https://doi.org/10.3329/cbmj.v13i2.75307

Comparison of Incidence of Laryngospasm between Laryngeal Mask Airway and Endotracheal Tube during the Recovery Phase following Urological Procedure in Paediatric Patients

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Abstract

Airway-related issues pose significant perioperative complications in paediatric anaesthesia, with laryngospasm being particularly noteworthy. The choice of airway device has been identified as a contributing factor to this concern. This research was conducted from January to December of 2023; it specifically investigated and compared the incidence of laryngospasm following removal of a laryngeal mask airway (LMA) versus an endotracheal tube (ET) in paediatric patients undergoing elective urological procedure. Sixty ASA – I/II patients, aged 2 to 5 years and of both genders, were randomly allocated into two groups: Group I received ETT, while Group II received LMA. Various parameters including hemodynamic measures and the occurrence of laryngospasm, cough, and other complications were assessed. Results demonstrated a higher incidence of laryngospasm and cough in the ET group compared to the LMA group ($p<0.05$). However, no significant differences were observed between the groups regarding other complications such as bradycardia, apnoea, desaturation, shivering, and abdominal distension. Adoption of a laryngeal mask airway (LMA) instead of an endotracheal tube (ET) during elective urological procedures in paediatric patients may lead to a lower occurrence of laryngospasm.

CBMJ 2024 July: vol. 13 no. 02 P: 183-191

Keywords: Laryngospasm, laryngeal mask airway, endotracheal tube, urological procedure

Introduction

Preventing laryngospasm is an important consideration during induction, maintenance and emergence phases of general anaesthesia.[1,2] Laryngospasm more commonly happens in pediatric anesthetic practices than adults.[3] Research showed that the incidence of

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laryngospasm after surgery to be as frequent as 21%–26%.[3,4] Key factors that can provoke laryngospasm include insufficient anesthesia depth, inadequate pain relief, the use of a suction catheter, irritation caused by thiopental sodium or inhalational agents, airway stimulation, tracheal intubation, anatomical airway abnormalities, and upper respiratory tract infections. Moreover, surgical procedures that induce parasympathetic activity, such as tonsillectomy, adenoidectomy, appendectomy, anal dilation, urogenital surgery, and thyroidectomy, can also contribute to the occurrence of laryngospasm.[5-7]

For pediatric patients, endotracheal tubes have long been the go-to option for airway management. Especially those with cuffs reliably secure the airway and prevent aspiration (Kaplan A, 2004). Recently, there's been a growing interest in investigating the potential connection between this outcome and the choice of airway device during anesthesia. Despite the endotracheal tube (ET) being the established standard for airway management, studies have shown a higher occurrence of laryngospasm, likely due to direct irritation to the larynx and trachea.[8]

Using the laryngeal mask airway (LMA) offers benefits such as avoiding stimulation of the larynx and vocal cords. It serves as a viable alternative to the endotracheal tube (ETT) for managing the airway, providing stable hemodynamics and reducing perioperative respiratory issues like sore throat, coughing, desaturation, bronchospasm, and postoperative nausea.[9] However, drawbacks of the LMA have been noted, including challenges in visualizing the surgical area and potential issues like leakage or kinking, which can hinder ventilation.[10] In children, the LMA is frequently used instead of tracheal intubation, offering advantages such as avoiding direct contact with the tracheal surface, not requiring direct laryngoscopy for placement, promoting improved hemodynamic stability during anesthesia induction and emergence decreasing the incidence of coughing and throat discomfort, enhancing oxygen levels, and reducing the amount of anesthesia needed for airway management.[11]

As of now, and based on our understanding, there haven't been any robust randomized trials directly comparing the occurrence of laryngospasm after removing a laryngeal mask airway (LMA) versus an endotracheal tube (ET) in pediatric patients under general anesthesia. We also looked into other complications like dysphagia, dysphonia, gastric inflation, coughing, oxygen desaturation, bradycardia, and soft tissue trauma. Hence, we devised a randomized controlled trial with the hypothesis that the rate of laryngospasm would be lower in pediatric patients who receive an LMA compared to those who receive an endotracheal tube (ET).

