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The Laryngeal Mask Airway: Is It Safe for Pediatric Adenotonsillectomy?

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Abstract

Tonsillectomy with or without adenoidectomy (T&A) is one of the most common pediatric surgical procedures performed in the United States. Traditionally, an endotracheal tube has been used to secure the airway in these cases. However, the laryngeal mask airway (LMA) is also used for pediatric T&As. This review explores the question, In pediatric patients undergoing tonsillectomy with or without adenoidectomy, does the laryngeal mask airway compared with the endotracheal tube provide a safe and effective means of airway management? While all evidence sources concluded that it was possible to use an LMA for pediatric T&A, not all investigators fully supported its use in this setting. The authors of 6 of the 7 evidence sources determined that the LMA was an overall safe and viable alternative for this procedure, but one of the randomized controlled trials identified issues with kinking and visualization and called for further study. Future investigation should compare different types of laryngeal mask airways to determine superiority in terms of surgical access, visualization, and reduced displacement or kinking with insertion of the mouth gag.

KEYWORDS: Adenotonsillectomy, anesthesia, laryngeal mask airway, pediatrics, tonsillectomy.

INTRODUCTION

About 500,000 tonsillectomies with or without adenoidectomy are performed in children younger than 15 years each year in the United States.[1] For the anesthesia provider, a secure and protected airway is one of the primary goals during this procedure due to sharing the airway with the surgeon. Traditionally, the endotracheal tube (ETT) has been the airway of choice for pediatric patients undergoing adenotonsillectomy (T&A), but it is not without potential complications. These include, but are not limited to, trauma to the lips, teeth, gums, and larynx; bronchospasm; and laryngospasm. Laryngospasm, occurring in 4% to 14% of pediatric patients undergoing general anesthesia, is a potentially life-threatening complication that can occur during induction or emergence from anesthesia.[2]

The laryngeal mask airway (LMA) was developed by Dr. Archie Brain, introduced to the practice of anesthesia in 1988, and approved by the U.S. Food and Drug Administration in 1991.[3] Its popularity within the anesthesia community continues to grow, and its use has been reported for otolaryngoscopy procedures.[4] This paper reviews the evidence comparing the efficacy of the LMA to the ETT in pediatric patients undergoing tonsillectomy or T&A.

HISTORY AND REVIEW OF THE LITERATURE

History. Tonsillectomy with or without adenoidectomy (collectively referred to as "T&A") is a common pediatric surgical procedure in the United States.[1] Reasons that children are scheduled for a T&A are chronic or recurrent tonsillitis, obstructive sleep apnea, and obstructive tonsillar hyperplasia. Upper respiratory infections are also a common comorbidity in this patient population. For these reasons, patients who present for this surgical procedure are at increased risk for airway complications.[1]

The LMA is a supraglottic airway device inserted into the patient's hypopharynx, where it rests above the laryngeal inlet. Advantages to using the LMA include ease of insertion, decreased respiratory stimulation, decreased risk of trauma (particularly to the larynx), and avoidance of the use of neuromuscular blocking agents.[2] The use of the LMA for T&As is not without potential complications, with 2 of the most common being mechanical obstruction with placement of the mouth gag by the surgeon and surgical access. The surgeon's training and preference and the experience level of the anesthesia provider are important factors that should not be over-looked.

A review of the literature examining patient outcomes and satisfaction of all involved may lead to a change in care for this patient population.

The PICO Question

The key to any successful search for evidence begins with the development of a well-focused clinical question. The patient, intervention, comparison, and outcome (PICO) design helps facilitate this search for evidence.[5] The PICO question guiding the literature search was "In pediatric patients undergoing T&A (patient), does the LMA (intervention) compared with an ETT (comparison) provide a safe and effective means of airway management (outcome)?"

Search Strategy

The search for evidence was conducted using the following databases: PubMed (1990-2014), National Guideline Clearinghouse (1990-2014), and the Cochrane Library (1990-2014). Keywords and keyword strings used for the search included "pediatric(s)," "laryngeal mask airway," "LMA," "endotracheal tube," "T&A," " tonsillectomy," "adenoidectomy," "adenotonsillectomy," and "complications," alone or in combination.

