PROSPECTIVE COMPARATIVE STUDY OF HAEMODYNAMIC CHANGES DURING INSERTION OF LARYNGEAL MASK AIRWAY VERSUS ENDOTRACHEAL TUBE IN PAEDIATRIC PATIENTS

Roshith Thomas[1], Habib Rahaman A. A[2], Sampathila Padmanabh[3]

[1]Resident, Department of Anaesthesiology, Yenepoya Medical College, Mangalore, Karnataka, India.
[2]Associate Professor, Department of Anaesthesiology, Yenepoya Medical College, Mangalore, Karnataka, India.
[3]Professor, Department of Anaesthesiology, Yenepoya Medical College, Mangalore, Karnataka, India.

ABSTRACT

BACKGROUND & METHODS

This study was conducted to determine and compare the pressor responses associated with insertion of a laryngeal mask airway with endotracheal tube during elective surgical procedures under general anaesthesia in paediatric patients. 64 patients of age between 2-12 years weighing between 10–40 kg, belonging to ASA grade I and II, scheduled for elective surgeries under general anaesthesia were included in the study. Patients belonging to ASA grade III and IV, those scheduled for emergency surgeries and patients with anticipated difficult airway were excluded from the study. The patients were randomised into two groups of 32 each, by computer generated software. For patients in group-L, airway was secured with laryngeal mask airway. Patients in group-E, airway was secured with endotracheal tube. Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and SpO2 were recorded just before induction and subsequently at 1, 3, 5 & 10 minutes. Mean heart rate increase at 1, 3 & 5 minutes was much less when compared to Group-E (p=significant). Mean systolic blood pressure of Group-L is significantly less at 1, 3, 5 & 10 minutes than that of Group-E (p=significant). Mean diastolic blood pressure of Group-L is significantly less at 1, 3 & 10 minutes compared to Group-E (p=significant).

RESULTS & CONCLUSION

Complications like sore throat, blood staining and coughing at the end of the procedure were seen less in Group-L than in group-E. In this study, we concluded that the pressor responses were less with LMA than with endotracheal tube. Based on our conclusion, we can say that LMA can be used as an alternative to endotracheal tube in maintaining an intact airway under general anaesthesia.

KEYWORDS

Laryngeal Mask Airway, Endotracheal Tube, Pressor Response.

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INTRODUCTION: Paediatric patients are considered as difficult airway because of difficulty in endotracheal intubation due to anatomical and physiological changes. Visualisation of glottis is more difficult in children compared to adult as the larynx is placed anteriorly and subglottic area is narrower. Laryngoscopy and endotracheal intubation triggers pressor responses like tachycardia and hypertension[1] that are well recognised. The sympathetic reflex provoked by stimulation of the airway is also associated with increase in intraocular pressure,[2] intracranial pressure and rise in plasma noradrenaline levels.[3] Many airway devices have been tried as an alternative to endotracheal tube to secure airway and to provide oxygenation and ventilation. By using supraglottic airway devices, laryngoscopy and associated pressor responses can be avoided.

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Corresponding Author:
Dr. Habib Rahaman A. A,
Associate Professor, Department of Anaesthesiology,
Yenepoya Medical College, Mangalore, Karnataka, India.
E-mail: habeeb100@gmail.com
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While inserting laryngeal mask airway, visualisation of glottis is not required and insertion done blindly. Laryngeal mask airway (LMA) is considered as an alternative to tracheal intubation for securing airway and providing adequate oxygenation and ventilation. The LMA was developed by Dr Archie Ian Jeremy Brain, a British anaesthetist in 1981. The first study of a laryngeal mask in 23 patients was conducted at London Hospital in 1982. In 1991, LMA was approved by the FDA, and has been in clinical practice since 1992.[4] Recently LMA is available in different sizes suitable for paediatric age group. LMA insertion being less invasive than endotracheal intubation provokes less sympathetic stimulation. As it does not require the visualisation of cords or the penetration of trachea, it causes minimal cardiovascular and respiratory effects[5] and also minimal rise in intracranial and intraocular pressure. Lesser risk of airway injury during the perioperative period[6] has made it as a potential alternative to tracheal intubation in paediatric anaesthesia. However, there are serious concerns with regard to its efficacy in airway protection during positive pressure ventilation in children. A thorough understanding and knowledge of the anatomical differences and characteristics of a child's airway, as compared to an adult

