Original Article

Pressor Response to Laryngeal Mask Airway Insertion versus Endotracheal Intubation in Standard Anesthetic Practice

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Abstract

Background: Laryngeal mask airways (LMAs) are being used increasingly nowaday as an alternate option to endotracheal intubation, as it is less invasive and causes less discomfort in the post-operative period. In a few patients, the pressor response associated with laryngoscopy and tracheal intubation may be harmful. The LMA avoids the need for laryngoscopy and allows positive pressure ventilation of the lungs in appropriate patients. In this study pressor responses to LMA insertion versus endotracheal intubation in a standard anesthetic practice were observed and analyzed.

Aim of the Study: The aim of the study was to compare the pressor responses to LMA insertion versus endotracheal intubation in standard anesthetic practice.

Materials and Methods: A total of 60 patients undergoing general anesthesia for various surgical procedures were divided into 2 groups. Group - I ventilated with endotracheal intubation and Group - II with laryngeal airway mask. During pre-induction, post-induction, and at 1, 3, and 5 min, the following post-induction hemodynamic parameters were noted such as (1) heart rate (HR), (2) blood pressure - systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure using NIBP at different intervals such as (a) before induction, (b) after induction, (c) at laryngoscopy and endotracheal intubation or insertion of the laryngeal mask, (d) 1 min after endotracheal intubation or insertion of the laryngeal mask, (e) 3 min after endotracheal intubation or insertion of the laryngeal mask, and (f) 5 min after endotracheal intubation or insertion of the laryngeal mask, (3) oxygen saturation, and (4) adverse events, if encountered. All the observed parameters were presented in a tabular form, and appropriate statistical methods were applied to obtain the results.

Observations and Results: Among 60 patients 16/30 (53.3%) in Group - I and 14/30 in Group - II (46.6%) were aged 21–30 years in Group II. The mean age and standard deviation in Group - I was 28.40 ± 9.16 and in Group - II it was 30.73 ± 7.26. In Group I there were 16/30 (53.4%) females and in Group - II there were 10/30 (33.4%) females. Similarly, males were 14/30 (46.4%) in Group - I and 20/30 (66.66%) in Group - II. Mean SBP was higher in group ETT (Group - I) as compared to group LMA (Group - II) at intubation, 1st min, and 3rd min after intubation or LMA insertion. There was significant increase in DBP in Group - I at ETT intubation or insertion of LMA in Group - II, at 1 and 3 min after intubation or insertion of LMA. Mean SBP was higher in group ETT as compared to group LMA at intubation, 1 min, and 3 min after intubation or LMA insertion.

Conclusions: Pressor response to LMA insertion is much less than that of laryngoscopy and endotracheal intubation. Duration and magnitude of the pressor response are transient during LMA insertion. LMA may be useful in airway management during anesthesia in situations where marked pressor response would be deleterious, for example, patients with hypertension and coronary artery disease. However, large-scale studies are required to confidently ascertain the findings of present study.

Key words: Airway, Anesthesia, Hemodynamic, Intubation, Laryngoscopy

INTRODUCTION

The development of laryngeal mask airway (LMA) began in 1982, at Royal London Hospital. Using laryngoscope to expose the larynx and complete endotracheal intubation is now a routine part of delivering a general anesthetic. In general, intubation is indicated for patients who are

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at risk of aspiration and for those undergoing a surgical procedure.[1-3] Following laryngoscopy and tracheal intubation during induction of anesthesia, transient hypertension, tachycardia, and arrhythmias are frequently associated. In healthy patients, such hemodynamic changes are of little consequence but they are more serious and hazardous with hypertensive patients and in ischemic heart disease.[3,4] Stimulation of the oropharyngolaryngeal mucosal structures may be playing an important role in the hemodynamic response generated with tracheal intubation. In susceptible patients especial with systemic hypertension, coronary heart disease, cerebrovascular disease, and intracranial aneurysm, such these transient changes may result in potentially deleterious effects such as left ventricular failure, arrhythmias, myocardial ischemia, cerebral hemorrhage, and rupture of cerebral aneurysm.[5-8] Various non-laryngoscopic intubation devices and methods have provided conflicting evidence of an attenuated hemodynamic response. In general, techniques that avoid or minimize oropharyngolaryngeal stimulation might attenuate the hemodynamic stress response.[9,10] One among them is the LMA which has been proved to be a popular addition to the range of equipment available for airway management. The LMA is intermediate in design and occupies a niche between oropharyngeal airway and endotracheal tube. It has the advantages of an endotracheal tube while avoiding its fundamental disadvantages since the vocal cords need to be neither visualized nor forced on.[11] However, it has its own limitations and contraindications especially in patients who are at risk of aspiration, with low airway compliance and in bleeding diathesis. To blunt these hemodynamic changes many methods are used such as minimizing the duration of laryngoscopy, the use of intravenous narcotics, lidocaine, vasodilators, and beta-blocking agents, but most of these have produced variable results. Bennet et al.[12] studied cardiovascular changes with the LMA for cardiac surgery and showed that cardiovascular stability can be achieved when the LMA is used, without the need for pharmacological techniques to control the circulation in patients with ischemic heart disease. Montazari et al.[13] compared hemodynamic changes after insertion of LMA, facemask, and endotracheal intubation. Aldemir et al.[14] studied which is responsible for the hemodynamic response due to laryngoscopy and endotracheal intubation- catecholamine, vasopressin, or angiotensin. Blood pressure, heart rate (HR), plasma epinephrine, norepinephrine, and vasopressin concentrations increased slightly in response to laryngoscopy and intubation, all returning to or below baseline 5 min later with no change in angiotensin-converting enzyme activity in normotensive patients. Tasyuz et al.[15] studied the effects of esmolol on hemodynamic responses to laryngoscopy and intubation in diabetic versus non-diabetic patients. They proposed that esmolol might be used effectively to control the hemodynamic responses to laryngoscopy and intubation in diabetic patients. They also determined that esmolol causes no difference in the blood glucose levels. Jamil et al.[16] studied the use of LMA in children and its comparison with endotracheal intubation and concluded that the LMA is a suitable alternative to endotracheal intubation for positive pressure ventilation. The present study is a comparative one to study the hemodynamic stress response to laryngoscopic tracheal intubation and LMA insertion in patients.