Methods

This multi-centred, prospective, randomized, single blind study was conducted from January to December of 2023. It involved 60 paediatric patients aged between 2 to 5 years, categorized as ASA class I and II, who were scheduled for urological surgery under general anaesthesia. Exclusion criteria comprised recent airway infections within 15 days, surgical positions other than supine decubitus, procedures lasting over

120 minutes, gastroparesis, gastroesophageal reflux, difficult airway conditions, anticipated postoperative mechanical ventilation, morbid obesity (BMI≥40 kg/m^2), and uncontrolled cardiovascular or respiratory conditions.

Patients underwent evaluation in the pre-anaesthetic check-up area, where their medical history was reviewed, and eligibility criteria were confirmed. Subsequently, patients and their parents were invited to participate in the study, and informed consent was obtained. Written consent was acquired from parents or legal guardians, and if appropriate, written assent was obtained from the patient. Parents were briefed about the available airway management options (LMA or ET) before general anaesthesia. Following parental consent, sixty children were randomly allocated to either the ET group (Group A) comprising 30 patients or the LMA group (Group B) comprising 30 patients. Randomization was performed using Random Number Generator Software.

On the surgical day, patients were instructed to fast for specific durations: 8 hours for regular or heavy meals, 6 hours for light meals, and up to 2 hours for clear fluids before the surgery. Upon arrival at the preoperative room, patients had an IV cannula of either 22G or 24G inserted into an upper limb.

Preoperative deficits and maintenance were provided to all patients in quantities deemed adequate to address the anticipated preoperative fluid loss and maintenance needs. The hourly administration of maintenance fluid was determined using the formula: hourly maintenance fluid (ml) = 4 × (first 10 kg of body weight) + 2 × (next 10 kg of body weight) + 1 × (body weight exceeding 20 kg), where body weight is abbreviated as B.W.[12] Initially, half of the total calculated replacement fluid volume was administered to patients within the first hour, with the remaining half distributed equally over the subsequent two hours. Both replacement and maintenance fluids were delivered through a pre-inserted IV cannula in an upper limb using a micro-infusion set. Lactated Ringer's infusion commenced at a predetermined rate.

Monitoring included non-invasive blood pressure measurement, heart rate monitoring, ECG and oxygen saturation (SpO_2). General anaesthesia was initiated with intravenous propofol (2mg/kg) and fentanyl (1.5µg/kg), LMA / ETT insertion was facilitated with suxamethonium. Then anaesthesia was maintained with isoflurane in a 50% O_2–N_2O gas. Neuromuscular blocking agents were administered during controlled ventilation.In all cases, after LMA / ETT insertion; caudal epidural analgesia was given.

Table-I: Laryngeal mask airway size and cuff inflation volume according to body weight

LMA size	Body weight (kg)	Cuff inflation volume (ml), LMA size ×5
1	<5	5
1.5	5–10	7.5
2	10–20	10
2.5	20–30	12.5
3	30–50	15

In group A, patients were intubated with the Endotracheal Tube (ET) (Well Lead Oral Endotracheal Tube, SSEM Mthembu Medical Ltd, South Africa), with the size and inflation of the balloon cuff determined based on the patient's age. In group B, the Laryngeal Mask Device (LMA Classic Airway, Teleflex Medical Europe Ltd, Ireland) was utilized. The size of the LMA and the volume of air for cuff inflation were selected based on the patient's body weight (see

Table-I).[13] Tracheal tube size was determined using an age-based[14] formula [internal diameter in mm = 0.25 x (age in years) + 3.5], with the final selection made by the attending paediatric anaesthesiologist ensuring satisfactory air leakage at a maximum of 20cm H_2O airway pressure. Mechanical ventilation via a circle system was employed to control ventilation, with adjusted tidal volume. After the procedure, removal of LMAs or ETs occurred upon the patient meeting standard extubation criteria, including the return of airway reflexes, grimace, and regular spontaneous respirations. Patients were considered eligible for discharge from the recovery room once they achieved two consecutive modified Aldrete scores of 9 or 10. The time when patients were assessed as suitable for discharge from the recovery room was documented.