The search for evidence was limited to systematic reviews with and without meta analysis, interventional studies, and observational studies. English language peer reviewed journal articles and evidence based clinical practice guidelines from professional organizations and governmental websites comparing the use of LMA with ETT for pediatric T&A were included. Evidence comparing the use of LMAs with ETTs in adults was excluded.

The title of each evidence source was reviewed to determine if inclusion criteria were met. The abstract was reviewed and the full text examined. The reference lists from included articles were searched for additional evidence. Surgical colleagues of the one of the authors (JR) were interviewed for potential sources of evidence. Any sources received from these experts went through the same steps to determine if inclusion criteria were met. Records were maintained for these sources after each level of review. Studies included in an appraised systematic review were not appraised.

Critical Appraisal of the Literature

Seven citations[4,6-11] met the search criteria (Figure 1). Critical appraisal of the evidence followed the methods outlined by Melnyk and Fineout-Overholt.[12] Table 1 contains the evaluations of five randomized controlled trials (RCTs),[4,6-9] a retrospective review[11] comparing the use of LMA to the ETT for pediatric T&A, and a prospective study[10] examining the safety of the LMA for pediatric T&A.

Authors of all the RCTs[4,6-9] randomly assigned subjects undergoing T&A using LMA or an ETT. All but 1 trial[6] used power analysis to determine sample size. Due to the nature of the trials, blinding of the anesthesia provider and surgeon was not possible. Only 1 trial[6] out of the 5 RCTs in this literature review had the advantage of being a blinded study. Postanesthesia providers and the phone surveyor who called the subjects 24 hours after surgery were blinded. This was also the only study that lost a subject to follow up, because phone surveyors were unable to reach that subject by phone. No mention of the data collectors' level of training was provided for any RCT.[4,6-9]

There were no statistically significant demographic differences between the LMA group and the ETT group in any RCT.[4,6-9] The only difference between the experimental and control group in each of these trials was the device used for airway management. All RCTs[4,6-9] sought to determine the suitability of the LMA for T&A. Three RCTs[4,6,7] involved anesthesia providers who had undergone additional pediatric training, and the other 28,[9] did not mention extra pediatric training. In an RCT,[9] 4 anesthetists participated and were experienced in pediatric intubation, but they had no experience with the LMA for T&As until the start of the study. The anesthesia providers involved in another RCT[8] spent a year before the start of the trial familiarizing anesthesia providers with the reinforced LMA.

The setting of the nonrandomized prospective study[10] was an office-based otolaryngology practice in Norway. Data were collected from 1,126 consecutive patients over a 5-year period. The authors examined whether the LMA was safe for T&A and if this procedure could be safely carried out in an office based practice. Subjects scheduled for adenoidectomy were 2 years old and older, while subjects scheduled for tonsillectomy were 3 years and older. The same surgical team was used for all procedures and consisted of a surgeon, anesthesiologist, nurse anesthetist, and nurse assistant. A reusable LMA was chosen for all patients. Data collection methods were not described in detail. All tonsillectomy patients were called 24 hours after surgery to identify problems such as sore throat.

Lalwani et al[11] reported the findings of a retrospective review conducted at a children's hospital in Oregon. Data were collected from the electronic health records of more than 1,000 subjects who underwent T&A from January 2002 to December 2006. Three pediatric otolaryngology surgeons and 15 pediatric anesthesiologists were involved in the cases, and subjects were grouped according to method of airway control.

DISCUSSION OF STATE OF THE ART

The authors of 4[4,6,8,9] of the 5[4,6-9] RCTs concluded that the LMA was a viable and overall safe alternative to the ETT for pediatric T&A. However, 1 group[4] indicated that visualization and kinking issues should be addressed. The RCT by Ranieri et al[7] concluded that the ETT was preferred over the LMA for safety.