Institute of Study
This study was conducted at Kamineni Institute of Medical Sciences, Narketpally, Nalgonda, Telangana.

Period of Study
This study was from October 2007 to September 2009.

Type of Study
This was a prospective randomized comparative study.

Objectives of the Study
The objectives are to study and compare cardiovascular responses to endotracheal intubation with the insertion of LMA by measuring parameters such as: Measured parameters: (1) Pulse rate, (2) systolic blood pressure (SBP), (3) diastolic blood pressure (DBP), and (4) electrocardiogram and derived parameters such as: Mean arterial pressure (MAP).

MATERIALS AND METHODS

A total of 60 adult patients undergoing elective surgery under general anesthesia in ASA Grade I and mallampati Grade I were included in the study. An ethical committee clearance was obtained from the Institutional Ethical Committee and its approved written, and informed consent was obtained from all the patients for the performance of anesthesia as well as the conduct of the study.

Inclusion Criteria
1. Patients belonging to either sex were included
2. Patients aged between 18 and 50 years were included
3. Patients belonging to ASA physical status I were included
4. Patients with airway assessment-mallampati Grade (modified) I were included.

Exclusion Criteria
Patients with:
1. History of respiratory problems
2. History of angina, palpitations, and syncopal attacks
3. Treatment with beta-blockers or calcium channel blockers
4. Regurgitation prone conditions

5. Pregnant patients
6. More than one attempt to intubate or insertion of LMA
7. Duration of endotracheal intubation or LMA insertion more than 30 sec were excluded from the study.

A total of 60 patients were randomly divided into two groups ($n = 30$) in each group by a computer-assisted randomization technique: Group-I: Endotracheal tube group (ETT) and Group-II: LMA group (LMA). Patients undergoing various procedures such as excision of fibroadenoma of breast, dilatation and curettage, upper limb orthopedic surgeries, and excision of swellings over upper extremity were selected for the study. All patients were assessed clinically preoperatively and investigated to rule out systemic diseases. The investigations carried out before were hemogram, urine analysis, blood urea, serum creatinine, electrocardiogram, and X-ray chest. All patients received Tab. Alprazolam 0.25 mg on the night before surgery orally. All patients kept nil orally 12 h before surgery.

Venous Cannulation and Monitors

Intravenous cannulation with 18G cannula was done. The intravenous infusion was started with Ringer's lactate solution. Non-invasive blood pressure monitor and pulse-oximetry probe were connected to the patients before induction of anesthesia.

Premedication

Injection glycopyrrolate 0.01 mg/kg, injection fentanyl 1 μg/kg, and injection midazolam 0.05 mg/kg were given intravenously 10 min before induction of anesthesia.

Anesthetic Technique

All the patients were preoxygenated for 6 min. Induction of anesthesia was done with injection thiopentone sodium (3–5 mg/kg body weight). Intubation was facilitated by using injection succinylcholine 1.5 mg/kg. Patients were ventilated with 100% oxygen for 1 min. At the end of 1 min, patients were ventilated with 100% oxygen for brief period, and intubation with the aid of Macintosh laryngoscope or insertion of LMA was carried out. Endotracheal tube or LMA of appropriate size was used. Time taken for intubation or insertion of LMA did not exceed 20 s. Anesthesia was maintained with intermittent positive pressure ventilation with nitrous oxide (3 L/min) oxygen (2 L/min) and halothane (0.5–1%). Further top-up doses of Vecuronium were given when required. Surgery was not allowed to commence until the study was completed, i.e., for 5 min after intubation/LMA insertion. At the end of surgery, residual neuromuscular block was reversed with a mixture of glycopyrrolate and neostigmine.

