Acta Clin Croat (Suppl. 1) 2016; 55:55-61 Review
doi: 10.20471/acc.2016.55.s1.07

SIMPLE, TIMELY, SAFELY? LARYNGEAL MASK AND PEDIATRIC AIRWAY

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SUMMARY – Laryngeal mask airway (LMA) was a useful, powerful airway management device for routine pediatric airway management, pediatric difficult airway, and in pediatric emergency situations. Over years, various designs, induction and insertion techniques have been described. LMA provides ease of placement and removal as compared with endotracheal intubation, less traumatism for the respiratory tract, better tolerability by patients, improved hemodynamic stability during emergency, less coughing, less sore throat, avoidance of laryngoscopy, and hands free airway. On the other hand, LMA is not suitable to overcome functional airway problems and mechanical airway obstruction in children. Simple airway management in pediatric patients is normally easy in experienced hands, for anesthesiologists working in specialized hospitals with appropriate personnel and equipment that guarantee optimal safety in these patients. On the other hand, pediatric airway management is a great challenge for anesthesiologists working in departments with a small number of pediatric surgical procedures. Careful preoperative evaluation, preparation and training in the recognition of challenges in pediatric airway are essential for the management of the airway in children. LMA plays a special role in the management of difficult pediatric airway; as a supraglottic airway device, it is incorporated into difficult pediatric airway algorithms.

Key words: *Anesthesia; Airway Management – Instrumentation; Laryngeal Masks; Child*

Introduction

Supraglottic airway devices (SADs) have become prevalent in pediatric airway management because they are typically more user-friendly than face mask and avoid many of the problems associated with endotracheal intubation. The term 'supraglottic' means 'above the glottis' or 'above the larynx'. Some authors refer to these products as 'extraglottic' devices. The most represented supraglottic airway device in pediatric patients is laryngeal mask airway (LMA). Anatomical and physiological specificity of neonates, infants and children, and differences compared with adults make even normal pediatric airway difficult for anesthesiologists working in departments with a small number of pediatric surgical procedures. The presence of congenital or acquired airway problems in children increases the risk to the patient and nervousness of the anesthesiologist. Careful preoperative evaluation, training in recognizing challenges in pediatric airway, preparation airway trolleys adapted to local conditions, and accepted difficult airway algorithms simple and easy to memorize are essential for the management of airway in children[1]. LMA is a useful, powerful airway management device for routine pediatric airway management and pediatric emergency situations. LMA plays special role in the management of difficult pediatric airway; as a supraglottic airway device, it is incorporated into pediatric airway algorithms. The aim of this article is to review LMA as the most represented SAD, as a useful and powerful

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Received March 1, 2015, accepted September 14, 2015

airway device for routine pediatric airway management and the central role of LMA in the management of difficult pediatric airway.

Discussion

Routine airway management in pediatric patients is normally easy in experienced hands for anesthesiologists working in specialized hospitals with appropriate personnel and equipment that guarantee optimal safety in these patients[2]. On the other hand, pediatric airway management is a great challenge for anesthesiologists working in departments with a small number of pediatric surgical procedures. Pediatric airway, especially in infants and small children, is substantially different from adult airway:

- smaller dimensions of the airway,
- relatively larger head in infants,
- relatively larger tongue,
- short jaw,
- long palate,
- long epiglottis,
- larynx located more cephalad,
- vocal cords angled more anteriorly,
- airway narrowest at the cricoid cartilage,
- soft airway, and
- airway more reactive and infants more prone to develop laryngospasm

The primary goal of pediatric airway management is to provide oxygenation and ventilation[3]. A sufficient basic bag-mask ventilation technique is the key point for success. Impossible face mask ventilation in the normal child probably does not exist in experienced hands of pediatric anesthesiologists[4]. Anatomical or functional airway problems require a simple, forward-only, easy to memorize algorithm to avoid hypoxia (Fig. 1) (suggested algorithm to overcome unexpected difficult oxygenation or ventilation problems in otherwise normal children)[5]. Really difficult pediatric airway is rare and usually is associated with anatomically and physiologically important findings such as congenital abnormalities and syndromes, trauma, infection, swelling and burns. Using predictors of difficult intubation in pediatric patients such as mandibular hypoplasia, limited mouth opening, limited neck mobility and facial asymmetry including abnormalities of the ear, stridor, and history of obstructive sleep apnea should be mandatory on preoperative assessment.