In an RCT, Sierpina et al[6] used a reinforced LMA for pediatric T&A. Thirty-six variables were analyzed, including safety, comfort, complications, and postoperative problems. Less coughing and gagging were reported with the LMA, and no statistically significant differences in rate of respiratory complications were reported between the 2 groups. None of the subjects in the LMA group required conversion to an ETT, but all anesthetics and surgical procedures were performed by providers with specialty training in the field of pediatrics. This may affect the results in settings where specialty trained providers are not available. There was no significant difference in operative times between the 2 groups. While the authors did not state that the LMA was as safe as the ETT, it is their airway of choice in healthy, nonobese children without severe obstructive sleep apnea presenting for T&A.[6]

The remaining 3 studies[4,8,9] also determined that the LMA was an effective alternative for airway management for pediatric T&A. The anesthesia providers involved in 1 RCT[4] had received extra anesthesia training. One of the studies[4] used flexible LMAs, and 28,[9] used reinforced LMAs. In the study[4] examining use of the flexible LMA, there was kinking of the LMA in 15 subjects with insertion of the mouth gag in the study using the flexible LMA, with 8 requiring conversion to an ETT. Two additional subjects required conversion to an ETT due to poor visualization. There were no significant differences in the postoperative rate of laryngospasm or desaturation between the 2 groups.

Both RCTs[8,9] using a reinforced LMA described 5 subjects requiring conversion to an ETT. Doksrød et al[9] reported that all 5 conversions were due to poor surgical access. In the other RCT,[8] 4 of the conversions were due to transient drops in oxygen saturation, and 1 was due to an unresolved leak with positive pressure ventilation in a subject with very large tonsils. The authors[8] pointed out that all 5 conversions occurred in the first 15 cases of the study. After it was discovered that a deeper plane of anesthesia was necessary before insertion of the LMA, no other subjects required conversion to an ETT. The occurrence of postoperative laryngospasm and desaturation were the same between the ETT and LMA groups.[8]

The investigators[7] of the fifth RCT analyzed concluded that the disposable LMA could be used, but the ETT was preferred for safety. They pointed out a greater incidence of desaturation due to unresolved leaks in the LMA group after establishment of the surgical field. Eight subjects in the LMA group developed a leak after hyperextension of the neck, which was unresolved after repositioning the LMA. One subject in the LMA group regurgitated and required conversion to an ETT. There were no significant differences in the operative time or rate of laryngospasm between the 2 groups.

The prospective study[10] provided a lower quality of evidence. A reusable LMA was used for all subjects unless a complication arose. Six subjects required repositioning of the LMA before the start of surgery, and conversion to ETT was required in 7 cases. It was not reported if repositioning was needed before or after insertion of the mouth gag. Six of the subjects who required conversion to an ETT had an air leak around the LMA, which may have been the result of using a flexible, reusable LMA. One subject required intubation at the end of surgery due to atelectasis from a bronchial plug. There was no discussion of how the sample size was determined or why a flexible LMA was chosen. Neither was there any discussion of the age of the subjects who required conversion to an ETT.

The retrospective review[11] also provided a lower quality of evidence. There were no statistically significant demographic differences among the LMA success, LMA failure, and ETT groups. The investigators identified predictors of failure and complications with the LMA and concluded that an LMA was an alternative technique for T&A. Of 1,162 subjects (LMA 37.6%, flexible LMA 2.7%, ETT 59.7%), the LMA failed 33 times, with almost 80% of the failures occurring during induction or insertion of the mouth gag. Age, type of surgery, mode of ventilation, and surgeon were associated with LMA failure. It is important to note that 1 surgeon and adenoidectomy alone had a statistically significant lower rate of failure, whereas the younger age of the subject and the use of controlled ventilation were associated with a statistically significant higher rate of failure. Self-report bias and lack of randomization were limitations of this retrospective review. It was impossible to determine if the experience level of the anesthesiologist affected outcomes, due to the low number of subjects per anesthesia provider.

SUMMARY

While all evidence[4,6-11] showed that it is possible to use an LMA for pediatric T&A, all investigators did not fully support its use in this setting. The authors of 6 of the evidence sources[4,6,8,9,-11] determined that the LMA was an overall safe and viable alternative for pediatric T&A, but 1 group[4] indicated that the issues with kinking and visualization needed further study. Only 1 source[7] concluded that the ETT was preferred over the disposable LMA for safety. The retrospective review[11] indicated that the LMA is an alternative to an ETT for T&A.