Observed Parameters

1. HR
2. Blood pressure -SBP, DBP, and MAP using NIBP at different intervals such as:
   a. Before induction
   b. After induction
   c. At laryngoscopy and endotracheal intubation or insertion of the laryngeal mask
   d. 1 min after endotracheal intubation or insertion of the laryngeal mask
   e. 3 min after endotracheal intubation or insertion of the laryngeal mask
   f. 5 min after endotracheal intubation or insertion of the laryngeal mask
3. Oxygen saturation
4. Adverse events, if encountered.

All the observed parameters were presented in a tabular form, and appropriate statistical methods were applied to obtain the results.

Statistical Analysis

Randomization

The sample was taken at random from a population when each member of the population has an equal chance of being chosen. The purpose is to produce groups that are as nearly similar as possible before the experimental procedure.

Mean

The mean of a collection of numbers is their arithmetic average, computed by adding them up and dividing by their number.

Standard deviation (SD)

It is a statistical measure of spread or variability. The SD is the root mean square deviation of the values from their arithmetic mean.

T-test

t-test or student t test gives an indication of separateness of two sets of measurements and is thus used to check whether two sets of measurements are essentially different with the null hypothesis that means of the two sets of measurements are equal. P-value: It indicates the probability of error and a value <0.05 is considered statistically significant.

OBSERVATIONS AND RESULTS

In this prospective randomized comparative study, 60 patients were randomly divided into two groups ($n = 30$) in each group, by a computer-assisted randomization technique. Group I was consisted of patients undergoing

surgeries under general anesthesia by endotracheal intubation (ETT) and Group II consisted of patients undergoing surgeries under general anesthesia by LMA group (LMA). The surgeries included various procedures such as excision of fibroadenoma of breast, dilatation and curettage, upper limb orthopedic surgeries, and excision of swellings over upper extremity were selected for the study. Patients belonging to the age group of 21–30 years were 16/30 (53.3%) in Group I and 14/30 (46.6%) in Group II. Patients belonging to the age group of 31–40 years were 07/30 (23.0%) in Group I and 09/30 (30.6%) in Group II. In the age group of 41–50 years they were 7/30 in both the groups [Table 1 and Figure 1].

The mean age and SD in Group-I was 28.40 ± 9.16 and in Group-II it was 30.73 ± 7.26. *P* value was 0.143 (*P* value was >0.05 hence not significant). Patients of both the groups were identical, and there was no statistically significant difference between them [Table 2].

The gender distribution among the two groups was compared and found that in Group I there were 16/30 (53.4%) females and in Group - II there were 10/30 (33.4%) females. Similarly, males were 14/30 (46.4%) in Group - I and 20/30 (66.66%) in Group - II [Table 3 and Figure 2].

It was observed that the weight of the patients in both the groups was similar with a mean weight of 59.73 ± 7.39 kg in Group - I and 56.53 ± 9.40 kg in Group - II. Statistically, there was no significance as *P* value was 0.241 (*P* > 0.05: Not significant) [Table 4 and Figure 3].

The mean SBP values in both the groups were comparable at the pre-induction and post-induction phases (*P* > 0.05). Whereas there was significant increase in SBP at ETT intubation or insertion of LMA, at 1st min and 3rd min after intubation or insertion of LMA. Mean SBP was higher in group ETT (Group-I) as compared to group LMA (Group - II) at intubation, 1st min, and 3rd min after intubation or LMA insertion. Mean SBP values were comparable in both the groups 5 min after ETT intubation or insertion of LMA with *P* value at 0.587 (*P* > 0.05) [Table 5 and Figure 4].

The mean DBP values in both the groups were comparable at pre-induction and after induction (*P* > 0.05). There was significant increase in DBP in Group - I at ETT intubation or insertion of LMA in Group - II, at 1 min and 3 min after intubation or insertion of LMA. Mean SBP was higher in group ETT as compared to group LMA at intubation, 1min, and 3 min after intubation or LMA insertion. Mean DBP values were comparable in both the groups 5 min after ETT intubation or insertion of LMA with *P* value at 0.51 (*P* > 0.05) [Table 6 and Figure 5].

Table 1: Age distribution of patients in the study (*n*=60)

Age distribution years	Group - I (ETT) *n*=30 (%)	Group - II (LMA) *n*=30 (%)
21–30	16 (53.3)	14 (46.6)
31-40	7 (23.0)	9 (30.6)
41-50	7 (23.6)	7 (23.8)

Table 2: Mean age of the patients (*n*=60)

Groups	Mean age in years	*P* value	Result
I - ETT (*n*=30)	28.40±9.16	0.143	Not significant
II - LMA (*n*=30)	30.73±7.26		

Table 3: Gender distribution of patients in the study (*n*=60)

Gender	Group - I (ETT) *n*=30 (%)	Group - II (LMA) *n*=30 (%)
Male	14 (46.4)	20 (66.6)
Female	16 (53.4)	10 (33.4)

Table 4: Weight distribution of patients in the study (*n*-60)

