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Systematic Review

Comparison of Endotracheal Tube (ETT) and Laryngeal Mask Airway (LMA) in Pediatric Anesthesia: A Systematic Review

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Abstract

The present systematic review compares the effects of the laryngeal mask airway (LMA) and the endotracheal tube (ETT) on hemodynamic response and airway difficulties in pediatric anesthesia patients. The terms "children," "postoperative," "pediatrics," "laryngeal mask airway," "endotracheal tube," and "subglottic" were utilized. The scope of the literature review was limited to randomized controlled trials (RCTs), and PubMed, Google Scholar, and the Cochrane Library were among the databases searched. Two reviewers used the Cochrane Risk of Bias Tool to assess quality. Eight RCTs in total were included. When compared to the ETT, results showed that the number of attempts for endotracheal intubation was fewer than for the placement of the LMA. Additionally, there was an increase in blood pressure, heart rate, and mean arterial pressure with the use of the ETT. The incidence of postoperative respiratory complications, including laryngospasm, bronchospasm, and sore throat, was higher with the use of the ETT. We conclude that the use of the LMA can be a safe alternative to the ETT in pediatric patients, producing fewer hemodynamic changes and postoperative complications.

Introduction and Background

Compared to the adult airway, the pediatric airway is less developed and much more compliant. Studies have shown that, due to the lack of muscular tone during general anesthesia, pediatric patients are more likely to experience airway collapse [1]. Before intubation, a thorough examination of the airways is essential to determine the risk of a difficult airway.

One of the critical life-saving skills that anesthesiologists possess is intubation. Additionally, they have a solid training background and a fundamental understanding of the various types of airway devices. The choice and type of airway device are at the discretion of the clinician after considering numerous factors, including the length and type of surgery, the patient's risk of aspiration, and the need for ventilation rather than intubation. Securing the airway is the primary indication for the use of these airway devices. Even with advancements in anesthetic practice, anesthesiologists' primary responsibility is to continuously ventilate and oxygenate patients while under general anesthesia. The ETT and the LMA are the two most widely used airway devices in elective surgeries.

Endotracheal Tube (ETT)

During general anesthesia, the patient's airway is secured with the ETT. It can serve as a conduit for ventilation and oxygenation of the lungs and has been the gold standard for airway control for many years. It is a tube that goes through the trachea and is positioned between the vocal cords, with the cuff inflated for positioning [2]. A laryngoscope or video laryngoscope is needed to see the cords. Adult ETTs are typically sized 7.0 for women and 8.0 for men. According to Alvarado & Panakos, the ETT size formula for children is (Age/4 + 3.5) for cuffed tubes and (Age/4 + 4) for uncuffed tubes [3]. Despite its popularity, there are several drawbacks, such as laryngospasm, a sore throat following extubation, and damage to the tracheal mucosa [4].

Laryngeal Mask Airway (LMA)

The laryngeal mask airway (LMA) is a supraglottic device that has become more well-known in anesthesia, particularly for procedures that don't require muscle relaxants and elective surgeries. LMAs have also been used for short-duration surgeries that require only ventilation for the patient. The Proseal laryngeal mask airway (PLMA) was developed in 1981 by Dr. Archie Brain as a substitute for the ETT for airway management. It is one of the most widely used forms of LMA [5]. Due to its benefits, which include being non-invasive, having a rapid placement time, a decreased rate of postoperative morbidity, and a minimal chance of damaging the tracheal mucosa, the LMA has become more favorable [6]. Nevertheless, some of the contraindications for the use of the LMA include severe lung illness, obesity, aspiration risk, and airway obstruction below the larynx, which makes the endotracheal tube a better option [7].

American Society of Anesthesiologists (ASA)

The ASA classification system is a tool widely used in the practice of anesthesia to classify the overall health status of a patient undergoing surgery and to stratify risks [8]. It is based on five classes (I to V) [9]:

i. The patient is a completely healthy, fit individual.

ii. The patient has a mild systemic disease.
iii. The patient has a severe systemic disease that is not incapacitating.
iv. The patient has an incapacitating disease that is a constant threat to life.
v. A moribund patient who is not expected to live 24 hours, with or without surgery.

