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ORIGINAL ARTICLE

Comparison of the Hemodynamic Responses with Laryngeal Mask Airway *vs* Endotracheal Intubation in Adults undergoing General Anesthesia for Elective Surgeries

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ABSTRACT

Aim: The aim of this study was to compare the hemodynamic response between laryngoscopy with endotracheal intubation and laryngeal mask insertion. The study also compared immediate postoperative complications between laryngeal mask airway (LMA) and endotracheal intubation.

Materials and methods: Fifty-five American Society of Anesthesiologists (ASA) physical status I and II adult patients who underwent elective surgeries under general anesthesia were included in either group I—LMA or group II—endotracheal tube (ETT). Patients were induced with intravenous (IV) propofol, fentanyl, and atracurium. After intubation/insertion, patients were mechanically ventilated and isoflurane was used to maintain adequate level of anesthesia with N_2O/oxygen mixture. Hemodynamic parameters were measured before induction and after insertion of the airway device every minute for the first 10 minutes and every 5 minutes after that for the first half hour following insertion of the airway device.

Results: A significant and longer increase in heart rate (HR) was noted after ETT intubation as compared with LMA group. However, a decrease in systolic, diastolic, and mean arterial pressures (SBP, DBP, and MAP) was noted after both LMA insertion and ETT intubation. The decrease was significantly more in LMA group ($p < 0.001$). Complications of postoperative sore throat and hoarseness of voice were also significantly more in ETT group.

Conclusion: Pressor responses might be of no clinical importance in the healthy, normotensive patients, but might be harmful in patients with hypertension, aortic or cerebral aneurysm, raised intracranial pressure, or other cardiovascular diseases. In such cases, the attenuated response of the LMA might be desirable. Therefore, where appropriate, the use of the LMA would be recommended in such patients to avoid the marked response produced by the ETT.

Keywords: Endotracheal tube, Hemodynamic responses, Intubation, Laryngeal mask airway, Randomized controlled study.

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INTRODUCTION

The choice of securing the airway during general anesthesia often lies between endotracheal intubation and insertion of the LMA. Though intubation has many advantages including provision of a reliable airway and prevention of aspiration, it is not without complications. These include airway trauma, physiological reflexes like hypoxia, tachycardia and hypertension, malposition, laryngospasm, narrowing, and increased airway resistance as well as negative pressure pulmonary edema.[1,2]

The LMA offers a much less invasive way of maintaining the airway as it does not pass through the glottis but is placed over the glottis. It does not require instrumentation, i.e., use of the laryngoscope. It acts as an intermediate between the ETT and the oropharyngeal airway and offers some of the advantages of the ETT while overcoming the disadvantages like stimulation of the laryngopharyngeal reflex.[2] This study aimed to determine and compare the hemodynamic responses elicited by laryngoscopy and endotracheal intubation with that elicited by laryngeal mask insertion. The study also compared the immediate postoperative complications of LMA and endotracheal intubation (laryngospasm, dental/airway trauma, postoperative sore throat, hoarseness of voice, dysphonia, dysarthria, dysphagia, postoperative nausea, and vomiting).

MATERIALS AND METHODS

A prospective randomized controlled study was conducted on 110 ASA physical status I and II patients from both genders in the age group 18 to 50 years, scheduled for elective surgical procedures, of duration 1 to 2 hours under general anesthesia. Ethical clearance was sought from the Ethical and Research Committee of St. John's Medical College and Hospital and was granted.

Exclusion criteria included patients who were obese, pregnant, difficult intubation (Mallampati III and IV), h/o chronic obstructive pulmonary disease, h/o autonomic neuropathy, patients undergoing head and neck surgeries, surgeries where prone positioning was required, and patients in whom more than one attempt at insertion of airway device was required

The patients were randomized via computer-generated table:

- *Group I*: Airway was secured using LMA
- *Group II*: Airway was secured using ETT

Preoperative Assessment

Preoperative evaluation of all the patients was performed with detailed history, physical examination including height, weight, airway examination, and systemic examination. The basal HR and blood pressure were recorded prior to surgery. All the patients were kept nil per oral for 8 hours. All patients were premedicated which includes ranitidine 150 mg on the night before surgery and also 2 hours prior to surgery and Alprazolam 0.25 mg on the night before surgery with sips of water. Informed valid written consent for participation in the study was taken from all the patients.