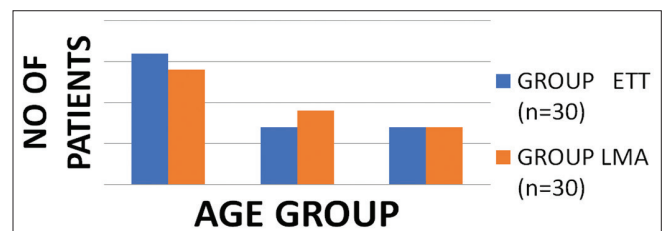| Group	Mean weight (KG)	*P* value	Result
ETT (*n*=30)	59.73 (7.39)	0.241	Not significant
LMA (*n*=30)	56.53 (9.40)		

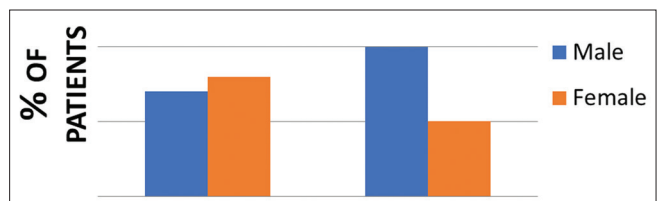Figure 1: Age distribution of patients in the study (*n* - 60)

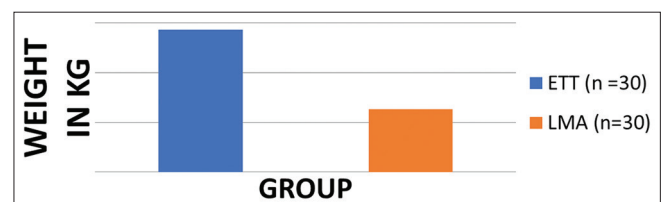Figure 2: Gender distribution of patients in the study

Figure 3: Weight distribution of patients in the study (*n*-60)

The MAP values in both the groups were comparable at pre-induction and after induction ($P > 0.05$). There was significant increase in MAP at ETT intubation or insertion of LMA, at 1 min and 3 min after intubation or insertion of LMA. Mean MAP was higher in group ETT as compared to group LMA at intubation, 1st min, and 3rd min after intubation or LMA insertion. Mean MAP values were comparable in both the groups 5 min after ETT intubation or insertion of LMA with P value at 0.177 ($P > 0.05$) [Table 7 and Figure 6].

The mean HR values in both the groups were comparable at pre-induction, and after induction ($P > 0.05$). There was significant increased in HR in Group - I at ETT intubation or insertion of LMA in Group - II at 1 min and 3 min after intubation or insertion of LMA. Mean HR was higher in Group - I ETT as compared to Group - II LMA at intubation, 1 min, and 3 min after intubation or LMA insertion. Mean HR values were comparable in both the groups 5 min after ETT intubation or insertion of LMA with P value at 0.144 ($P > 0.05$) [Table 8 and Figure 7].

DISCUSSION

Laryngoscopy results in stimulation of pharyngeal wall mucosa and cause marked hemodynamic changes. Endotracheal tube passes through glottis and causes a continuous stimulus and provocation of hemodynamic response. The pressor response to tracheal intubation may be harmful to patients with ischemic heart disease, hypertension, or cerebrovascular disease. Attempts are made to attenuate this response with a variety of pharmacological maneuvers and recently role of fiber-optic laryngoscopy was also investigated. In 1983, Brain A.I.J. described LMA. It does not pass through glottis; rather it sits above the glottis. Moreover, insertion of LMA avoids laryngoscopy. Stimulation of mechanoreceptors in the pharyngeal wall, epiglottis and vocal cords are thought to be the cause for the hemodynamic response. The receptors are abundant over arytenoid cartilage, vocal cords, epiglottis, and hypopharynx. Transitory rises in HR and blood pressure in the perioperative period are a matter of concern in patients with hypertension or coronary artery disease. Hemodynamic instability makes hypertensive patients prone to myocardial ischemia in the perioperative period.

Table 5: Comparison of mean SBP at various time intervals (n=60)

Time interval	Group ETT (n=30)	Group LMA (n=30)	t value	P value	Significance
Pre-induction	116.33±12.12	111.60±9.66	1.672	0.120	Not significant
After induction	102.07±10.01	100.60±10.29	0.559	0.578	Not significant
At intubation or insertion of LMA	136.07±9.98	115.73±10.07	7.854	0.000	Significant
Post-intubation/LMA					
1 min	131.47±8.52	112.53±8.48	8.624	0.000	Significant
3 min	120.47±8.34	108.40±7.69	5.824	0.000	Significant
5 min	110.73±8.61	107.67±6.33	0.527	0.587	Not significant

SBP: Systolic blood pressure

Table 6: Comparison of mean DBP at various time intervals in both groups of the study (n=60)