We assessed the occurrence of laryngospasm in both study groups. We also monitored desaturation (SpO_2) [where oxygen saturation (SpO_2) levels drop below 90%], bradycardia (a heart rate below the 5th percentile for the relevant age group), apnoea, coughing, shivering, and any other associated complications. Data were collected and recorded in separate forms, including patient demographics and clinical information sourced from hospital records and anaesthesia records. Baseline characteristics of the participants were summarized using frequencies and percentages for qualitative variables. The discrepancy in proportions between the two groups concerning the incidence of laryngospasm was assessed using the Chi-square test for statistical significance. Statistical analysis within groups was conducted using paired student t-tests, while comparison between groups utilized unpaired t-tests. Each result was presented with its corresponding 95% confidence interval (CI) and P-value, with statistical significance defined as a P-value below 0.05. All analyses were performed using SPSS 26.0 software.

Results

The study involved 60 children who were enrolled, with eligible pediatric patients randomly divided into two groups for comparison of data. Table-II displays the baseline patient characteristics, revealing that the demographic traits of both groups are similar. This suggests that they are adequately matched for the study or analysis being undertaken. There is no significant difference in the distribution of surgery types between the two groups (p = 0.995), indicating similarity in the surgical procedures performed on the patients in both groups (table-III). After comparing heart rate (HR) and mean blood pressure (MBP) between the groups, there was no significant difference observed (Fig. 1 & 2). In Group A, 13.3% experienced mild laryngospasm, 10% experienced moderate laryngospasm, and 3.3% experienced severe laryngospasm.In Group B, 3.3% experienced mild laryngospasm, 3.3% experienced moderate laryngospasm, and none experienced severe laryngospasm. The difference in the incidence of laryngospasm between the two groups is statistically significant (p=0.038), which suggests that Group A had a higher incidence of laryngospasm during the recovery period compared to Group B (Table-IV). Among all adverse events, coughing was reported in 33.3% of patients in Group A and 10% in Group B, showing a statistically significant difference (p=0.028), while other adverse events showed no significant difference between the two groups (Table-V).

Table-II: Demographic characteristic of patients (n=60)

Characteristic		Group A (n=30)	Group B (n=30)	P value
Age (yrs.)		3.7±0.6	3.4±0.7	0.07*
Weight (kg)		14.9±2.0	14.6±1.4	0.09*
Sex	Male	19 (63.3%)	21(70%)	0.584**
	Female	11(36.7%)	9(30%)	
ASA class	Class I	23 (76.7%)	21(70%)	0.559**
	Class II	7(23.3%)	9(30%)	
Duration of anesthesia (minutes)		51.2±3.2	53.3±1.5	0.83*
Duration of surgery(minutes)		65.8±2.7	68.5±1.9	0.77*

Values were expressed as mean±SD and values within parenthesis indicates corresponding percentage (%), p value was determined by *Student t-test and **Chi-square test (χ2)

Table-III: Distribution of patients as types of Urological Procedure

Types of surgery	Group A (n=30)	Group B (n=30)	P value
Circumcision	5 (16.7%)	6 (20%)	0.995
Orchidopexy	5(16.7%)	6 (20%)	
Urothroplasty	6 (20%)	6 (20%)	
Meatotomy	5(16.7%)	4 (13.3%)	
Hernia	4(13.2%)	4 (13.3%)	
Cystoscopy	5(16.7%)	4 (13.4%)	

Values were expressed as frequency within parenthesis indicates corresponding percentage (%), p value was determined by Chi-square test (χ2)

Fig. 1: Comparison of heart rate (HR) during perioperative period (n=60)