Intraoperative Assessment

Patients were randomly allocated into either group I (LMA) or group II (endotracheal intubation). Intravenous access was obtained in all patients. In all selected patients, preinduction (baseline) SBP, DBP, MAP, pulse rate (HR), and oxygen saturation (SpO_2) were recorded. Patients were preoxygenated with 100% O_2 for at least 3 minutes. Anesthesia induced with IV propofol 2 mg/kg, fentanyl 2 µg/kg, and atracurium 0.6 mg/kg was administered for mechanical ventilation. Patients were then ventilated for 3 minutes before intubation/insertion. In the ETT group, intubation of the trachea was attempted with a cuffed tracheal tube (internal diameter 7.5 mm for women and 8.5 mm for men) using direct laryngoscopy. In the LMA group, the size 3/4 for women and size 4/5 for men were chosen. Patients' lungs were mechanically ventilated and minute volume set to maintain end-tidal CO_2 at 30 to 35 mm Hg. Isoflurane was used to maintain adequate level of anesthesia with N_2O/oxygen mixture in 50%; 50% volume ratio. The SBP, DBP, MAP, HR, and SpO_2 were measured before induction and after insertion of the airway device every minute for the first 10 minutes and every 5 minutes for the first half hour following insertion of the airway device. Heart rate, SBP, and DBP responses were prospectively defined as an HR increase of ≥10 bpm, an SBP and DBP increase of ≥15 mm Hg. Duration of intubation/insertion was defined as the time from the start of laryngoscopy/LMA insertion, until cuff inflation.

Monitoring

Heart rate and noninvasive blood pressure which included SBP, DBP, and MAP were monitored throughout the study and recorded at the following time points.

- Preinsertion/intubation
- One minute after intubation or insertion of laryngeal mask
- Every minute after that for the first 10 minutes
- Every 5 minutes after that for the first half hour.

Oxygen saturation and end-tidal CO_2 were also monitored. All data were collected by the principal investigator.

The data collected were coded and entered into Statistical Package for the Social Sciences (SPSS) software version 17.

Continuous variables were described using mean ± standard deviation or median and interquartile range as appropriate. Categorical variables were reported using frequency and percentage. Changes in SBP, DBP, HR, and MAP over time in groups and by group were analyzed using repeated-measures analysis of variance. All the analyses were done using SPSS version 17. A p-value of < 0.05 was considered statistically significant.

RESULTS

This study was done at St John's Medical College over a period of 2 years. All the patients who met the inclusion criteria were included in the study. In the LMA group, three patients were excluded, two patients who needed two attempts at insertion and one patient in whom LMA got displaced. In the ETT group, three patients were excluded as they needed more than one attempt at intubation. Each group had a total of 55 participants for analysis.

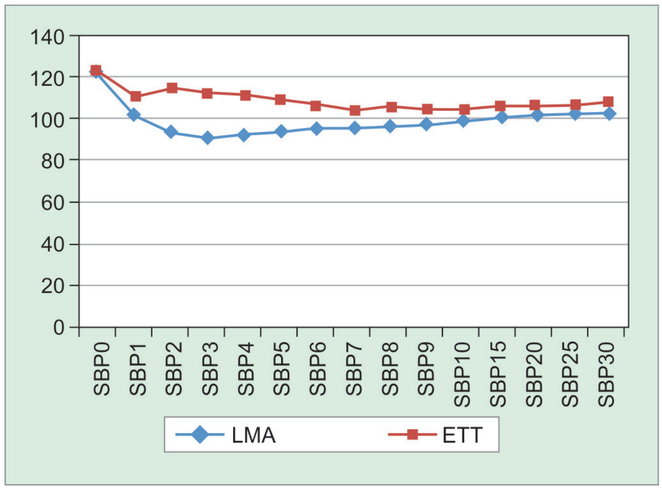
The two groups were comparable in terms of demographic data as there were no significant differences between the two groups in terms of age, sex, and ASA classification ($p > 0.001$; Table 1).