Difficult laryngoscopy (Cormack and Lehane grade 3 or 4) is generally less common in children than in adults. Difficult laryngoscopy could be expected if patient is less than 1 year old and there is evidence for craniofacial dimorphism[6]. In addition, the American Society of Anesthesiologists physical status greater than 3, Mallampati score greater than 3, extreme body mass index and specific types of surgery (cardiac and maxillofacial) are associated with difficult laryngoscopy[7].

Tracheal intubation must be limited to maximum of three attempts by an experienced anesthesiologist because pediatric airway is sensitive to swelling and trauma. A simple algorithm using the best local facilities is indicated (Fig. 2) for unexpected difficult tracheal intubation in children[5].

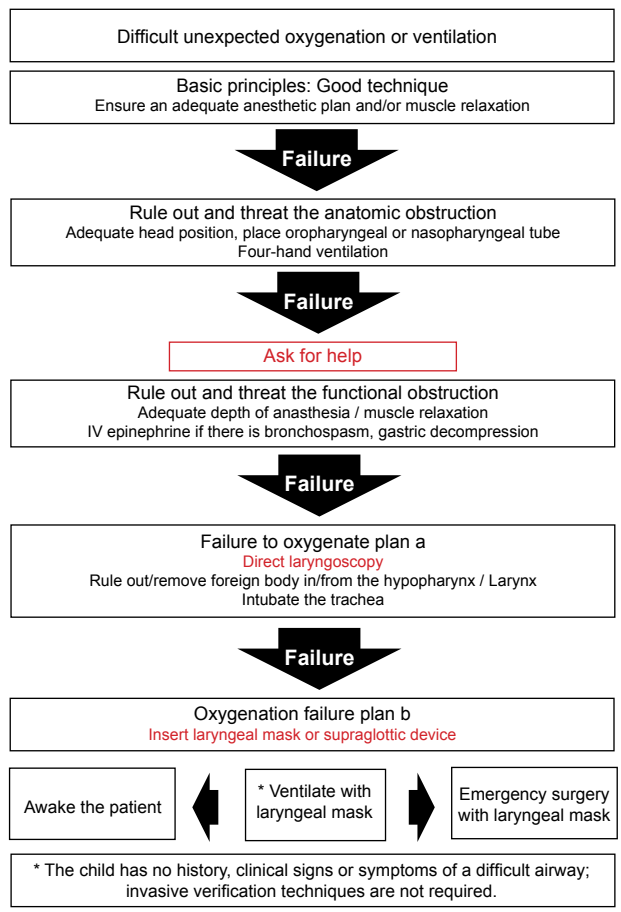

Fig. 1. Algorithm for difficult unexpected oxygenation and ventilation[5].