Accurate assessment is essential because research has demonstrated that misclassification can have a major impact on perioperative mortality and morbidity.

While the use of the LMA is still debatable, the ETT has long been regarded as the gold standard in pediatric anesthesia. There has been limited research on LMA use in pediatric anesthesia, even though studies have validated its usage in adults. Thus, in our systematic review, we compare ETT versus LMA use in anesthesia patients by assessing outcomes, including insertion attempts, hemodynamic changes, and postoperative respiratory complications.

METHODS

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standards were followed in the conduct of this systematic review. For this investigation, ethical approval was not required, as this research paper uses exclusively publicly available research papers [10].

On October 29, 2023, a thorough search was initiated using PubMed, Google Scholar, and Cochrane databases. The advanced search engine was used to conduct the search. The terms 'laryngeal mask airway,' 'endotracheal tube,' 'pediatrics,' 'anesthesia,' 'postoperative,' and 'laryngospasm' were used. Additional terms included 'children' and 'supraglottic device.' For a more focused search, advanced filters such as publication date (2006–2023), English language, and RCT were applied. By reviewing each study's reference section, additional studies were found.

Inclusion Criteria

The systematic review was limited to randomized controlled trials published between 2006 and 2023 and written in English. Studies that included pediatric participants with an ASA status of I/II, between the ages of 1 and 12 years old, and undergoing elective surgery were selected and included.

Exclusion Criteria

Studies that included pediatric patients with an ASA status of III or higher, an anticipated or history of difficult airways, an upper respiratory tract infection, or were obese were excluded. Additionally, studies that included adult patients older than 18 years were also excluded.

Quality Appraisal

To find pertinent papers, two researchers (E.R. and K.H.) independently examined abstracts and titles. The Cochrane Risk of Bias Tool was then used by the two researchers (E.R. and K.H.), and the data was formulated in an Excel spreadsheet. The data was then reviewed and re-analyzed collaboratively by the two researchers. Articles that satisfied the inclusion criteria were included. Any inconsistencies were resolved with a third researcher (A.K.). Table 1 displays the evaluation findings for the listed studies.

Reference	Dar et al. [11]	Gaikwad et al [12]	Khoshfetrat et al. [13]	Devi & Narasimhan [14]	Jamil et al [15]	Lalwani et al [16]	Afzal [17]	Obsa et al [18]
Domain 1: Risk of bias arising from the randomization process	+	+	+	+	-	+	+	+
Domain 2: Risk of bias to deviations from the intended interventions	+	+	+	+	+	+	+	+
Domain 3: Missing outcome data	+	+	+	+	+	++	-	+
Domain 4: Risk of bias in measurement of the outcome	++	+	+	+	+	++	+	++
Domain 5: Risk of bias in the selection of the reported result	+	-	+	+	+	+	+	+
Overall risk of bias	+	+	+	+	++	+	++	+

Low risk of bias	High risk of bias	Unclear risk of bias
+	++	-

Table 1: Cochrane Risk of Bias Tool for Included Studies

Data Collection

Data collection was conducted individually for the final articles after the quality assessment. The following data was collected: i) author/year of publication; ii) purpose of the study; iii) pros of the LMA vs. ETT; iv) cons of the ETT vs. LMA; v) type of study.

RESULTS

Using our databases, a total of 1,696 studies were located: 102 from Cochrane, 144 from PubMed, and 1,450 from Google Scholar. After removing 210 duplicate studies, a total of 1,325 were excluded before screening due to ineligibility. Based on the titles and abstracts screened, 161 pertinent studies were selected for further analysis; 107 of them were ultimately discarded. After retrieving full-text studies from the remaining 33 studies, 25 were further excluded: 8 were not RCTs, 2 did not have a comparison group, 7 included the adult population, and 8 were of low quality. The final systematic review consisted of eight RCTs in total. The PRISMA flow chart for the research approach is displayed in Figure 1.