Table 1: Demographic data

	LMA (n = 55)	*ETT (n = 55)*	*p-value*
Mean age (years)	35.35	35.85	0.820
Sex			
Male	34	32	0.697
Female	21	23	
ASA			0.101
I	40	47	
II	15	8	

p-value < 0.05 is significant

Graph 1: Comparison of HR between the two groups over 30 minutes after insertion



Graph 2: Comparison of SBP between the two groups over 30 minutes after insertion

The HRs of the two groups were comparable at induction. At insertion, the HR increased substantially higher in the ETT group over the first 5 minutes while in the LMA group there was no significant increase in HR. The elevation in HR significantly persisted for a longer period of time in the ETT group, where it returned to the baseline value by 7 minutes as compared with the LMA group where it returned by 2 minutes. After this a decrease in HR was noted in both groups and by 14 minutes HRs in both groups were comparable (Graph 1 and Table 2).

The SBP in the two groups was comparable at baseline. A significant decrease in SBP was noted in both groups, but was substantially lower in the LMA group ($p > 0.001$). In ETT group after intubation, there was an initial decrease in SBP to 110 mm Hg (mean) in the first minute, followed by an increase in SBP to 115 mm Hg at 2 minutes, which was then followed by a progressive decrease. In the LMA group, however, following insertion, there was a progressive decrease in SBP. The decrease in SBP continued to be persistent in both groups and was significantly lower in the LMA group, even over the first 30 minutes (Graph 2 and Table 3).

The baseline DBPs between both groups were comparable. After instrumentation, a significant decrease in DBP was noted in the LMA group ($p < 0.001$) which persisted over the first 30 minutes. The ETT group did not show a significant change in DBP in the first 5 minutes after intubation. However, after the first 5 minutes, there was a gradual but significant decrease in DBP in ETT group, though not as significant as in LMA group. Laryngeal

Table 2: Mean HR at different times among ETT and LMA study participants

Time		*LMA (mean ± SD)*	*p-value for differences within LMA group*	*ETT (mean ± SD)*	*p-value for differences within ETT group*	*p-value for differences between LMA and ETT group*
Preinsertion (minutes)		88.31 + 13.43		88.25 ± 18.57		0.986
1	Over 5 min	89.44 + 13.72	0.186	92.85 ± 17.82	<0.001*	0.003
2		88.00 + 13.21		95.16 ± 16.57		
3		86.69 + 14.17		94.60 ± 17.05		
4		87.25 + 14.34		91.69 ± 17.39		
5		87.09 + 14.29		90.55 ± 16.98		
6	Over 30 min	86.11 + 13.28	= 0.001	89.53 ± 17.74	<0.001*	<0.001*
7		84.82 + 12.43		87.78 ± 17.53		
8		84.35 + 11.90		85.69 ± 16.30		
9		83.93 + 12.34		84.18 ± 15.15		
10		83.49 + 12.43		82.95 ± 15.17		
15		82.04 + 12.86		82.56 ± 14.84		
20		82.96 + 12.73		82.00 ± 14.33		
25		82.13 + 12.79		81.42 ± 13.19		
30		81.75 + 12.33		81.44 ± 13.50		