The reinforced LMA was used in 3 of the trials[6,8,9] supporting the use of the LMA, and the flexible LMA was used in the 2 trials[4,7] reporting issues with kinking and other complications. Although the investigators of a large study[10] successfully used a non-reinforced LMA, they concluded that the type of LMA used could have been responsible for its failure. Age may also play a role in failure of the LMA. Lalwani et al[11] reported that, as age decreased, the rate of failure increased. It should be noted that the flexible LMA was used in all subjects in this review.

Anesthesia providers must choose the airway management method in conjunction with the surgeon and consider the risks and benefits of each device. To increase safety, it is important that the anesthesia provider has experience using the LMA in the pediatric population. The cooperation of the surgeon is also necessary, because adjustment of the LMA or mouth gag may be necessary.

Future research should compare the reinforced LMA with the flexible LMA to determine if it provides better surgical access, visualization, and reduced kinking or displacement (or both) on insertion of the mouth gag. Because a benefit of using the LMA is decreased respiratory stimulation, the inclusion of subjects with asthma or recent upper respiratory infections should also be considered.

Short Biographical Statement

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Figure 1 —Evidence Comparing the Use of the Laryngeal Mask Airway to the Endotracheal Tube for Pediatric Adenotonsillectomy

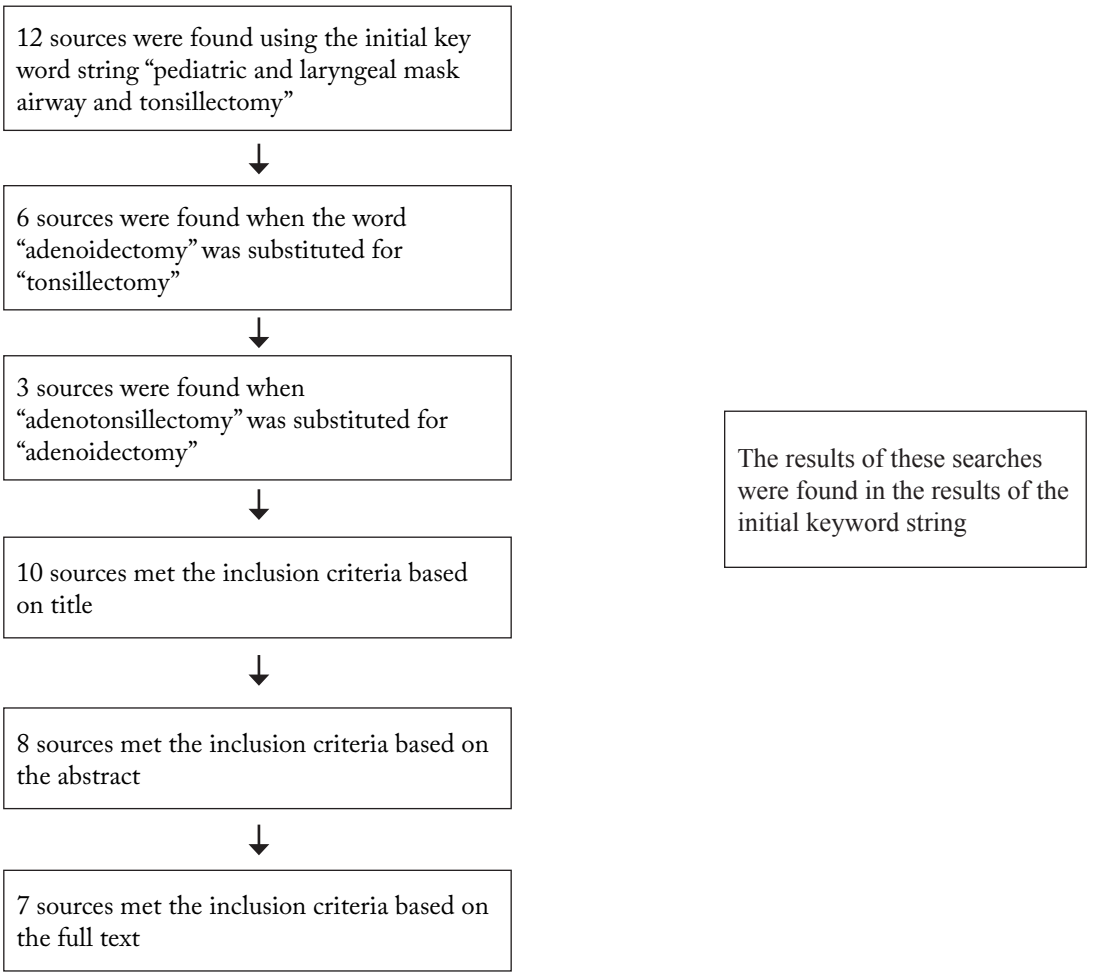

Table 1

Evidence Source	Type and level of evidence[a] Sample size LMA Type	Outcome	Comments
Webster et al[9] (1993)	Randomized clinical trial Level II 109 Reinforced	LMA inserted faster than ETT in 91% of cases (P<.001) HR and MAP less (P<.001) in LMA group	Sample size determined using a power analysis 5 subjects were converted to ETT early in the study when providers were unfamiliar with the LMA for T&A
Gravningsbråten et al[10] (2009)	Prospective study Level III 1,126 Reusable	Conversion from LMA to ETT occurred in 6 subjects (0.5%) due to leakage with ventilation 1 subject (0.1%) required intubation with lavage and suction due to a bronchial plug at the end of the operation	The same team performed all cases No randomization; the LMA was the first choice for airway management