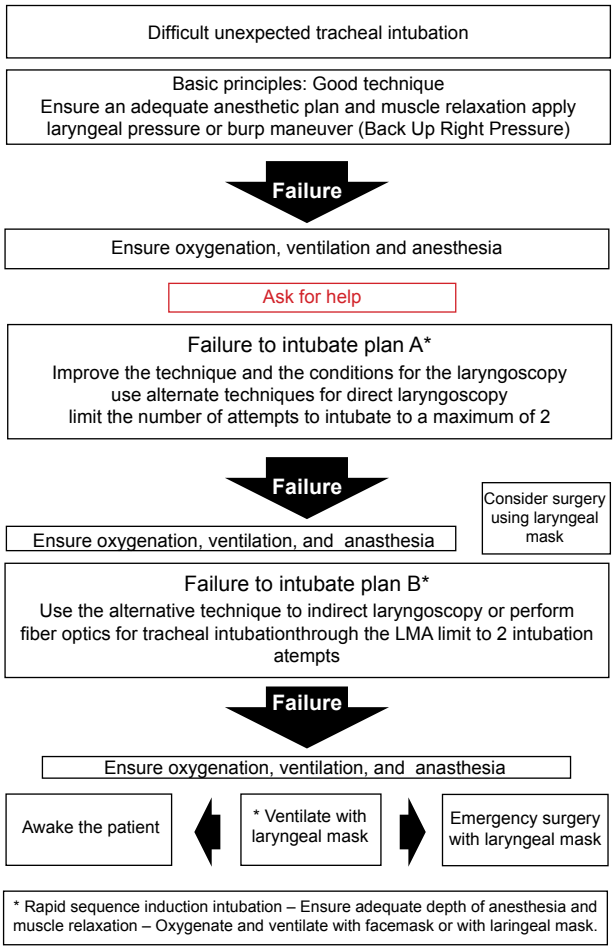

Fig. 2. Algorithm for difficult unexpected tracheal intubation[5].

As we can see, in both algorithms, LMA plays an important role.

Laryngeal mask airway is widely used in pediatric anesthesia. LMA is acceptable alternative to endotracheal intubation and a device for difficult airway management in pediatric patients[8]. The size of LMA has to be appropriate to the weight of the child (Table 1).

Table 1. Laryngeal mask airway (LMA) sizes in pediatric patients

Child weight	LMA size
<5 kg	#1
5-10 kg	#1.5
10-20 kg	#2
20-30 kg	#2.5
30-50 kg	#3

Several techniques of insertion have been described, which reflect the fact that correct placement is not always easy. Examples include:

1. Using the thumb and index finger to guide the LMA against the hard palate in the midline with cuff completely deflated or partially inflated allowing softer leading edge against the posterior pharyngeal wall;
2. Using a modified preconfigured styletted LMA;
3. Inserting a partially inflated LMA laterally 45° against side of the tongue, advancing until resistance is met and then rotating back into the midline; and
4. Inserting the LMA with its cuff facing the palate and turned 180° as entering the hypopharynx – similar to inserting an adult Guedel airway.

The last techniques are intended to avoid pushing the tongue back into the hypopharynx and causing obstruction to passage. Multiple insertion attempts may increase the incidence of postoperative sore throat.

Many pediatric anesthesiologists prefer to insert smaller LMA in a reverse fashion, with the opening of the mask against the palate, and then rotate it in place when it is fully inserted[9]. This technique can only be used in LMA with rigid tube. It is common to inflate the cuff partly during insertion. The amount of air should keep it expanded but not distended. With this technique, it should not be necessary to inflate the cuff further. If there is a leakage around the LMA, it is probably misplaced or LMA is too small. At the end of anesthesia, position of the child is on the side, if possible. When the patient has sufficient spontaneous ventilation, the LMA has to be removed. Recommendation for timing of removal LMA is rather early, even before the return of reflexes. The LMA plays an important role in difficult airways for maintaining the airway during inhalational anesthesia or as a conduit for intubation using fiberoptic scope.

Nitrous oxide diffused into the cuffs and would increase cuff pressures in several adult studies. The incidence of sore throat was significantly reduced if 'just-seal' or half of the maximum recommended volume was used[10]. An overinflated cuff may be displaced from the pharynx with the loss of seal, and be too rigid to adapt to the contours of the pharynx.

Hyperinflation of the LMA cuff, resulting in direct compression of pharyngeal structures, has been implicated in reports of recurrent laryngeal and hypoglossal nerve paralysis in children. This problem will be exacerbated if the LMA is too small and the cuff is overinflated to obtain an effective seal. In theory, a correctly positioned LMA should not be in contact with the area of the hypopharynx in which the vessels and nerves run. The use of manometry to limit LMA intra-cuff pressure has become a routine practice.