airway is very essential for airway management in a paediatric patient. Constantly, new techniques are put forward in allowing us to administer paediatric anaesthesia in a safe and effective way. With the LMA being available in smaller assorted sizes appropriate for usage in children, the question arises as to whether the conventional endotracheal intubation brings about more risk of trauma in children whose mucosal tissues are more vulnerable to injury.[7] The present study was designed to compare haemodynamic changes during insertion of laryngeal mask airway and endotracheal intubation and the ease of insertion of laryngeal mask airway and endotracheal intubation.

METHODOLOGY: After ethical committee approval and written and informed consent from parents, the study of 64 ASA I& II patients of either sex weighing between 10-40 kilograms of age ranging between 2-12 years admitted during the period of October 2013 to October 2015, scheduled for various elective surgical procedures was commenced. All patients were premedicated with Triclofos (50 mg/kg) and Atropine (30 µg/kg) orally. All patients were allocated to one of the two groups of 32 each by computer generated randomisation. In Group E (ETT group), laryngoscopy and endotracheal intubation with appropriate sized uncuffed endotracheal tube (Romsons, India) was done while in Group L (LMA group) LMA-Excell (Romsons, India) appropriate size were inserted by the same anaesthesiologist in all patients. The cuff of LMA was inflated with air according to seal recommended by manufacturing company. Inhalation induction was done with O_2, N_2O and sevoflurane until unresponsive to pain and intravenous cannula was inserted, followed by vecuronium bromide 0.1 mg/kg IV to facilitate insertion of ETT/LMA. If LMA insertion was unsuccessful after two attempts, the patients were withdrawn from the study. The position of endotracheal tube (ETT) or LMA was checked by observing movements of chest wall and auscultation for breath sounds during controlled ventilation. The efficacy of positive pressure ventilation was assessed by observing adequate chest rise on manual ventilation, bilateral equal air entry on auscultation and normal rectangular shape capnograph tracing. Following successful ETT or LMA insertion, anaesthesia was maintained with N_2O+O_2+sevoflurane and intermittent doses of vecuronium bromide as intravenous injections. Heart rate, systolic, diastolic blood pressure, mean arterial pressure, oxygen saturation was monitored. Chest was auscultated and EtCO2 was monitored to determine the efficacy of ventilation perioperatively. Haemodynamic changes were recorded before induction (baseline), then at 1, 3, 5 min. and 10 min. after intubation. At the end of surgery, the residual neuromuscular blockade was reversed with neostigmine 0.04 mg/kg and atropine 0.02 mg/kg IV. Oxygenation was continued with a face mask in the recovery room.

RESULTS: All data are reported as mean values ± 2SD. Statistical Analysis of the demographic data was done using chi-square test. Comparison between the groups was done using student 't' test. A p value <0.05 was considered statistically significant.

	Group	N	Mean	Std. Deviation	P Value
Age (In yrs.)	LMA	32	8.06	3.192	0.825
	ETT	32	7.88	3.563	
Demographic Data - Age					

There is no statistically significant difference in age between the two groups.

	Group	N	Mean	Std. Deviation	P Value
p/I HR	LMA	32	103.88	12.088	0.294
	ETT	32	107.63	15.967	
1 min.	LMA	32	107.91	12.584	<0.001
	ETT	32	130.5	15.429	
3 min.	LMA	32	107.56	12.702	<0.001
	ETT	32	129.66	16.09	
5 min.	LMA	32	101.59	13.423	0.046
	ETT	32	108.78	14.804	
10 min.	LMA	32	102.16	13.026	0.261
	ETT	32	105.94	13.614	
Heart Rate					

Shows the mean heart rate pre-induction and at 1, 3, 5, & 10 minutes of LMA and ETT group. Statistically significant difference exists at of 1, 3 and 5 minutes and not at the end of 10 minutes.

