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COMPARATIVE STUDY OF THE EFFICACY OF LARYNGEAL MASK AIRWAY OVER ENDOTRACHEAL INTUBATION IN CHILDREN

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Abstract

Background: Endotracheal intubation is now the standard of care, but it can cause complications, such as vocal cord injury and laryngeal oedema. Supraglottic airway devices (SADs) are a newer technology that offers a middle ground between facemasks and endotracheal intubation. The study aimed to investigate the efficacy and safety of the Laryngeal Mask Airway (LMA) for positive pressure ventilation with size 2 LMA in children and compare it with endotracheal intubation (ETT). **Materials and Methods:** The study was conducted in 60 paediatric ASA Grade I and II patients posted for short surgical procedures (< two hours). Patients were divided randomly into Group (E): anaesthesia with an endotracheal tube (ETT), and Group (L): anaesthesia with a laryngeal mask airway (LMA). **Results:** After the insertion of ETT, there was a greater increase in heart rate and mean arterial pressure compared to the insertion of LMA. The rise in heart rate and mean arterial pressure in the ETT group was more even after 1 min than in the LMA group. Also, the heart rate and mean arterial pressure almost returned to pre-induction values after 3 min in the LMA group, but a persistent rise was in the ETT group. The heart rate and mean arterial pressure returned to baseline values in both groups at 5 min. No significant difference exists between groups in conditions during placement and number of attempts needed, abdominal circumference and postoperative complications. **Conclusion:** The LMA is a less invasive and simpler alternative to ETT in pediatric patients, making it a satisfactory airway for positive pressure ventilation in routine elective short surgical procedures.

INTRODUCTION

The anaesthesia provider's fundamental responsibility is maintaining a patent airway for adequate respiration and gas exchange. The facemask [1] was the only alternative used to deliver an entire anaesthetic in the past. It allows gas administration to the patient without introducing any apparatus into the patient's mouth. Still, it is associated with more episodes of oxygen desaturation, difficulty maintaining an airway, and complications such as pressure effects, corneal abrasion, and foreign body aspiration. Endotracheal intubation is widely accepted to overcome these problems. However, using a facemask is associated with a lower incidence of sore throat, requires less anaesthetic depth, and is cost-efficient for short cases. Endotracheal intubation is widely accepted to overcome these problems.

The Endotracheal Tube (ETT) [2] is inserted through the larynx into the trachea to convey gases and vapours to and from the lungs. An endotracheal tube is a rapid, simple and safe non-surgical technique that achieves all the goals of airway management, namely maintaining a patent airway, protecting the lung from aspiration (can be used in full stomach patients, pregnancy, obesity, ascites), permitting leak free ventilation during mechanical ventilation, can be used in intraoral pathology and remains the gold standard procedure for airway management. An endotracheal tube is not without complications, and the insertion of an endotracheal tube needs a deeper plane of anaesthesia. The majority of these complications are as a result of a failure of the tube to pass into the trachea over an intubating device, trauma and oedema of the airway structures, oesophageal intubation, inadvertent bronchial intubation, postoperative sore throat, hoarseness, neurologic injuries, vocal cord dysfunction or granuloma, tracheal stenosis.

Supraglottic airway devices [3] are a new development in airway management, filling a niche between the facemask and tracheal tubes regarding the anatomical position and degree of invasiveness. The Laryngeal Mask Airway (LMA) was designed and ultimately released by Dr Archie Brain (1988). The insertion of LMA is easier and faster than ETT, even in inexperienced hands, can be inserted with the patient in any position where access to the mouth is possible, less invasive and associated with smooth awakening, avoids the complications of laryngoscopy and intubation, requires less anaesthesia for its tolerance, no need of neuromuscular blockade, fewer complications (coughing, breadth holding, cardiovascular changes, improved oxygen saturation, trauma, sore throat, dysphonia, dysphagia), protects from barotrauma. The possibility of accidental oesophageal or bronchial intubation is avoided. The LMA is useful in a "cannot intubate/ cannot ventilate" scenario. The LMA can also facilitate the passage of a tracheal tube, aiding in diagnostic and therapeutic fiber optic laryngo-tracheoscopy and bronchoscopy. While blood pressure and heart rate usually increase after an LMA is inserted, these increases are similar to those seen after the insertion of an oral airway. They are less marked and of shorter duration than those associated with tracheal intubation. It is advantageous in patients with myocardial or cerebrovascular disease. The LMA is especially useful in professional singers and speakers in whom the laryngeal complications of intubation would be severe. The LMA causes less change in vocal function than tracheal intubation. The LMA can also be used in children, including infants whose unusual anatomy makes tracheal intubation difficult. Even though using LMA is popular in adults, very few studies have been conducted on LMA in paediatric patients. Hence, the main objectives are to study and investigate the efficacy and safety of the Laryngeal Mask Airway (LMA) for positive pressure ventilation with size 2 LMA in children and compare it with endotracheal intubation (ETT).