Advantages of LMA over bag and mask ventilation

- Improves clearer airway
- Reduces upper airway obstruction
- Improves ventilation and oxygenation
- Reduces gastric insufflation
- Decreases gastric distension during resuscitation procedure
- Reduces incidence of failed tracheal intubation

Advantages of LMA over tracheal tube

- No need for laryngoscopy
- Less trauma to local tissues and respiratory tract
- No risk of endobronchial or esophageal intubation
- Amount of expertise required

Relative contraindications for LMA (if using second seal generation LMA) LMA airway is contraindicated in elective patients who:

- have not fasted or fasting cannot be confirmed
- may have retained gastric contents

Contraindications for LMA

- functional airway problems (fixed decreased pulmonary compliance)
- mechanical airway obstruction (foreign bodies or soiled upper airways)

Over years, various designs of SADs, induction and insertion techniques have been described with variable results. The LMA Classic and the LMA ProSeal have an established record of safety and efficacy for routine cases in pediatric patients. The LMA ProSeal may provide a better airway seal and protection against aspiration than the LMA Classic. The I-gel, as a novel single use SAD, does not have an inflatable cuff, but is designed to create a non-inflatable anatomical seal of the pharyngeal, laryngeal and perilaryngeal structures, whilst avoiding compression trauma and a gastric channel runs through the device[11]. The I-gel LMA is suitable for children of all ages. I am convinced that further clinical trials will establish this type of LMA as simple, timely and safely for pediatric patients. In the quest for an ideal SAD, the newest devices that separate the alimentary and respiratory tracts are uniquely innovative. The routine use of SAD with gastric access may be evolving to a new standard of care.

Using LMA in prone position is a current topic of controversy, pros and cons in the literature as an innovation, but may also carry a specific risk. We have to bear in mind that anesthesia is a medical specialty with a reputation for the highest possible standards of safety[12].

The role of LMA in difficult pediatric airway

Laryngeal mask airway is a useful airway device for general anesthesia and for emergency airway maintenance. Difficult face mask ventilation in healthy children is very rare, 0.02% of total cases, and the case of impossible face mask ventilation probably does not exist[1]. The incidence of difficult intubation in healthy children under 16 years of age is 0.095%, with a higher incidence of 0.24% in children under 1 year of age[5].

Table 2. Pediatric airway: unexpected impaired and expected difficult airway

Airway scenario	Challenges
Unexpected difficult normal pediatric airway	Anatomic obstruction Functional airway obstruction
Impaired normal pediatric airway	Inflammation Foreign body Allergy Trauma
Known or expected difficult pediatric airway	Head, neck airway anomalies Congenital associated with syndromes Acquired (burns and scars) Tumor and other masses Subglottic and tracheal disorders Anterior mediastinal mass syndrome