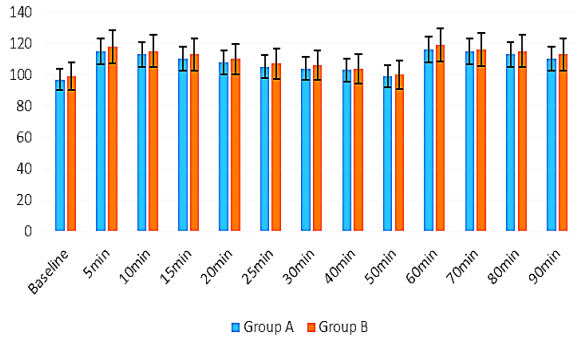

Fig. 2: Comparison of mean blood pressure (MBP) during perioperative period (n=60)

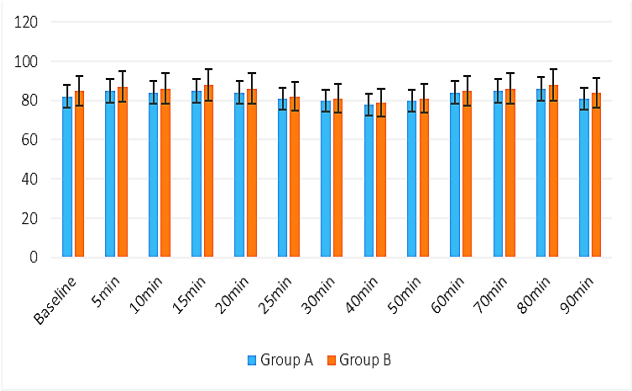

Table-IV: Incidence of laryngospasm during recovery period

Degree	Group A (n=30)	Group B (n=30)	P value
Mild	4(13.3%)	1(3.3%)	0.038[SS]
Moderate	3(10%)	1(3.3%)	
Severe	1(3.3%)	0	
Total	8(26.7%)	3(6.6%)	

Values were expressed as frequency within parenthesis indicates corresponding percentage (%), p value was determined by Chi-square test (χ2)

Table-V: Adverse events during recovery period

Events	Group A (n=30)	Group B (n=30)	P value
Coughing	10 (33.3%)	3 (10%)	0.028[SS]
Bradycardia	3 (10%)	2 (6.7%)	0.667
Apnea	4 (13.3%)	3 (10%)	0.741
Desaturation	5 (16.7%)	2(6.7%)	0.381
Shivering	5(16.7%)	4(13.3%)	0.827
Abdominal distension	3(10%)	5(16.7%)	0.287

Values were expressed as frequency within parenthesis indicates corresponding percentage (%), p value was determined by Chi-square test (χ2)

Discussion

A smooth recovery from anesthesia is preferred because sudden movements such as bucking and coughing upon awakening can trigger bleeding, leading to further airway irritation and potential complications like laryngospasm. The Laryngeal Mask Airway (LMA) has gained widespread acceptance in pediatric anesthesia, initially designed for challenging airway scenarios. Its advantages over tracheal intubation in reducing respiratory issues in patients with undiagnosed upper respiratory tract infections have been underscored. In our study, we standardized the use of size 2 laryngeal mask airways (LMAs) for positive pressure ventilation in all patients within the LMA group, considering its established suitability for insertion and ventilation in children weighing between 10 and 20 kg. The risk of laryngospasm appears to be influenced by the depth of anesthesia during LMA removal, possibly due to its stimulating effect on the upper respiratory tract during recovery, particularly noticeable in children. Nevertheless, the incidence of laryngospasm did not differ between the use of LMA and endotracheal intubation in children under six years old according to a study.[15]

The use of the laryngeal mask airway (LMA) in pediatric anesthesia results in a significant reduction in the incidence of laryngospasm and cough compared to the use of endotracheal tubes (ET) during the post-anesthesia recovery period. Our investigation revealed that the majority of laryngospasm cases occurred during the awakening phase, with none observed during the induction and maintenance of anesthesia. Other postoperative complications such as bradycardia, apnea, desaturation, shivering, and abdominal distension showed no significant disparity between the groups. Like our study some studies observed conducted to date comparing the ETT to the LMA for use in other surgery types have shown either an increased incidence of laryngospasm when ETTs are used or no difference was detected.[16-18] Moreover, the systematic review by Yu *et al*. outlined above included seven studies that dealt with this topic.[17] Their analysis showed an increased incidence of laryngospasm in surgeries where the ETT was used compared to those in which the LMA was used.