MATERIALS AND METHODS

This comparative study was conducted on 60 pediatric patients with ASA grade I and ASA grade II scheduled for short surgical procedures lasting less than 2 hours at the Department of Anaesthesia, Government Medical College, Aurangabad, from June 2009- May 2012.

All procedures were performed according to Ethical Committee standards. Informed consent was obtained from all parents of the patients. The intervention was initiated after a thorough pre-operative examination and a detailed medical history according to the proforma.

Inclusion Criteria

Pediatric patients of ASA grade I and ASA grade II, aged 4-10 years and weighing 10-20 kg, were included. Patients with a healthy cardiovascular system and no contraindications to airway masks with laryngeal masks were included.

Exclusion Criteria

Patients with anticipated difficult intubation, elevated intracranial pressure, pharyngeal pathology (upper respiratory tract infection, bronchial asthma), pulmonary or cardiovascular disease, morbidly obese patients, and contraindications to the laryngeal mask airway were excluded.

Patients are kept nil by mouth 6 hours before surgery. All equipment and agents required for resuscitation and general anaesthesia are kept ready. Cardiac monitors, NIBP, pulse oximeters, and ETCO2 monitors are used for intra-operative monitoring. Heart rate, mean arterial pressure and abdominal circumference were recorded before surgery. Adequate venous access is established, and the crystalloid infusion is initiated.

Sixty patients were randomly divided into two groups of 30 patients, each receiving anaesthesia via a laryngeal mask (size 2) or endotracheal tube. Group E: Anesthesia with an endotracheal tube (ETT), and Group L: Anesthesia via laryngeal mask airway (LMA).

Group E (Endotracheal Tube): After intravenous anaesthesia induction, direct laryngoscopy was performed, and the patient was intubated with an appropriately sized cuffed endotracheal tube. The cuff was inflated until no leakage sound was heard. The tube position was confirmed by bilateral auscultation of breath sounds, and the tube was taped down.

Group L (Laryngeal Mask Airway): After intravenous anaesthesia induction, the patient's head was placed in a sniffing position. The mouth was left open. A semi-inflated LMA no.2 lubricated with 2% lignocaine jelly was inserted into the mouth with the concave side forward and blindly advanced over the tongue into the pharynx until resistance was felt. Correct placement of the LMA was judged by resistance to further downward progress and bulging of the tissues overlying the larynx. The rim was immediately inflated with air (approximately 10 ccs of air) until no sound or palpable leak.

All patients received premedication with glycopyrrolate injection (0.004 mg/kg) iv, ranitidine injection (1 mg/kg) iv, metoclopramide injection (0.2 mg/kg) iv, midazolam (0.02 mg/kg) iv, pentazocine injection (0.3 mg/kg) iv. They were then pre-oxygenated with 100% oxygen for 3 minutes. All patients were inducted with ketamine injections (2 mg/kg) iv. LMA/ETT insertion was placed under the effect of Inj. Succinylcholine (2 mg/kg) iv. After successful ETT/LMA insertion,

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anaesthesia was maintained with O2 + N2O + halothane + injection atracurium (0.5 mg/kg) iv + intermittent doses of atracurium injection (0.1 mg/kg) iv.

To ensure effective positive pressure ventilation with a taped-down ETT/LMA, observe chest wall movement, and auscultate for breath sounds. Assess for sufficient chest rise, bilateral equal air entry, and normal pulse oximeter readings. To assess ease of insertion after LMA/ETT placement, record whether insertion was easy, difficult, or impossible and the number of trials required to place the LMA properly (1, 2, or >2 trials). Complications during and after LMA/ETT insertion include laryngospasm, bronchospasm, aspiration, coughing, vomiting, and breath holding. After successful ETT/LMA insertion, anaesthesia was maintained with O2 + N2O + halothane + injection. Intermittent administration of atracurium (0.5 mg/kg) + atracurium injection (0.1 mg/kg). Vital signs of heart rate, non-invasive blood pressure, and pulse oximeter monitoring are performed perioperatively.