*p-value < 0.05 is significant

Table 3: Mean systolic blood pressure at different time points

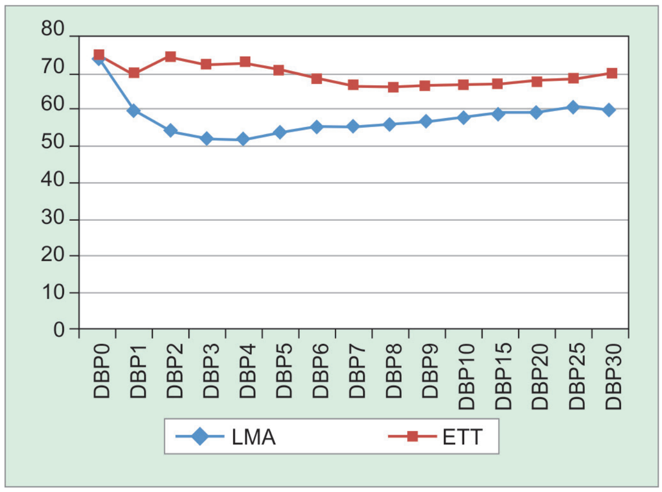
Time		*LMA (mean ± SD)*	*p-value within LMA group over time*	*ETT (mean ± SD)*	*p-value within ETT group over time*	*p-value for difference between the groups*
Preinsertion (minutes)		123.18 ± 12.40		124 ± 14.11		0.747
1	Over 5 min	101.73 ± 11.92	= 0.001	110.98 ± 17.33	= 0.001	<0.001
2		93.42 ± 12.39		115.04 ± 20.28		
3		91.22 ± 11.12		111.96 ± 16.51		
4		92.62 ± 13.44		110.95 ± 15.86		
5		93.76 ± 12.04		109.07 ± 14.30		
6	Over 30 min	95.11 ± 11.65	= 0.001	106.51 ± 14.76	= 0.001	<0.001
7		95.35 ± 12.93		103.82 ± 10.16		
8		96.31 ± 11.20		105.82 ± 10.12		
9		97.45 ± 12.08		104.64 ± 10.83		
10		99 ± 12.25		104.58 ± 10.89		
15		100.47 ± 11.88		105.67 ± 11.57		
20		101.95 ± 11.12		106.04 ± 13.05		
25		102.09 ± 11.52		106.33 ± 14.77		
30		102.25 ± 12.56		107.89 ± 15.35		

p-value < 0.05 is significant

mask airway group showed a significant and persistent decrease in DBP over time (Graph 3 and Table 4).

The baseline MAP between both groups was comparable. After LMA insertion, there was a very significant decrease in MAP over 5 minutes and over 30 minutes as well. In ETT group, there was a decrease in MAP over 5 minutes as well as over 30 minutes. The decrease in MAP was much significant in LMA group as compared with ETT group and did not return to baseline (Graph 4 and Table 5).

Laryngospasm was not noted in any patient in the ETT group. However, two patients (4%) in the LMA group developed laryngospasm which required deepening the plane of anesthesia. Airway trauma was noted in two patients (4%) in the ETT group while in LMA group no airway trauma was noted. Postoperative sore throat was

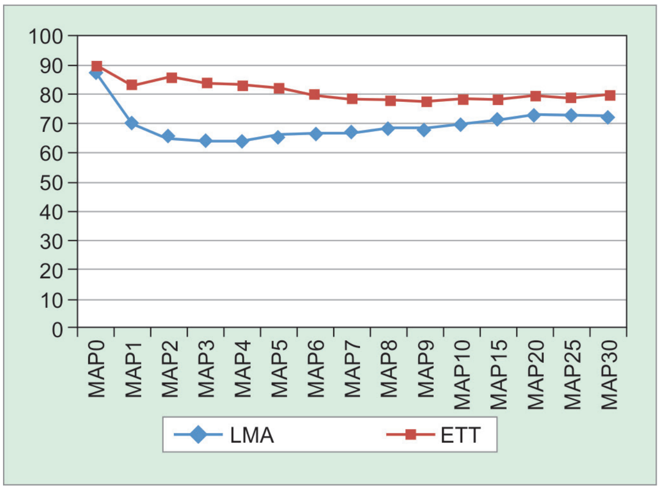


Graph 3: Comparison of DBP between the two groups over 30 minutes after insertion

Table 4: Mean DBP at different time points

Time		*LMA (mean ± SD)*	*p-value within LMA group over time*	*ETT (mean ± SD)*	*p-value within ETT group over time*	*p-value for difference between two groups*
Preinsertion (minutes)		74.38 ± 11.04		75.42 ± 9.94		0.606
1	Over 5 min	59.35 ± 14.08	= 0.001	69.71 ± 14.19	0.101	<0.001
2		54.18 ± 13.21		74.27 ± 16.73		
3		51.91 ± 12.60		72.05 ± 14.85		
4		51.65 ± 14.09		72.55 ± 13.46		
5		53.71 ± 13.04		71.05 ± 13.21		
6	Over 30 min	55.56 ± 13.47	= 0.001	68.67 ± 12.48	0.001	< 0.001
7		55.18 ± 13.09		66.40 ± 10.45		
8		55.93 ± 12.73		66.18 ± 9.19		
9		56.69 ± 13.09		66.69 ± 11.43		
10		57.95 ± 12.94		66.73 ± 12.04		
15		59 ± 13.43		66.96 ± 11.12		
20		59.15 ± 11.93		67.73 ± 12.43		
25		60.42 ± 12.61		68.09 ± 12.41		
30		59.80 ± 13.45		69.56 ± 11.98		