Time interval	Group ETT (n=30)	Group LMA (n=30)	t value	P value	Significance
Pre-induction	80.60±8.21	79.67±6.13	0.499	0.620	Not significant
After induction	76.93±(8.98)	77.57 ±(7.66)	2.94	0.770	Not significant
At intubation or insertion of LMA	93.60±(7.87)	78.27±(7.55)	7.701	0.000	Significant
Post-intubation/LMA					
1 min	93.60±7.87	78.27±7.55	7833	0.000	Significant
3 min	85.20±6.78	75.93±6.20	5.524	0.000	Significant
5 min	77.87±8.50	74.27±5.09	1.991	0.051	Not significant

DBP: Diastolic blood pressure

Table 7: Comparison of mean of mean blood pressures at various time intervals in Groups I and II (n=60)

| Time interval	Group ETT (n=30)	Group LMA (n=30)	t value	P value	Significance
Pre-induction	92.51±9.22	90.31±6.58	0.990	0.326	Not significant
After induction	85.31±7.72	85.24±7.04	0.018	0.986	Not significant
At intubation or insertion of LMA	107.76±7.91	90.76±6.55	9.071	0.000	Significant
Post-intubation/LMA					
1 min	105.87±7.33	89.33±6.79	9.076	0.000	Significant
3 min	96.96±6.14	86.76±5.62	6.658	0.000	Significant
5 min	88.82±7.91	86.07±4.58	1.592	0.177	Not significant
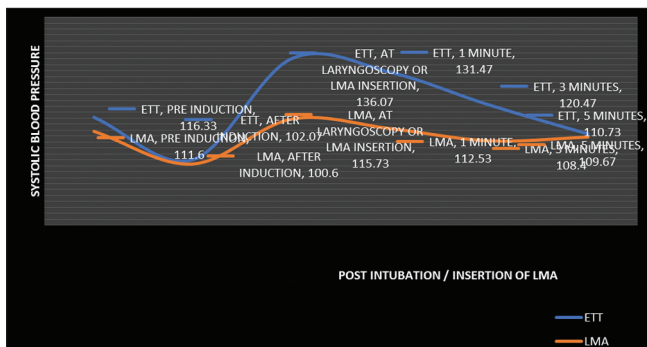
Figure 4: Line diagram showing comparison of systolic blood pressure at different intervals in Groups I and II patients (*n*-60)
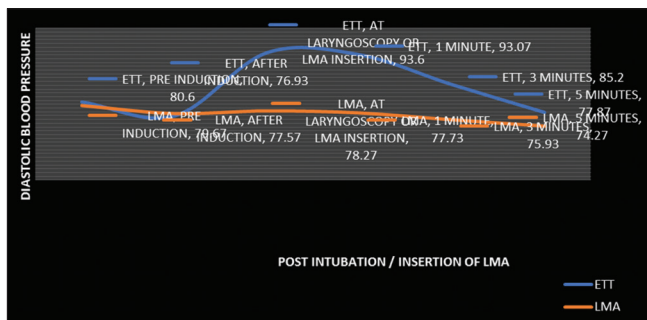

Figure 5: Line diagram showing comparison of diastolic blood pressure at different intervals in both groups of the study (*n*-60)

Figure 6: Line diagram showing a comparison of mean arterial pressures at different intervals in both the study groups (*n*-60)

Figure 7: Line diagram showing a comparison of mean heart rates at different intervals in Groups I and II of the study (*n*-60)

There is a significant association between perioperative myocardial ischemia and post-operative ischemic cardiac events such as unstable angina, non-fatal myocardial infarction, and cardiac death.

Patient Demographics

Age-wise distribution of the cases

The mean age in Group - I (ETT) patients was 28.40 ± 9.16 years, whereas the mean age in Group - II (LMA) patients was 30.73 ± 7.26 years. Thus, both the groups were statistically comparable (*P* > 0.05). The mean age in Group - I (ETT) patients was 34.72 ± 9.20 years whereas the mean age in Group - II (LMA) patients was 35.60 ± 6.93 years. In a similar study carried out by Bukhari *et al.*, [Table 9].[17] It was observed that both the groups consisted of patients of similar age groups.

Sex-wise distribution of cases

There were more male patients (66.6%) in Group - II (LMA) as compared to Group - I (ETT), (46.4%), similarly, there were more female patients in Group - I (ETT), (53.4%) as compared to Group - II (LMA) (33.4%). There were more female patients in ETT (64.0%) as well as in LMA group (84.0%) in the study carried out by Bukhari *et al.* [Table 10].[17]