Hemodynamic changes are recorded before induction (baseline), immediately after intubation/LMA insertion (0 min), and 1, 3, and 5 min after intubation/LMA insertion. At the end of the surgery, any remaining neuromuscular blockage is reversed by injection. Neostigmine 0.04 mg/kg iv + injectable glycopyrrolate 0.01 mg/kg iv. The ETT/LMA was removed after a thorough aspiration of the oropharynx. Face mask oxygenation continues until the patient is transferred to the recovery room. Patients were evaluated for changes in abdominal circumference compared to pre-operative values immediately after ETT/LMA removal. Complications such as laryngeal spasm, bronchospasm, coughing, aspiration, sore throat, hoarseness, and breath holding are recorded immediately after surgery and within 24 hours.

A master chart was prepared using the available individual data from the patient proforma, following which the data was analyzed. Statistical calculation was done using Statistical Package of Social Science (SPSS) version 20. The quantitative data is expressed in terms of mean (standard deviation). Unpaired 't' and chi-square tests were employed, and a p-value <0.05 is considered significant.

RESULTS

The mean age group in group E was 5.7 ± 1.460, and in group L was 5.5 ± 1.309. The sex ratio (M: F) in group E was 14:16, and in group L was 13:17. The mean age and weight were similar between the two groups, and the sex ratio was also comparable.

Table 1: Demographic data of the study

	Group E	Group L	P-value
Age (Years)	5.7 (1.460)	5.5 (1.309)	0.547
Weight (kg)	15.7 (1.730)	15.4 (1.289)	0.584
Sex ratio (M: F)	14:16	13:17	1.0
Duration of surgery (Minutes)	34.8 (8.558)	35 (7.310)	0.935

The mean duration of surgery in group E was 34.8 ± 8.558, and in group L was 35 ± 7.310. The duration of surgery was also similar between the two groups. There is no significant difference in age, weight, sex ratio, and duration of surgery between groups (Table 1).

Table 2: Heart rate, MAP, SPO2, and abdominal circumference between groups

		Group E	Group L	P-value
Heart rate	Pre-induction	105 (6.272)	105.9 (5.388)	0.553
	0 min	128.7 (5.801)	120.9 (7.060)	<0.0001
	1 min	119.8 (4.413)	115 (6.022)	0.0008
	3 min	112.9 (4.642)	108.7 (5.344)	0.0017
	5 min	107 (5.105)	106.8 (5.365)	1.000
MAP	Pre-induction	67 (4.378)	65.3 (4.807)	0.1575
	0 min	83.5 (5.630)	77.5 (5.263)	<0.0001
	1 min	78.3 (5.466)	72.1 (4.983)	<0.0001
	3 min	73.2 (4.789)	68.2 (4.528)	<0.0001
	5 min	68.1 (4.628)	65.9 (4.704)	0.071
SPO2	Pre-induction	98.5 (1.165)	98.76 (1.072)	0.492
	0 min	98.6 (1.033)	98.4 (1.041)	0.536
	1 min	98.5 (1.041)	98.5 (1.016)	0.905
	3 min	98.6 (1.06)	98.3 (1.09)	0.408
	5 min	98.4 (1.194)	98.7 (1.01)	0.299
Changes in abdominal circumference	Pre-induction	44.3 (2.005)	44.1 (1.949)	0.745
	Post-extubation	44.7 (1.945)	45 (1.912)	0.445

The pre-induction heart rate was comparable between the two groups. However, after insertion, there was a significantly greater increase in heart rate in the ETT group compared to the LMA group.

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The rise in heart rate in the ETT group was more even after 1 minute than in the LMA group. The heart rate returned to pre-induction values after 3 minutes in the LMA group, but a persistent rise was in the ETT group. After 5 minutes, heart rate values returned to baseline in both groups. There is a significant difference in heart rate between groups at 0, 1, and 3 mins.

The pre-induction mean arterial pressure was comparable between the two groups. However, after insertion, there was a significantly greater rise in mean arterial pressure in the ETT group compared to the LMA group. The rise in mean arterial pressure in the ETT group was more even after 1 minute than in the LMA group. The mean arterial pressure returned to pre-induction values after 3 minutes in the LMA group, but a persistent rise was in the ETT group. After 5 minutes, mean arterial pressure values returned to baseline in both groups. The mean arterial pressure rises significantly in the ETT group compared to the LMA group at 0, 1, 3, and 5 min after ETT/LMA insertion.

