 mm) that allows it to be preloaded onto a fiber-optic bronchoscope (FOB) that is smaller than 4.6 mm. The external diameter (6.5 mm) will accommodate tracheal tubes larger than 7 mm.

The AIC is 56 cm long, so that when loaded onto the FOB, the directable distal 3 cm of the bronchoscope is left free. The catheter has removable Rapi-Fit adapters (Cook Medical), which permit the use of a ventilatory device during exchange procedures, if necessary. To perform the exchange, following insertion through the SGA and into the trachea, the FOB is removed leaving the catheter in place; the SGA is then removed and the tube inserted over the AIC. This allows ventilation that virtually is uninterrupted—first maintained through the SGA, and subsequently through the catheter using a standard 15-mm adapter. Connection to a breathing circuit is possible after the SGA is removed. The main advantage of using the AIC is that the need for changing a small diameter tracheal tube for a larger diameter tube is eliminated.14,15

Three Case Studies

Awake Insertion Using the sLMA

A 43-year-old obese woman (body mass index [BMI], 46 kg/m²), presented for vaginal hysterectomy. She had gastroesophageal reflux disease that was well controlled, in addition to asthma, and diabetes for which she was taking oral medication. Her medical history included direct laryngoscopy that had been difficult, and refusal of regional anesthesia.

An awake technique for managing the airway was planned because of the possibility of difficult bag-mask ventilation. Plan A was to insert an sLMA. Plan B was to perform a flexible fiber-optic intubation.

The patient was administered 0.2 mg of glycopyrrolate, 2 mg of midazolam, and 50 mcg of fentanyl. Six milliliters of 4% lidocaine was applied topically to the oropharynx. A fully deflated, lubricated sLMA (size 4) was inserted with ease and inflated to 60 cm H₂O; a 14-F orogastric tube was then passed into the stomach (Figure 7). IV ketamine (30 mg) was then administered while ventilation tests were conducted. The oropharyngeal leak pressure was 34 cm H₂O, with an exhaled volume of 900 mL. Sevoflurane and vecuronium (5 mg) were then administered and the patient placed on pressure-support ventilation for an uneventful 2-hour surgery. The sLMA was removed when the patient was fully awake. The patient was questioned the following day and had no recall of the sLMA insertion.

This case illustrates that a patent airway can easily be established with a SGA before anesthesia is induced in a patient with potentially difficult bag-mask ventilation.

The i-gel for Airway Rescue

A 63-year-old man with a potentially difficult airway (BMI, 53 kg/m²; thickness of the neck) was experiencing seizures in a general medical ward. He was hypoxic...
and unconscious; bag-mask ventilation was ineffective. The medical intern successfully placed a size-5 i-gel SGA. After satisfactory control of the airway was achieved and the stomach decompressed via an orogastric tube, the patient was transferred to the intensive care unit, where he was subsequently intubated with use of an AIC.

This case illustrates that placement of an i-gel does not require the clinician’s fingers to be placed in the patient’s mouth, and that the i-gel can be inserted when access for routine tracheal intubation is difficult.

**THE KING LTS-D IN PREHOSPITAL USE**

A 49-year-old man undergoing acute myocardial infarction was being transported by ambulance to the hospital. While in transit, he went into cardiac arrest. Tracheal intubation was abandoned because the medic was unable to visualize any portion of the laryngeal anatomy with a Macintosh 3 laryngoscope blade. With the laryngoscope still in the patient’s mouth, a King LTS-D airway easily was placed into the esophagus and bag-mask ventilation established. The patient was subsequently intubated in the emergency room, and survived cardiac arrest.

This case illustrates that first responders who do not practice intubation frequently can easily place the tip of an LTS airway into the esophagus while attempting direct laryngoscopy.

**Conclusion**

In the quest for an ideal SGA, the newest devices that separate the alimentary and respiratory tracts are uniquely innovative. Several single-use devices that are easy to insert, minimally invasive, and allow high ventilatory pressure are now available. They also may provide some protection from pulmonary aspiration. Aspiration pneumonia, although rare, can have dire consequences. Even after patients have fasted, the volume of stomach contents can place them at risk for aspiration. The routine use of SGAs with gastric access may be evolving to a new standard of care.

**Acknowledgments**

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This article is dedicated to the memory of Andy Ovassapian, MD (1936-2010), founder of the Society for Airway Management. He was my friend and mentor (AG).

**References**