p-value < 0.05 is significant



Graph 4: Comparison of MAP between the two groups over 30 minutes after insertion

noted in 33 patients in ETT group (60%) while no patient in LMA group complained of postoperative sore throat. Hoarseness of voice was noted in 26 patients in the ETT (47%) group while no patient in LMA group complained of hoarseness of voice. Two patients (4%) in ETT group complained of dysphonia. Postoperative nausea and vomiting was noted in seven patients (13%) in ETT group while no patient in LMA group complained of postoperative nausea and vomiting (Table 6).

DISCUSSION

A study by Tahir et al[3] also concurred with our observations where ETT insertion was found to have shown a statistically significant increase in HR as compared with LMA insertion.

Our study, however, demonstrated a significant decrease in SBP, DBP, and MAP in the first 5 minutes which continued into the first 30 minutes in both groups. The decrease was, however, statistically very significant in the LMA group as compared with ETT group. A comparison done in healthy patients compared the cardiovascular responses induced by laryngoscopy and intubation with those produced by insertion of laryngeal mask. They concluded that insertion of laryngeal mask was accompanied by smaller cardiovascular responses than those after laryngoscopy and intubation and that its use may be indicated in those patients in whom a marked pressor response is deleterious.[4]

The use of propofol for induction of anesthesia could be one of the reasons for the decrease in arterial blood pressure. Masoudifar and Beheshtian[4] studied the cardiovascular response to laryngoscopy and tracheal intubation after induction of anesthesia with propofol. Their study demonstrated hypotension in patients induced with propofol.[5] Other studies too have shown that inducing anesthesia with propofol 2 to 2.5 mg/kg of body weight could lower blood pressure as much as 25 to 40%: It could occur in all patients regardless of any underlying conditions and has been reported in every studied patient.

Propofol-caused hypotension is due to the reduction of heart's preload and afterload, which are not synchronized with heart's compensatory responses, such as increased cardiac output and increased HR. This hemodynamic drop would be intensified by high doses of the drug and high speed of injection of the drug.

The significant decrease in arterial pressures with LMA insertion could be attributed to the use of propofol

Table 5: The MAP at different points

Time		*LMA (mean ± SD)*	*p-value within LMA group*	*ETT (mean ± SD)*	*p-value within ETT group*	*p-value for difference between the two groups*
Preinsertion (minutes)		87.95 ± 12.10		89.84 ± 11.07		0.395
1	Over 5 min	70.16 ± 12.47	= 0.001	82.65 ± 14.60	0.005	<0.001
2		65.27 ± 12.23		86.11 ± 17.97		
3		63.73 ± 11.91		83.89 ± 14.68		
4		63.98 ± 13.52		83.05 ± 14.19		
5		65.60 ± 12.17		82.07 ± 11.79		
6	Over 30 min	66.67 ± 12.18	= 0.001	79.73 ± 12.71	0.001	<0.001
7		66.87 ± 12.83		78.18 ± 9.99		
8		67.85 ± 12.46		77.91 ± 8.72		
9		68.55 ± 13.06		77.55 ± 10.46		
10		69.91 ± 12.46		78.25 ± 10.42		
15		71.05 ± 12.75		78.36 ± 9.55		
20		72.87 ± 12.04		79.42 ± 11.05		
25		72.76 ± 12.06		78.29 ± 11.31		
30		72.31 ± 12.97		79.62 ± 11.62		