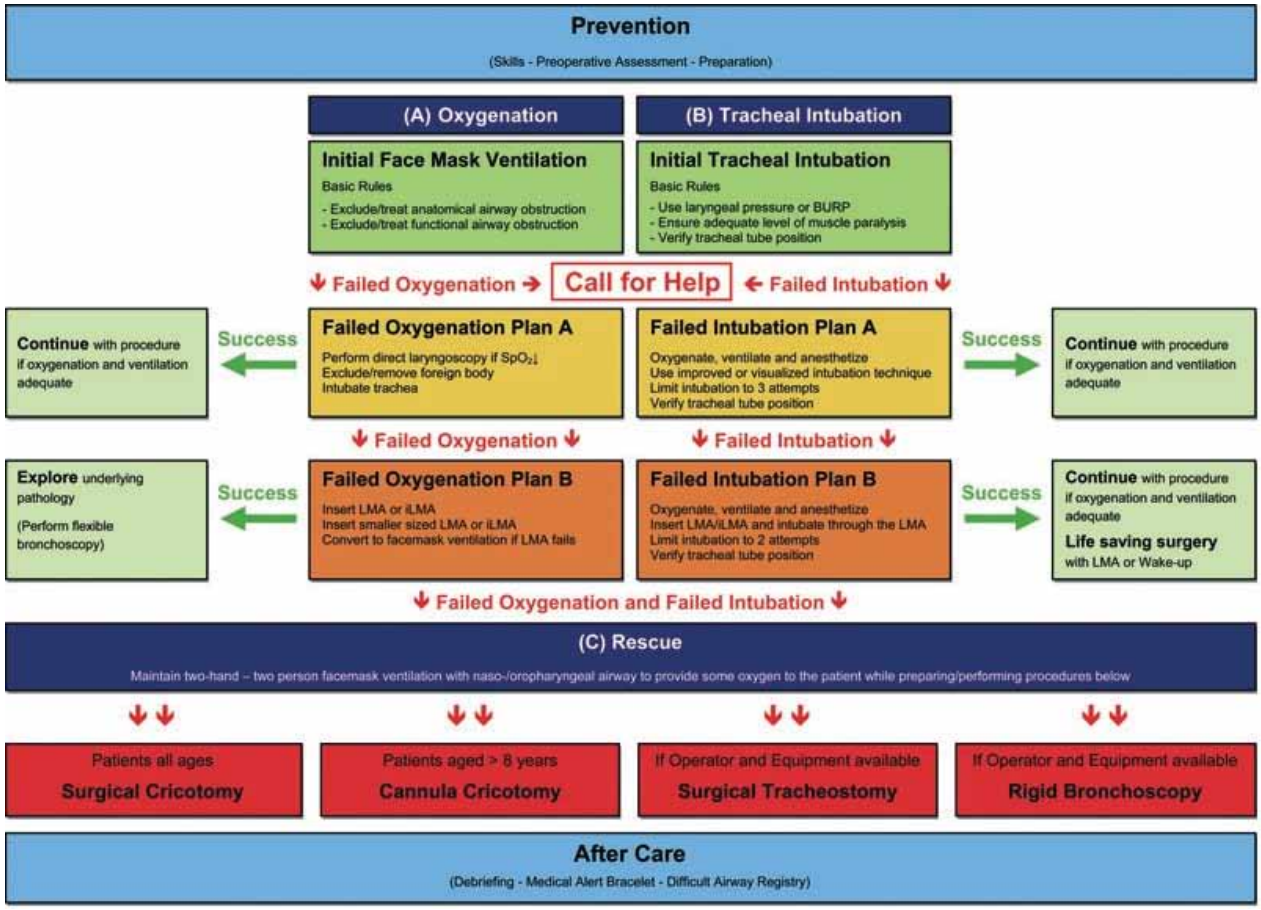

Fig. 3. Unanticipated difficult pediatric airway algorithm (adapted from Difficult Airway Society)[5].

Tracheal intubation problems in children with normal airway are uncommon, provided optimal conditions of the head and neck, adequate depth of anesthesia, and muscle paralyses[1]. Unexpected problem with pediatric airway could happen when handled by inexperienced anesthesiologist; it happens extremely rare with experienced pediatric anesthesiologist. Difficult airway algorithm has to consist of three parts: oxygenation (A), tracheal intubation (B), and rescue (C). The proposed algorithm for the management of unexpected difficult pediatric airway is illustrated in Figure 3[5].

The causes of unexpected face mask ventilation are anatomical (nasopharyngeal obstruction, etc.), when we need to reopen the airway, and functional (laryngospasm, thoracic rigidity, bronchospasm, etc.).

The causes of unexpected tracheal tube ventilation problems include are Displacement of TT, Obstruction of TT, Pneumothorax, Equipment problems, Stomach-increased intra-abdominal pressure (DOPES).

Anesthesiologists can face problems with unexpected normal, impaired normal, and known or expected difficult pediatric airway (Table 2)[1].

Children with unexpected difficult normal airway are usually healthy and have no previous symptoms or signs indicative of difficult airway. The airway problems in these children could be anatomical (upper airway collapse and adenoid hypertrophy) and functional (laryngospasm, bronchospasm, insufficient depth of anesthesia and muscle rigidity, gastric hyperinflation, and alveolar collapse). This problem is time critical and requires prompt recognition and immediate treatment to prevent hypoxia and potentially devastating consequences. Early muscle paralysis and epinephrine administration helps resolution of these functional airway obstructions. Fiberoptic intubation *via* LMA of the