Weight wise distribution of cases

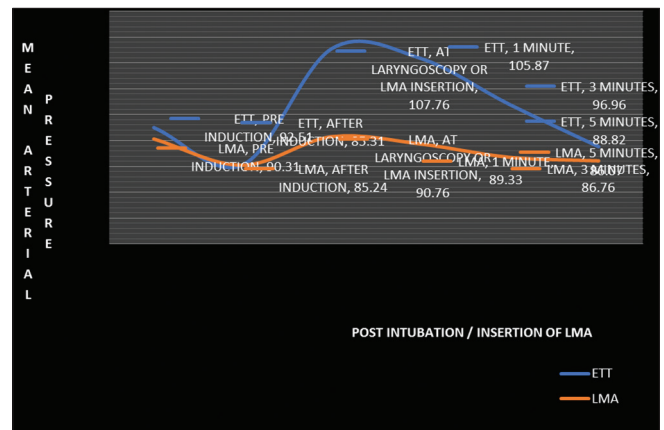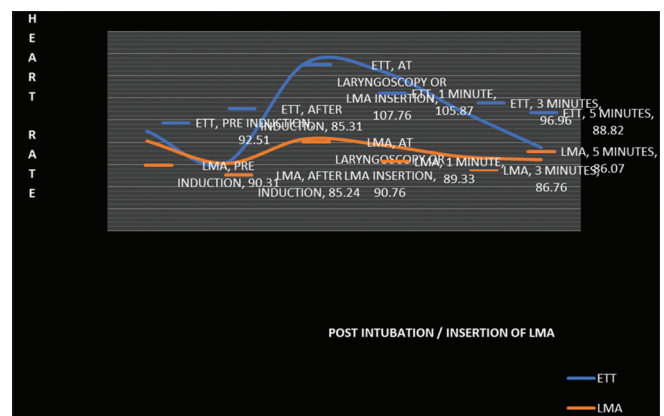The mean weight in Group - I (ETT) patients was 59.73 ± 7.39 kg; whereas the mean weight in Group - II (LMA)

patients was 56.53 ± 9.40 kg. Thus, both the groups were statistically comparable (*P* > 0.05) [Table 11]. It was observed that in the study by Bukhari *et al.*[17] also both the groups consisted of patients with similar weight 58.08 ± 11.07 and 57.60 ± 6.64, respectively.

Changes in HR

The pre-induction mean HR in Group - I (ETT) was 80.47 ± 9.30 beats/min, whereas in Group - II (LMA) it was 82.20 ± 7.56 beats/min. Thus, the baseline mean HR in both the groups was statistically comparable (*P* = 0.432). There was a statistically significant (*P* = 0.034) rise in mean heart after induction in both the groups. The rise in HR after induction can be attributed to compensatory tachycardia in response to thiopentone sodium-induced hypotension. At the time of ETT intubation or LMA insertion, there was an increase in mean HR values in both the groups. This rise was marked in Group - I (ETT), (116.43 ± 3.94 beats/min) as compared to Group-II (LMA) (107.80 ± 8.18 beats/min). This rise was statistically significant as *P* value was 0.000 (*P* significant at <0.05). The mean HR values in Group - I (ETT) at 1 min, 3 min, and 5 min after ETT intubation were 107.80 ± 7.33, 109.53 ± 17.47, and 96.4 ±

Table 8: Comparison of mean HRs at various time intervals in both the study groups (n=60)

Time interval	Group ETT (n=30)	Group LMA (n=30)	t value	P value	Significance
Pre-induction	80.47±9.30	82.20±7.56	−7.92	0.432	Not significant
After induction	85.27±11.44	87.13±6.24	−7.85	0.436	Not significant
At intubation or insertion of LMA	116.43±3.94	107.80±8.18	5.209	0.001	Significant
Post-intubation/LMA					
1 min	107.80±9.27	98.00±11.79	3.579	0.001	Significant
3 min	109.53±17.47	97.80±11.50	3.073	0.003	Significant
5 min	96.40±13.04	92.00±9.71	1.482	0.144	Not significant

Table 9: A comparative study of age distribution between present study and Bukhari et al. study

Group	Bukhari et al.[17]	Present study
ETT	34.72±9.20	28.40±9.16
LMA	35.60±6.93	30.73±7.26

Table 10: Comparative study of gender distribution among the patients of the study Groups I and II

Group	Bukhari et al.[17] (%)	Present study (%)
ETT	Male: 36	Male: 46.4
	Female: 64.0	Female: 53.4
LMA	Male: 16	Male: 66.6
	Female: 84	Female: 33.4

Table 11: Comparative study of weight distribution in the patients of Groups I and II in the study

Group	Bukhari et al.[17] Mean weight (kg)	Present study Mean weight (kg)
ETT	58.08±11.07	59.73±7.39
LMA	57.60±6.64	56.53±9.40