p-value < 0.05 is significant

Table 6: Postoperative complications

	LMA (n = 55)	ETT (n = 55)	p-value
Laryngospasm			
No	53	55	0.49
Yes	2	0	
Airway trauma			
No	55	53	0.49
Yes	0	2	
Postoperative sore throat			
No	55	22	<0.001
Yes	0	33	
Hoarseness of voice			
No	55	29	<0.001
Yes	0	26	
Dysphonia/dysarthria/ dysphagia			
No	55	53	0.49
Yes	0	2	
Postoperative nausea and vomiting			
No	55	48	0.013
Yes	0	7	

along with fentanyl and muscle relaxant for induction, absence of bispectral index (BIS) monitor to determine the depth of anesthesia at insertion, and also avoidance of laryngoscopy for LMA insertion, thereby avoiding a sympathoadrenal stimulation and hence, resulting in an exaggerated decrease in blood pressure as compared with ETT group. Hosseinzadeh et al[5] studied the hemodynamic changes following anesthesia induction and LMA insertion with propofol, etomidate, and propofol + etomidate and reported significant decrease in SBP, DBP, and MAP in the propofol-only group. Propofol with a dose of 2 to 2.5 mg/kg is accompanied by good relaxation and avoidance of complications, such as coughing and bucking during and after LMA insertion. This, however, could be associated with undesirable decreased blood pressure and prolonged apnea.[6]

Studies by Kautto[6] demonstrated that fentanyl administered prior to intubation at doses of 2 µg/kg will attenuate and 6 µg/kg will abolish both the HR and blood pressure increases related to laryngoscopy and tracheal intubation.[7]

Brimacombe[8] studied the advantages of LMA over the ETT which included increased speed and ease of placement by both inexperienced and experienced personnel; improved hemodynamic stability at induction and during emergence; minimal increase in intraocular pressure following insertion; reduced anesthetic requirements for airway tolerance; lower frequency of cough during emergence; improved oxygen saturation during emergence; and lower incidence of sore throat in adults. Disadvantages over the ETT were lower seal pressures and a higher frequency of gastric insufflations.

Jamil et al[9] studied the use of LMA in children and compared it with endotracheal intubation. They concluded that during routine pediatric use, LMA provides a satisfactory airway for positive pressure ventilation. Hemodynamic response is less and is short lived with LMA as compared with endotracheal intubation. Incidence of postoperative complications is also less with LMA than with ETT. Therefore, LMA is a suitable alternative to endotracheal intubation for elective surgical procedures in pediatric patients.

Peirovifar et al[10] concluded that postoperative cough, sore throat, and difficulty in swallowing were significantly less in LMA than ETT group and that if careful measures regarding insertion techniques, correct LMA position, and routine monitoring of LMA cuff pressure are taken, LMA can be used as a safe alternative with lower incidence of postoperation complication compared with ETT.

LIMITATIONS

- This study was conducted on ASA I and ASA II patients, i.e., even well-controlled hypertensive patients were considered for the study. However, some of these patients were on antihypertensives and this could have possibly affected the hemodynamics after insertion/intubation.
- Patients, who were enrolled in this study, were all successfully intubated in the first attempt. Perhaps the hemodynamic parameters would show a different picture in patients with difficult intubation.
- Our study was a single-center study, therefore, larger multicenter studies with larger sample sizes are recommended.
- In our study, due to absence of BIS monitor, we were unable to assess the depth of anesthesia prior to intubation/insertion.
- Since preloading or coloading with IV fluids was not standardized in the study, patients were either preloaded or coloaded based on what the treating anesthetist considered appropriate for each patient. Hence, it is possible that this could have affected the hemodynamic parameters after insertion/intubation and over the first 30 minutes as well.
- Also all drug doses were calculated based on actual body weight, not ideal body weight. Since patients' built was not standardized, this could have resulted in higher doses of drugs being administered.

CONCLUSION

Pressor responses might be of no clinical importance in the healthy, normotensive patients, but might be harmful in patients with hypertension, aortic or cerebral aneurysm, raised intracranial pressure, or other cardiovascular diseases. In such cases, the attenuated response of the LMA might be desirable. Therefore, where appropriate, the use of the LMA would be recommended in such patients to avoid the marked response produced by the ETT. In recent years, studies have also been done to assess the utility of the LMA in emergency situations as a life-saving airway management tool.

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