There is no significant difference in SPO2 between groups at pre-induction, 0, 1, 3 and 5 mins. The pre-induction abdominal circumference was comparable between the two groups. After extubation, there was no statistically significant increase in abdominal circumference in the LMA group compared to the ETT group (Table 2).

Table 3: Conditions, number of attempts, and postoperative complications between groups

		Group E	Group L	P-value
Conditions	Easy	86.66%	73.33%	0.333
	Difficult	13.33%	26.66%	0.333
	Impossible	0%	0%	
Number of attempts	1	86.66%	73.33%	0.333
	2	13.33%	20%	0.730
	>2	0%	6.66%	0.491
Postoperative complications	Coughing	6.67%	6.67%	1.00
	Sore throat	13.33%	3.33%	0.353
	Breadth holding	Nil	Nil	
	Aspiration	Nil	Nil	
	Hoarseness	Nil	Nil	
	Airway obstruction	Nil	Nil	

ETT placement was easy in 86.66% of patients and difficult in 13.33%. LMA placement was easy in 73.33% of patients and difficult in 26.66%. The percentage of patients experiencing cough and sore throat was similar between the ETT and LMA groups. No other postoperative complications were noted. No significant difference exists between groups in conditions, number of attempts, and postoperative complications (Table 3).

DISCUSSION

It has been nearly 20 years since **Dr Archie Brain [4]** introduced the first supraglottic airway device-the Laryngeal Mask Airway (LMA). It now has a well-established role in managing patients with normal and difficult-to-manage airways. In the present study, we investigated the cardiovascular parameter changes during LMA and ETT placement for short-duration surgical procedures in paediatric patients. In both groups, induction was with ketamine and choline for ETT insertion/LMA placement. Our study observed a significant increase in heart rate with laryngoscopy and tracheal intubation compared to LMA placement. We maintained patients on O2+N2O+Halothane + Inj. Atracurium.

1) HEART RATE

Our study observed a significant increase in heart rate with laryngoscopy and tracheal intubation compared to LMA placement. Also, the mean changes in heart rate were highly significant at 0,1,3 minutes after ETT/LMA insertion. The heart rate returned to baseline values after 5 minutes in Group E, while it returned to baseline within 3 minutes in Group L.

Lee Y [5] et al. (1991) compared the pressure response of tracheal intubation (T group) with that of laryngeal mask insertion (L group) in hypertensive patients. They found that the changes in heart rate exhibited a similar but attenuated response pattern with laryngeal mask insertion compared to tracheal intubation.

Wood ML [6] et al. (1994) showed that the changes in all cardiovascular parameters measured following LMA insertion were significantly less ($P < 0.05$) when compared with those following laryngoscopy and tracheal intubation.

Yoshitaka Fujii et al. [7] found that the HR increased after induction of anaesthesia in both groups and remained elevated for 5 minutes in the ETT group and 3 minutes in the LMA group. The HR in hypertensive patients increased more than in normotensive patients.[15]

Montazari K et al. [8] compared hemodynamic changes after the insertion of LMA, ETT and facemask. The study found that using LMA resulted in smaller cardiovascular changes than FM or ETT.

Bhattacharya D et al. [9] found that the heart rate increase from baseline value in the endotracheal intubation and LMA groups were significant. They concluded that insertion of LMA was associated with lesser pressure response than endotracheal intubation in patients with controlled hypertension.

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Ajuzieogu OV et al. [10] study found that the heart rate increase in the ETT group was more compared to the LMA group. Laryngoscopy and intubation can lead to hypertensive 'pressure' response, while the LMA is less invasive and is relatively atraumatic to the pharynx and larynx during insertion. Bhardwaj N et al. [11] found that the heart rate increased significantly after tracheal intubation and returned to baseline 4 minutes after intubation. The heart rate increase was significantly higher in the ETT group than in the LMA group at all observation times.

2) MEAN ARTERIAL PRESSURE

In this study, the pre-induction mean arterial pressure was similar in both the ETT and LMA groups. However, there was a significant increase in mean arterial pressure just after ETT placement/LMA insertion, and the mean arterial pressure returned to baseline after 5 minutes in the ETT group and 3 minutes in the LMA group. This indicates that less pressure response was seen after LMA insertion than after ETT insertion.

Braude N [12] et al. (1989) reported a significant increase in both the systolic and diastolic blood pressure in the ETT group compared to the LMA group. Also, the rise lasted for a longer duration in the ETT group as compared to the LMA group.