unexpected difficult pediatric airway is a simple technique to solve the problems. Children with impaired normal airway (foreign body, allergy, and inflammation) require significant experience in pediatric anesthesia, particularly in bag face mask ventilation and direct laryngoscopic intubation, and can be managed successfully by either inhalational or careful intravenous induction of anesthesia. Supraglottic airway devices should not be used in this situation, except if the scenario requires life-saving or limb-saving emergency. Ear, Nose and Throat (ENT) surgical support should be useful. Children with expected difficult (abnormal) airway must be transferred/treated to a specialized hospital with appropriate experience, personnel, and equipment available to guarantee optimal safety[1]. The presence of a capable, scrubbed, and ready-to go ENT surgeon at induction is essential in patients of this group. Fiberoptic tracheal intubation is considered as the gold standard of difficult pediatric airway management. Surgical tracheostomy may remain the only and the last option to secure airway in these children.

LMA and cardiopulmonary resuscitation

During cardiopulmonary resuscitation (CPR), tracheal intubation provides the most reliable airway, but should be attempted only if the healthcare provider is properly trained and has regular, ongoing experience with the technique[13]. In the absence of personnel skilled in tracheal intubation, LMA is an acceptable alternative[13].

Studies have shown that providers frequently require multiple attempts to successfully intubate the neonatal trachea during resuscitation[14]. In these situations, LMA may be a life-saving device; however, its role as a primary airway device remains to be established[14]. It has been used as an effective and less invasive alternative to endotracheal intubation[15]. LMA has been included in the International Guidelines for Neonatal Resuscitation since 2000[16].

Conclusion

Endotracheal intubation has been considered the gold standard for safe airway control for decades. This attitude has changed after the introduction of LMA. Generations of second seal LMA confirm this statement and go a step further. Ease of placement and removal of LMA, less traumatism for the respiratory tract, better tolerability by pediatric patients, improved hemodynamic stability during emergency, less coughing, less sore throat, avoidance of laryngoscopy, and hands free airway are some advantages of LMA. LMA has been included in the international guidelines for neonatal and pediatric resuscitation and plays an important role in routine pediatric general anesthesia, as well as in difficult airways for maintaining the airway during inhalational intravenous anesthesia or as a conduit for intubation using fiberoptic scope.

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Sažetak

JEDNOSTAVNA, PRAVODOBNA, SIGURNA? LARINGEALNA MASKA I PEDIJATRIJSKI DIŠNI PUT

M. Karišik

Laringealna maska (LMA) je korisna i moćna alatka kako za rutinsko upravljanje pedijatrijskim dišnim putom tako i za upravljanje pedijatrijskim dišnim putom u izvanrednim situacijama. Tijekom godina opisane su različite vrste LMA, različiti načini njenog postavljanja, kao i njezina uporaba pri različitim anesteziološkim tehnikama indukcije. LMA je jednostavna za postavljanje i uklanjanje u odnosu na endotrahealnu intubaciju, manje je traumatična za dišne putove, bolje se podnosi, poboljšava hemodinamsku stabilnost u izvanrednim situacijama, uzrokuje manje kašlja, grlobolje, izbjegava se laringoskopija i anesteziolog ima slobodne ruke. S druge strane, LMA nije prikladna u situacijama kada postoje funkcionalni problemi i mehaničke opstrukcije dišnih putova u djece. Upravljanje dišnim putom u pedijatrijskih bolesnika je obično lako u rukama iskusnog pedijatrijskog anesteziologa koji radi u specijaliziranim bolnicama koje raspolažu odgovarajućom logistikom. S druge strane, upravljanje pedijatrijskim dišnim putom je velik izazov za anesteziologa koji radi u odjelima s malim brojem pedijatrijskih kirurških zahvata. Prijeoperacijska procjena, priprema i trening u prepoznavanju izazova neophodni su za posjedovanje vještine upravljanja dišnim putom u djece. LMA igra posebnu ulogu u upravljanju teškim pedijatrijskim dišnim putom te je kao supraglotična alatka satavni dio algoritma za teški pedijatrijski dišni put.

Ključne riječi: *Anestezija; Dišni put – zbrinjavanje; Laringealne maske; Dijete*