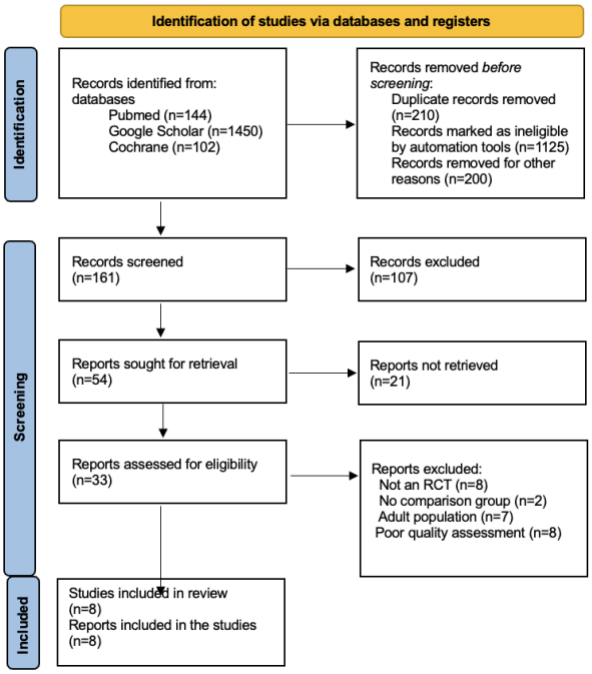

Figure 1: PRISMA flow diagram

Study characteristics

The following study characteristics of our eight RCT's are included: i) author; ii) purpose of the study ii) pros of LMA vs ETT; iv) cons of ETT vs LMA; v) study design;. This is summarized in Table 2.

Author	Purpose of the study	Pros of LMA vs ETT	Cons of ETT vs LMA	Study Design
Dar et al [11]	To evaluate the safety and efficacy of ProSeal LMA as an airway device in pediatric patients.	Hemodynamic changes less with LMA	Less post-operative complications with LMA	RCT
Gaikwad et al [12]	Comparison of PLMA with ETT for airway management in pediatrics.	No difference in hemodynamic changes	More post-operative complications seen with ETT	RCT
Khoshfetrat et al [13]	Compare LMA and ETT in incidence of laryngospasm after surgery in pediatric patients	Less postoperative risks	More risk of laryngospasm with ETT	RCT
Devi & Narasimhan [14]	Compare pediatric proseal LMA with ETT for intubation	Less insertion attempts with ETT, higher high-rate response.	More postoperative complications with ETT	RCT
Jamil et al [15]	Efficacy of LMA for positive pressure ventilation in pediatrics compared to ETT in pediatrics.	Less hemodynamic changes with LMA	More postoperative complications with ETT	RCT
Lalwani et al [16]	Compare PLMA and ETT with number of attempts for placement, hemodynamic responses, and perioperative respiratory complications in pediatrics.	Less changes with LMA	More postoperative complications and hemodynamic changes in ETT	RCT
Afzal [17]	Determine the incidence of perioperative complications related to LMA vs ETT in pediatrics.	No differences	No differences	RCT
Obsa et al [18]	Comparison of hemodynamic changes after LMA insertion and ETT intubation in pediatrics.	Less changes in hemodynamics with LMA	More changes in hemodyanmics with ETT	RCT

Table 2: Study characteristics of included studies
LMA: laryngeal mask airway; ETT: endotracheal tube; PLMA: proseal laryngeal mask airway.

Outcomes

The purpose of our systematic review is to compare the ETT and LMA in pediatric anesthesia. The outcomes that were compared include the number of insertion attempts, changes in blood pressure, heart rate, mean arterial pressure, and postoperative complications, including laryngospasm, bronchospasm, and sore throat.

Four RCTs found that, in comparison with the LMA group, patients in the ETT group needed fewer attempts to achieve insertion [11, 14, 15, 16]. Changes in blood pressure, heart rate, and mean arterial pressure were observed with the use of the ETT [11, 12, 13, 14, 15, 16, 18]. These findings suggest that, compared to the ETT, the LMA could considerably lessen hemodynamic response, achieving greater hemodynamic stability. In contrast, one RCT found that the hemodynamic responses of the two groups were not significantly different from one another [17]. Regarding postoperative complications such as laryngospasm, bronchospasm, and sore throat, three RCTs [12, 14, 15] showed a higher incidence of these complications with the use of the ETT. However, two RCTs [13, 17] argued that both the ETT and the LMA have an equal risk of postoperative complications.