	Group	N	Mean	Std. Deviation	P Value
p/I SBP	LMA	32	100.09	5.888	0.476
	ETT	32	101.84	12.441	
1 min.	LMA	32	107.03	6.12	<0.001
	ETT	32	125.66	9.553	
3 min.	LMA	32	105	5.43	<0.001
	ETT	32	125.63	8.838	
5 min.	LMA	32	101.41	4.976	<0.001
	ETT	32	110.78	12.391	
10 min.	LMA	32	93.97	4.869	0.003
	ETT	32	106.03	20.49	
Systolic Blood Pressure					

Shows the systolic blood pressure of LMA and ETT group pre-induction and at 1, 3, 5, 10 minutes. There is statistically significant difference at 1, 3, 5 and end of 10 minutes.

	Group	N	Mean	Std. Deviation	P value
p/I DBP	LMA	32	64.75	4.392	0.021
	ETT	32	61.03	7.622	
1 min.	LMA	32	69.78	5.216	<0.001
	ETT	32	81.31	8.719	
3 min.	LMA	32	68.22	5.505	<0.001

	ETT	32	81.59	9.304	
5 min.	LMA	32	65.94	5.435	0.434
	ETT	32	67.34	8.503	
10 min.	LMA	32	62.13	4.248	0.003
	ETT	32	66.84	7.561	
Diastolic Blood Pressure					

Shows the diastolic blood pressure of LMA and ETT group pre-induction and at 1, 3, 5, 10 minutes. Statistically significant difference is there at 1, 3 and end of 10 minutes and not at 5 minutes.

DISCUSSION: In this study, we included 64 patients divided in two groups of 32 each. We aimed at comparing the haemodynamic changes elicited by laryngoscopy with endotracheal intubation, to those elicited by laryngeal mask airway insertion. The participants were comparable in terms of age, sex, ASA class and baseline haemodynamic parameters. This study demonstrated that insertion of LMA as well as laryngoscopy and endotracheal intubation are associated with haemodynamic response consisting of an increase in heart rate, SBP, DBP and MAP. However, the response caused by laryngoscopy with ETT insertion is significantly greater than that caused by LMA insertion.

Heart Rate: Baseline mean heart rate in LMA group was 103.88; and after intubation at 1 min., it was 107.91 and at 3, 5 and 10 min. was 107.56, 101.59 and 102.16 respectively. Heart rate variability during insertion of LMA was minimal. Baseline mean heart rate in ETT group was 107.63 and after intubation at 1 min. it was 130.5 and at 3, 5 and 10 was 129.66, 108.78 and 105.94 respectively.

The heart rate changes during LMA insertion and ETT placement show marked difference clinically at 1 min. and 3 min. and also statistically significant. But heart rate changes at 10 min. were found to be statistically insignificant. So the haemodynamic changes were maximally seen up to 5 min. of LMA or ETT placement. Shribman et al concluded that the major cause of the sympathoadrenal response to tracheal intubation arises from stimulation of the supraglottic region by tissue irritation induced by direct laryngoscopy. Insertion of the tube through the vocal cords and inflation of the cuff in the infraglottic region should contribute very little additional stimulation[8]. Webster AC et al conducted a study where 55 children were randomised into LMA group and 54 children into ETT group and they found that heart rate, MAP and blood loss in the LMA group were 110±21, 74±9 mmHg and 1.92±1.22 mL/kg respectively, compared with 143±13 ($P < 0.001$), 85±12 mmHg ($P < 0.001$) and 2.62±1.36 mL/kg ($P < 0.05$) with tracheal intubation. They concluded that the need for assisted ventilation was reduced and haemodynamic responses were diminished compared with tracheal intubation.[9] Similar results were obtained in our study.