Likewise, a study noted that following the removal of endotracheal tubes (ETT) or laryngeal mask airways (LMA), the occurrences of laryngospasm and cough were notably higher in Group A (ET) compared to Group B (LMA) ($p<0.05$). However, other complications showed no significant variance between the groups. They recommended that LMA presents a viable substitute for endotracheal intubation in elective surgical procedures for paediatric patients (Jamil SN, 2009). In a study, researchers discovered that the LMA offered several advantages over the ETT, facilitating nasal and sinus surgeries as day-case procedures. These advantages included shorter recovery times, a lower incidence of sore throat (though not statistically significant), and significantly fewer instances of coughing and laryngospasm.[19]

Certain authors have suggested that for infants undergoing elective surgical procedures, the use of laryngeal mask airways (LMAs) resulted in notably fewer complications such as laryngospasm and coughing compared to endotracheal tubes. This disparity should be taken into account when deciding which airway

device to use.[19] Recent research has demonstrated that endotracheal tubes (ETs) are linked to a higher incidence of complications compared to laryngeal mask airways (LMAs). Previous studies have highlighted several advantages of LMAs over ETs, such as a more favourable hemodynamic profile during insertion and removal, as well as a reduced occurrence of postoperative laryngopharyngeal symptoms.[20,21] This discrepancy is likely influenced by various factors, including mechanical stimulation by the ETT during intubation and particularly during awake extubation, potential intraoperative movements of the ETT requiring repositioning, lung recruitment effects after coughing, and the potential use of muscle relaxants leading to decreased functional residual capacity.[22]

Furthermore, tissue trauma caused by the ETT can trigger the release of inflammatory mediators and subsequent nerve sensitization, as well as mucosal swelling. Studies have indicated fewer cases of bronchospasm in both groups compared to infants, which suggests infants may be more susceptible to bronchospasm. In our trial, no instances of bronchospasm were recorded, possibly due to our older participants and the exclusion of patients with current upper respiratory tract infections.[23,24]

The controversy surrounding the use of the Laryngeal Mask Airway (LMA) and its potential association with increased laryngospasm incidence persists. Additionally, there's ongoing debate regarding whether to remove the LMA early or after the return of airway reflexes.[25] Our research indicates significant differences between the LMA and Endotracheal Tube (ETT) groups concerning laryngospasms post-surgery when the airway is removed. This aligns closely with findings by Dante Ranieri D *et al.* However, some studies suggest that the ETT carries a higher risk of laryngospasm induction compared to the LMA. This heightened risk has been attributed to factors such as cuff usage with ETT or the accumulation of secretions, which can serve as a potent airway stimulus.[26]

Endotracheal tubes continue to serve as valuable tools in managing the paediatric airway, particularly in cases where laryngeal mask airways (LMAs) are not suitable and when ensuring optimal airway security against aspiration is crucial. When deciding on the appropriate airway device, anaesthesiologists must consider various factors, especially in paediatric patients who are particularly susceptible to airway complications. However, the current study suggests that using a laryngeal mask airway during general anaesthesia may decrease the occurrence of complications such as hypoxemia and postoperative cough when compared to endotracheal intubation.

Conclusion

To conclude, adoption of a laryngeal mask airway in paediatric anaesthesia leads to a reduction in common post-anaesthetic complications in comparison to using an endotracheal tube, including the incidence of laryngospasm and postoperative cough during emergence. Consequently, it is deemed a valuable device for paediatric airway management.

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