DISCUSSION

Maintaining a patient's airway is one of the most important core competencies of an anesthesiologist for adequate oxygenation and ventilation. Anesthesiologists may face certain difficulties and challenges due to the differences between a pediatric airway and an adult airway. To effectively maintain oxygenation and ventilation, the anesthesiologist needs to have in-depth knowledge of the anatomy, physiology, and pathology associated with the pediatric airway. It has been demonstrated that the use of an LMA during anesthesia in children reduces the incidence of postoperative problems, including laryngospasm, bronchospasm, and sore throat, as well as the risk of hemodynamic variability. Additionally, the LMA facilitates easier insertion and first-time attempts.

The ETT had higher first-time insertion attempts than the LMA. This could be because the ETT is commonly used and is the cornerstone of a successful anesthesiologist's practice. This can be seen in a study conducted by Devi and Narasinham, who discovered that anesthesiologists succeeded in intubating their patients with an endotracheal tube on their first attempt [14]. These findings align with other studies conducted by Lalwani et al. and Dar et al. [16, 17]. In contrast to these findings, Jamil et al. reported a first-time success rate while inserting the LMA [15].

Sustained and substantial increases in blood pressure, heart rate, and mean arterial pressure were observed in children intubated with the ETT versus the LMA. Several RCTs supported these findings [11, 12, 13, 14, 15, 16, 18]. It is hypothesized that this occurs more with the ETT due to stimulation of the sympathetic system while lifting the glottis during laryngoscopy [19]. In contrast, the Afzal study [17] found no significant difference between the groups and concluded that both the ETT and LMA were similar. Furthermore, the LMA has

increased in use due to fewer hemodynamic changes and intraoperative complications.

Laryngospasm, bronchospasm, and sore throat are frequent postoperative complications that may occur after extubation. The incidence of these problems has been observed more with the ETT compared to the LMA [12, 14, 15]. The ETT's irritation of the tracheal mucosa and the cuff's inflation are the primary causes of these problems [20]. These complications, particularly laryngospasm, can harm patients and increase their chances of developing long-term problems. Even though it was reported that the LMA had a reduced incidence of cough and sore throat, we found multiple RCTs that revealed that laryngospasm and bronchospasm did not differ between the two devices [13, 17]. It can be suggested that the LMA does not irritate the tracheal mucosa, resulting in a lower risk of bronchospasm, laryngospasm, and sore throat.

The choice of airway devices is not solely determined by the type or duration of surgeries; it is based on patient factors, including specific contraindications such as severe lung diseases, obesity, aspiration risk, and airway obstruction [7]. Although the LMA is a good alternative to the ETT, anesthesiologists still choose to use the ETT despite its known hemodynamic changes and postoperative complications.

The systematic review had several limitations. The first limitation was that the population did not include children with difficult airways. Secondly, more RCTs involving a larger number of patients with long-term follow-up are needed to strengthen the validity of the studies. Thirdly, in all the RCTs included, there was a distinction between whether cuffed or uncuffed ETTs were used, which could impact the frequency of laryngospasm and bronchospasm.

Conclusion

In conclusion, the LMA provides a satisfactory airway for pediatric anesthesia patients. The LMA has a lower hemodynamic response than the ETT. Additionally, fewer postoperative complications occur with the LMA compared to the ETT. Therefore, the LMA is a suitable alternative to the ETT for children undergoing elective surgical procedures.

Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services information: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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KH located relevant studies and contributed to the initial draft of the manuscript. KS helped with the introduction and background sections. SN helped with the methods section, including defining the eligibility criteria and devising a search strategy. AK contributed to the results section, including the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram. Furthermore, CH provided valuable insights and expertise for the discussion section and explored the limitations associated with the study. All authors read and approved the final manuscript. PH supervised the process and helped with edits.

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