13.04 beats/min, respectively. Whereas mean HR values at 1, 3, and 5 min after LMA insertion in Group - II (LMA) were 98.00 ± 11.79, 97.80 ± 11.50, and 92.00 ± 9.71 beats/min, respectively. Thus, mean HR values in Group - I (ETT) were significantly higher as compared to those of Group - II (LMA) at 1 min ($P = 0.000$) and 3 min ($P = 0.003$) after ETT intubation or LMA insertion. At 5 min, the mean HR values were statistically comparable in both the groups ($P = 0.144$). Further, it was observed that the mean HR values increased markedly at ETT insertion in group ETT, whereas the same values increased marginally in group LMA. The mean HR values did not return to pre-induction levels even after 5 min after ETT intubation or LMA insertion in both the groups. The results pertaining to changes is HR in the present study are in accordance with those of a similar study conducted by Bukhari et al.[17] who observed a significant increase in HR in both the groups immediately after ETT intubation as well as LMA insertion. They further noticed that mean HR remained elevated up to 3 min after ETT intubation or LMA insertion ($P < 0.01$). However, the

increase in HR was found to be more in Group - I (ETT) at 1 min after intubation (121.16 ± 15.68 beats/min) as compared to Group - II (LMA) (110.24 ± 13.07 beats/min). The results of the present study are also in accordance with those of Joad et al.[18] who observed a significant increase in HR in both the groups immediately after ETT intubation as well as LMA insertion. They further noticed that mean HR remained elevated up to 5 min after ETT intubation or LMA insertion ($P < 0.01$). However, the increase in HR was found to be more in group ETT at 1 min and 3 min after intubation (111.24 ± 13.06 and 111.04 ± 12.06 beats/min) as compared to group LMA (103.88 ± 11.67 and 92.12 ± 12.6 beats/min). Further group LMA had a significantly lower HR than group ETT (repeated measure ANOVA: $P < 0.005$) [Table 12].

Changes in SBP
The pre-induction mean SBP in Group - I (ETT) was 116.33 ± 12.12 mmHg, whereas in Group - II (LMA) it was 111.60 ± 9.66 mmHg. Thus, the baseline mean SBP in both the groups was statistically comparable ($P = 0.100$). There was a statistically significant ($P = 0.001$) fall in mean SBP after induction in both the groups. The fall in SBP after thiopentone induction may be attributed to decreased systemic vascular resistance. At the time of ETT intubation or LMA insertion, there was an increase in mean SBP values in both the groups. This rise was marked in Group - I (ETT) (136.07 ± 9.98 mmHg) as compared to Group - II (LMA) (115.75 ± 10.07 mmHg). This rise was statically significant (0.000). The mean SBP values in Group - I (ETT) at 1 min, 3 min, and 5 min after ETT intubation were 131.47 ± 8.52, 120.7 ± 8.34, and 110.73 ± 8.61 mm Hg, respectively. Whereas mean SBP values at 1, 3, and 5 min after LMA insertion in group LMA were 112.53 ± 8.48, 108.40 ± 7.69, and 109.67 ± 6.33 mmHg, respectively. Thus, mean SBP values in Group - I ETT were significantly higher as compared to those of Group - II LMA at 1 min ($P = 0.000$) and 3 min after ETT intubation or LMA insertion. At 5 min, the mean SBP values were statistically comparable in both the groups ($P = 0.587$) further it was observed that the mean SBP values increased markedly at ETT insertion in Group - I (ETT), whereas the same values increased marginally in group LMA. The mean SBP values returned to pre-induction levels after

3 min in Group - I (ETT) as compared to after 1 min in Group - II (LMA). The results pertaining to changes in SBP in the present study are in accordance with those of a similar study conducted by Bukhari et al.[17] who observed a significant increase in SBP in Group - I (ETT) at 1 and 2 min after insertion as compared to group LMA ($P < 0.01$). The results of the present study are also in accordance with those of Joad et al.[18] who observed a significant increase in SBP in group ETT at 1 min, 2 min, and 3 min after insertion as compared to group LMA ($P < 0.01$) [Table 13].

Changes in DBP

The pre-induction mean DBP in Group - I (ETT) was 80.60 ± 8.21 mmHg whereas in Group - II (LMA), it was 79.67 ± 6.13 mmHg. Thus, the baseline mean DBP in both the groups was statistically comparable ($P = 0.620$). There was a statistically significant ($P = 0.001$) fall in Mean DBP after induction in both the groups. At the time of ETT intubation or LMA insertion, there was an increase in mean DBP values in both the groups. This rise was marked in Group - I (ETT) (93.60 ± 7.87 mmHg) as compared to Group-II (LMA) (78.27 ± 7.55 mmHg). This rise was statically significant in Group-I (ETT) (0.000) but not in Group-II (LMA) ($P = 0.120$). The mean DBP values in Group - I (ETT) at 1 min, 3 min, and 5 min after ETT intubation were 93.07 ± 7.53, 85.20 ± 6.78, and 77.87 ± 8.50 mmHg, respectively. Whereas mean DBP values at

1, 3, and 5 min after LMA insertion in Group - II (LMA) were 77.73 ± 7.53, 75.93 ± 6.20, and 79.27 ± 5.09 mmHg, respectively. Thus, mean DBP values in Group - I (ETT) were significantly higher as compared to those of Group - II (LMA) at 1 min ($P = 0.000$) and 3 min ($P = 0.000$) after ETT intubation or LMA insertion. At 5 min, the mean DBP values were statistically comparable in both the groups ($P = 0.051$) further it was observed that the mean DBP values increased markedly at ETT insertion in Group - I (ETT), whereas the same values increased slightly in Group - II (LMA). The mean DBP values returned to pre-induction levels at 5 min in both the groups. The results pertaining to changes in DBP in the present study are in accordance with those of a similar study conducted by Bukhari et al.,[17] who observed a significant increase in DBP in group ETT at 1 and 2 min after insertion as compared to Group - II (LMA) ($P < 0.01$). The results of the present study are also in accordance with those of Joad et al.[18] who observed a significant increase in DBP in Group - I (ETT) at 1 min, 2 min, and 3 min after insertion as compared to Group - II (LMA) ($P < 0.01$), [Table 14].

