The Laryngeal Mask Airway For Pediatric Anesthesia

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Introduction

The invention and development of the laryngeal mask airway (LMA) by Dr. Archie Brain has had a significant impact on the practice of anesthesia, management of the difficult airway, and cardiopulmonary resuscitation. The LMA provided anesthesiologists with a new type of airway device: the *supraglottic airway*, and airways can now be classified into three categories: 1) pharyngeal airways, 2) supraglottic airways, and 3) intratracheal airways. Anesthesiologists have a greater variety of airways from which to choose and the airway can be closely matched with the patient, type of anesthesia, and the surgical procedure.

Pediatric patients are more likely to develop intraoperative and postoperative airway complications. Can the LMA be used as frequently for pediatric patients as for adult patients? Are the potential benefits and complications of LMA use the same for pediatric and adult patients?

Pediatric Airway Anatomy And Physiology

Neonates have a high metabolic rate and a large oxygen consumption per unit of body weight that is over twice that of the adult: 7 ml/kg/min (neonate), 3 ml/kg/min (adult). The respiratory muscles are weak and prone to fatigue. Tidal volume is relatively fixed and an increased demand for oxygen must be met with an increase in respiratory rate. The ratio of the minute alveolar ventilation to the functional residual capacity (FRC) is high which reduces the oxygen reserve in the lungs once ventilation ceases.

The relatively large tongue and prominent soft tissue of the neck and pharynx increase the likelihood of upper airway obstruction after a sedative drug (intravenous or inhalation) has been administered. The infant and child's airway reflexes are very reactive to foreign materials and infectious agents.

The maturation process of the pediatric airway is gradual and inflection points of change to a more adult-like pattern cannot be precisely identified. Perioperative management of the pediatric airway must be done with great care and precise monitoring. In addition to the complications of tracheal intubation that occur in adults, children are more likely to develop mucosal injury, hoarseness, subglottic edema, and cough. Administration of anesthesia via an LMA may reduce the incidence of many of these postoperative complications. An LMA should not, however, be used for patients when tracheal intubation is clearly indicated.

LMA Insertion Technique

The technique for LMA insertion as developed by Brain has been shown to provide the best position of the airway device in the widest variety of patients for many types of surgeries. Although a number of variant techniques have been advocated, none have been consistently shown to be better than Brain's technique. Many of the alternative techniques result in an LMA placement that is too high in the upper airway and the cuff is over-inflated to prevent gas leak around the LMA. A high LMA cuff pressures is more likely to cause swelling of pharyngeal structures and a reduced tolerance for the LMA during emergence. The concept of LMA insertion is similar to the physiologic process of swallowing. After food is thoroughly masticated, the tongue flattens the bolus of food against the hard palate and in concert with pharyngeal muscles propels the food into the hypopharynx. Insertion of the LMA, in a similar fashion, is done by flattening the deflated LMA

cuff against the hard palate with the index finger pushing the LMA along the surface of the hard and soft palate in a sweeping arc into the hypopharynx. This technique is suitable for both adults and children and is basic for all LMA models.

LMA Models

The classic LMA, unlike other supraglottic airways, is available in a wide range of sizes, one of which will fit neonates or large adults. Selecting the correct size for the individual pediatric patient is not always precise and different sizes should be readily available. The LMA has an increased likelihood of malposition in children that may be secondary to sizing irregularities. The success of the classic LMA prompted development of other LMA models for specific purposes such as blind tracheal intubation (intubating LMA) and access to the stomach (proseal LMA). The proseal LMA offers two advantages: 1) the presence of the gastric conduit permits passage of a gastric tube and gastric decompression, and 2) a redesign of the LMA cuff that results in a better fit of the LMA to the airway and higher potential inflation pressures. Currently, the smallest size available for the intubating LMA and the proseal LMA is size #3.

The LMA And Pediatric Anesthesia

The LMA provides a more secure airway than can be obtained with a pharyngeal airway and a face mask in pediatric patients. The LMA bypasses the tongue and upper pharyngeal structures that cause upper airway obstruction in children. The brevity of the surgical procedure such as a myringotomy may not warrant an LMA, but in certain patients (mandibular hypoplasia), the LMA may be a better choice for even brief procedures. In the situation where an anesthesiologist is working alone (even if tracheal intubation is planned) and an inhalation induction is being performed, an LMA inserted after induction of anesthesia may provide a secure airway while the anesthesiologist is cannulating a vein prior to tracheal intubation.

The LMA is especially appropriate when general anesthesia is required for relatively non-invasive diagnostic or therapeutic procedures such as MRI, CT scanning, cardiac catheterization, nuclear scans, and radiation therapy. The complications and side effects of tracheal intubation can be avoided for these types of procedures. Other types of surgery for which the LMA has been useful include non-cavity invasive general surgery, orthopedic surgery, plastic surgery and genitourinary surgery. The LMA is not a replacement for the tracheal tube; however, many pediatric patients have, in the past, been intubated simply because standard pharyngeal airways have not provided a secure enough airway. Each anesthesiologist should review the indication for tracheal intubation in their pediatric patients to determine whether an LMA may provide a secure airway with minimal risk of side effects.

The ProSeal LMA

The question of whether pediatric patients are more prone to aspiration of gastric contents has been debated for many years. The most recent comprehensive review of aspiration indicates that the pediatric patient has only a slightly increased risk of perioperative aspiration pneumonitis. Excessive positive pressure ventilation by face mask may produce gastric distention, which by increasing intragastric pressure, can increase the likelihood of regurgitation. Most children have very compliant lungs and the level of positive pressure ventilation suitable for an adult, when applied to the child, can overcome closure of the upper and lower esophageal sphincters and cause distention of the stomach. Such distention also limits diaphragmatic excursion and impairs effective ventilation. The proseal LMA with the gastric conduit provides a means by which the stomach can be decompressed after the LMA is in place. The proseal LMA is a more anatomic fit for the airway and is more suitable for positive pressure ventilation. These two advantages of the proseal LMA should be of great benefit for pediatric anesthesia when smaller sizes of proseal LMAs are manufactured.

The LMA And The Difficult Airway

Although not specifically invented for management of the difficult airway, the LMA has proven to be the most significant advance in difficult airway management in the past thirty years. The medical literature is replete with case reports and clinical studies demonstrating the efficacy of the LMA to establish ventilation in patients with difficult airways

under elective and emergent conditions. This is true for both adult and pediatric patients. Ventilation of pediatric patients with congenital syndromes such as Pierre-Robin, Treacher-Collins, Goldenhar, Klippel-Feil, Beckwith-Weidemann is much easier with an LMA than other devices. Fiberoptic-assisted tracheal intubation is facilitated by the presence of an LMA and has revolutionized airway management for a wide variety of patients with airway abnormalities. In most cases the LMA can be inserted after the patient has been rendered unconscious with an inhalation agent (sevoflurane). For patients where ventilation may be unpredictable after induction of anesthesia, the LMA can be facilitated with topical anesthesia.

Summary

The invention and development of the LMA for clinical use has revolutionized operative management of the airway for patients with normal and abnormal airways. The LMA is the first true supraglottic airway. The success of the classic LMA design led to the production of several different LMA models with specific indications.

Airway management is the most important task for the anesthesiologist and the importance of this function cannot be overemphasized. The anesthesiologist cannot accept limitations in airway management and must always be prepared to abandon a technique when the clinical situation requires a different approach. There is no single airway device or technique that is suitable for every patient and anesthesiologists must be skilled in many techniques to ensure optimal airway management with minimal risk.

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