Systolic Blood Pressure, Diastolic Blood Pressure and Mean Arterial Pressure: The systolic, diastolic blood pressure, mean arterial pressure showed mild rise in LMA group as compared to endotracheal tube group from the base line values. The baseline mean systolic pressure in LMA group is 100.09. The mean SBP in LMA group at 1, 3, 5 and 10 min. are 107, 105, 101 and 94 respectively. Baseline mean diastolic pressure in LMA group is 64.75. The mean DBP in LMA group at 1, 3, 5 and 10 min are 69, 68, 65 and 62 respectively. Baseline mean systolic blood pressure in ETT group is 101.84. The mean SBP in ETT group at 1, 3, 5 and 10 min. are 125,125,110 and 106 respectively. Baseline mean diastolic blood pressure in ETT group is 61.03. The mean DBP in ETT group at 1, 3, 5 and 10 min. are 81, 81, 67 and 66 respectively. Diastolic blood pressure between the groups also showed statistically significant difference at 1, 3 and 10 minutes and not at 5 minutes. The mean arterial pressure of LMA group at 1, 3, 5 and 10 min. are 81, 79, 77 and 71 respectively and ETT group at 1, 3, 5 and 10 min. are 96, 96, 81 and 81 respectively. In a similar study conducted by Jamil SN et al found that the changes in haemodynamic parameters were significantly higher after endotracheal intubation as compared to LMA placement. Furthermore, these changes persisted for longer duration after endotracheal intubation in comparison to LMA insertion. Incidence of postoperative complications i.e. bronchospasm, laryngospasm and soft tissue trauma was significantly higher after endotracheal intubation[10.]

Ease of Insertion: Out of 32 patients in LMA group, there were 5 patients who required re-manipulation. In 27 patients who had correct placement of LMA, there was no problem with ventilation as evidenced by the pulse oximetry monitoring which showed value above 98% throughout the procedure. Endotracheal intubation was successful in all 32 patients, 2 patients required assistance while inserting ETT. Ventilation was adequate as monitored with pulse oximetry.

Complications: Insertion of airway devices leads to complications. Data for complications with the LMA classic in children show an overall incidence of complications of 12%. Common problems (5–10%) include sore throat and cough. Difficulty placing the airway, airway obstruction, hypoxaemia, laryngospasm, and blood staining of the device are more infrequent and comprise 5% of the complications. Factors affecting these complications include inexperience with use of the LMA and the increasing number of attempts required for insertion. Sore throat is more likely with higher cuff pressures, and with the PVC as opposed to the silicone constructed LMA.[11] Splinter WM et al found that postoperative sore throat after minor paediatric surgery is uncommon and if it does occur, it is mild and the incidence is unaffected by the choice of an LMA or endotracheal tube[12]. In our study, sore throat was only seen 3 out of 32 patients in the ETT group and it was not reported in the LMA group. Cough at the end of extubation was seen in 6 out of 32 patients in ETT group and 2 out of 32 patients after removal of LMA. Studies have demonstrated that Flexi LMA has advantages over endotracheal intubation in terms of improved airway recovery profile with less coughing and bucking during emergence.[13] In studies conducted by Maltby

JR et al[14] and Ozdamar D et al,[15] postoperative airway complications like sore throat, coughing, hoarseness and laryngospasm were rare during the first two hours after end of anaesthesia. However, a 2:1 case-control study including 130 cases of laryngospasm in children under 18 years conducted by Flick et al identified LMA use as an independent risk factor for laryngospasm in general anaesthesia.[16] Sierpina DI et al concluded that use of the LMA during paediatric tonsil surgery does not appear to have any major disadvantages compared to use of the ETT. In fact, analysis of safety, comfort, complications, and postoperative problems suggests that LMA may be superior for some outcome variables such as coughing and gagging. Use of spontaneous ventilation is more common among LMA patients, although the significance of this finding is uncertain[17.] In our study, laryngospasm was not seen in any of the patients. Blood staining was seen in 5 out of 32 patients in ETT group and it was not seen in LMA group.

CONCLUSION: The study conducted on 64 paediatrics patients with LMA and ETT insertion in two groups of 32 each concluded that:

1. Heart rate increased significantly after the LMA insertion as well as after endotracheal intubation. Significant increase in heart rate was seen till 5 minutes after the procedure. Heart rate increase was much higher in ETT group compared to LMA group. Heart rate returned to baseline at 5 minutes in LMA group and at 10 minutes in ETT group.
2. Systolic, diastolic and mean arterial pressure increased significantly after LMA insertion and endotracheal intubation. Increase in blood pressure was much less in LMA group compared to ETT group. Systolic, diastolic and mean arterial pressure return to baseline early in LMA group compared to ETT group.
3. Ease of insertion and adequate of ventilation was both with endotracheal group.
4. Complications like cough, bleeding and sore throat were more with the ETT insertion when compared to LMA.
5. Oxygen saturation remained above 98% in both groups throughout the period of anaesthesia.

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