Doksrød et al[8] (2010)	Randomized Single center trial Level II 134 Reinforced	5 LMA cases converted to ETT due to inferior surgical access Significantly less pain in LMA group (P=.015) during first 4 hours	Randomization based on computer generated program Case completion rate with LMA was 92.8% Faces/Pain Scale was used, and subjects/ parents were instructed in its use Sample size based on 80% statistical power and a level of 5%
Peng et al4 (2011)	Randomized clinical trial Level II 134 Flexible	No statistically significant difference in rate of laryngospasm or adverse perioperative events No statistically significant difference in total anesthesia, surgical, or recovery times	Sample size determined using a power analysis Data from 12 subjects in the LMA added to ETT, so did not follow intention to treat
Sierpina et a[16] (2012)	Randomized clinical trial Level II 117 Flexible	Less coughing and gagging during anesthesia for all surgeries with LMA but no difference between the ETT tonsillectomies	Recovery nurses and phone surveyors were blinded No discussion of how sample size was determined
Ranieri et al[7] (2012)	Randomized clinical trial Level II 204 Disposable	No significant difference in respiratory complications 4 subjects converted to ETT Greater incidence of SaO2 decreased in LMA after operative field established (P=<.001)	Single surgical and anesthesia team Specific definitions for each respiratory complication were provided LMA repositioned; if leak still present, converted to ETT to avoid hypoxemia or other complications Limitations due to nature of study include lack of randomization and possible self-report bias
Lalwani et al[11] (2013)	Retrospective review Level IV 1,199 Flexible (2.7%, of subjects) LMA type not described (37.6% of sub-jects) ETT (59.6%	Overall failure rate of the LMA was 6.8% Adenoidectomy alone had lower odds of failure compared with tonsillectomy or T&A (OR 0.28, 95% CI 0.15-0.52) One surgeon associated with decreased odds of failure (OR 0.46, 95% CI 0.45-0.48) Younger subjects associated with increased odds of failure (OR 1.05 for each year decrease in age, 95% CI 1.03-1.07) Controlled ventilation associated with increased odds of failure (OR 7.17, 95% CI 4.99-10.32) Unable to compare outcomes between anesthesia providers due to inadequate number of cases per provider	Unable to compare outcomes between anesthesia providers due to inadequate number of cases per provider

[a]From Melnyk and Fineout-Overholt[12]

CI, confidence interval; ETT, endotracheal tube; HR, heart rate; LMA, laryngeal mask airway; MAP, mean arterial pressure; OR, odds ratio; T&A, adenotonsillectomy; S_aO_2, oxygen saturation of hemoglobin in arterial blood.