In a study by Yoshitaka Fujii [7] et al., the MAP increased after the induction of anaesthesia in both groups. It remained elevated for 3 minutes in the ETT group and 1 minute in the LMA group. The changes in MAP from baseline after tracheal intubation or LMA insertion were similar in normotensive and hypertensive patients, possibly due to the hypertensive patients' pre-operative use of oral anti-hypertensives.

A study by Montazari K et al. [8] compared hemodynamic changes after inserting LMA, ETT, and facemasks. The MAP values immediately before the insertion of the device were significantly higher than the pre-induction values, but no significant differences were seen among the three groups. The mean maximum increase in MAP during 15 and 30 minutes after insertion of LMA was significantly smaller than those with FM and ETT. Thus, hemodynamic responses to LMA insertion are significantly lower than ETT and FM under halothane/N_2O anaesthesia.

A study by Bhattacharya D et al. found that the increase in systolic and diastolic blood pressure following endotracheal intubation was much higher than LMA insertion, with a significant difference ($p<0.01$) between the two groups. [9]

Ajuzieogu OV et al. found a greater increase in mean arterial pressure in the ETT group compared to the LMA group at 1, 2, 3, and 5 minutes after intubation/insertion.[10]

Bhardwaj N et al. found that both systolic and diastolic blood pressure significantly increased in the ETT group compared to the LMA group.[11]

Our study also observed a significant increase in mean arterial pressure in the ETT group compared to the LMA group. There were no significant differences in SpO2 at pre-induction, 0, 1, 3, 5 minutes intervals within and between the study groups($P>0.1$). SpO2 values were maintained in the normal range in both groups. There was no significant change in the abdominal circumference in both groups. The incidence of coughing was 6.67% in both groups, while the incidence of sore throat was 13.33% in the ETT group and 3.33% in the LMA group. No other postoperative complications were noted.

Radu AD [13] et al. found that using the LMA was associated with a lower incidence of postoperative sore throat and hoarseness than tracheal intubation.

Lee SK [14] et al. observed that the LMA causes less vocal change than tracheal intubation.

Denny NM [15] et al. showed that LMA reduces the incidence of immediate postoperative upper airway complications following general anaesthesia for cataract surgery, and its use is advantageous.

Voyagis GS [16] et al. showed that LMA, as opposed to ETT, secured normocapnia during PPV with low PIPs.

Tait Alan R [17] et al. showed that the number of respiratory complications was more in the ETT group; hence if the decision is made to proceed with anaesthesia for a child with an upper respiratory tract infection, then the LMA is a suitable alternative to ETT.

Saeki H [18] et al. suggested that LMA is most appropriate to reduce postoperative sore-throat compared to endotracheal intubation and cuffed oropharyngeal airway.

Deakin CD [19] et al. studied the time paramedical staff took to secure the airway and showed that the LMA has a higher success rate in securing the airway and overall secures the airway more reliably than ETT.

Zoremba M [20] et al. concluded that in moderately obese patients undergoing minor surgery, using the LMA may be preferable to orotracheal intubation concerning postoperative saturation and lung function.

In our study, the placement of ETT was easy in 86.66% of patients and difficult in 13.33% of patients. The placement of LMA was easy in 73.33% of patients and difficult in 26.66% of patients. The placement of ETT/LMA was impossible in none of the patients.

Laryngoscopy and endotracheal intubation cause a significant increase in heart rate and arterial blood pressure in about 90% of patients due to stimulation of the nerve endings of the vagus and trigeminal nerve. As opposed to this, laryngeal mask airway insertion does not require laryngoscopy and hence is not associated with increased cardiovascular parameters. The haemodynamic response is thus less and short-lived with a laryngeal mask airway compared to endotracheal intubation.

CONCLUSION

In conclusion, the study found that LMA is a suitable alternative to ETT for elective short-duration surgical procedures in pediatric patients. The study showed that LMA insertion was easier in most patients than ETT insertion. The study also found a significant increase in heart rate and mean arterial pressure with ETT placement compared to LMA insertion. However, there were no significant changes in abdominal circumference in both groups. The incidence of postoperative complications, such as cough and sore throat, was similar between the two groups. Ease, simplicity of use, and avoidance of postoperative complications make using LMA a satisfactory airway for positive pressure ventilation in routine paediatric use. Therefore, LMA is a suitable alternative to endotracheal intubation for elective surgical procedures in paediatric patients.

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