Changes in mean arterial blood pressure

The pre-induction mean MAP in Group - I (ETT) was 92.51 ± 9.22 mmHg, whereas in Group - II (LMA) it was 90.31 ± 6.58 mmHg. Thus, the baseline mean DBP in both the groups was statistically comparable ($P = 0.620$).

Table 12: Comparative study of HR between the study group and another two studies

Time interval	Bukhari et al.[17]		Joad et al.[18]		Present study	
	ETT	LMA	ETT	LMA	ETT	LMA
Pre-induction	84.68±11.21	84.88±6.96	81.12±13.3	81.18±13.05	80.4±9.30	82.20±7.56
After induction	98.08±12.01	105.4±11.27	91.44±1.95	91.64±2.61	85.27±11.44	87.13±6.24
At intubation/insertion of LMA	**	**	**	**	116.43±3.94	107.80±8.18
Post-intubation/LMA						
1 min	121.16±15.68	110.24±13.07	111.24±13.06	103.88±11.67	107.80±7.33	98.00±11.79
2 min	102.02±11.85	102.62±12.71	111.32±12.64	98.88±11.13	**	**
3 min	86.24±12.11	90.62±9.86	111.04±12.06	92.12±12.6	109.53±17.4	97.80±11.50
4 min	**	**	108.84±11.46	88.88±12.73	**	**
5 min	**	**	90.64±11.22	85.64±11.19	96.4±13.04	92.00±9.71

**Not observed

Table 13: Comparative study of systolic blood pressure (SBP) between the present study and other studies

Time interval	Bukhari et al.[17]		Joad et al.[18]		Present study	
	ETT	LMA	ETT	LMA	ETT	LMA
Pre-induction	128.02±16.91	133.32±11.38	120.40±14.73	119.36±14.87	116.3±12.12	111.60±9.66
After induction	108.68±14.24	102.92±6.76	106.32±12.43	105.76±12.21	102.07±10.01	100.60±10.2
At ETT intubation/insertion of LMA	**	**	**	**	136.07±9.98	115.75±10.0
Post-intubation/LMA						
1 min	157.44±28.17	111.32±14.93	144.72±13.01	130.94±10.59	131.47±8.52	112.53±8.48
2 min	132.64±11.85	110.08±10.93	145.92±11.66	130.02±10.69	**	**
3 min	119.64±17.11	114.08±8.46	144.40±11.31	126.56±10.70	120.47±8.34	108.40±7.69
4 min	**	**	133.68±13.01	124.00±10.40	**	**
5 min	**	**	126.68±14.00	120.36±9.58	110.73±8.6	109.67±6.73

**Not observed

Table 14: Comparative study of DBP between the present study and another two studies

Time interval	Bukhari et al.[17]		Joad et al.[18]		Present study	
	ETT	LMA	ETT	LMA	ETT	LMA
Pre-induction	80.92±8.21	83.36±6.93	78.68±7.57	79.08±7.47	80.60±8.21	79.67±6,13
After induction	67.44±6.94	66.04±5.97	76.98±7.43	77.04±7.68	76.93±8.98	77.57±7.66
At ETT intubation/insertion of LMA	**	**	**	**	93.60±7.87	78.27±7.57
Post-intubation/LMA						
1 min	103.48±15.35	74.06±9.87	86.96±5.59	82.52±7.32	93.07±7.53	77.73±7.53
2 min	86.88±14.09	77.82±6.57	86.96±5.19	81.48±7.41	**	**
3 min	78.12±11.97	75.76±7.21	84.32±5.73	80.06±7.25	85.20±6.78	75.93±6.20
4 min	**	**	81.48±6.56	79.58±7.27	**	**
5 min	**	**	78.92±7.43	79.56±7.32	77.87±8.50	79.27±5.09

**Not observed. DBP: Diastolic blood pressures

Table 15: Comparative study of MAP of the present study and other two studies

Time interval	Bukhari et al.[17]		Present study	
	ETT	LMA	ETT	LMA
Pre-induction	96±10.9	100±8.6	92.51±9.22	90.31±6.58
After induction	80±9.6	78±6.3	85.3±7.72	85.24±7.04
At ETT intubation/insertion of LMA	**	**	107.76±7.91	90.76±6.55
Post-induction intubation/LMA				
1 min	120±20.2	86±11.6	105.87±7.33	89.33±6.79
2 min	102±13.3	88±7.2	**	**
3 min	92±12.9	88±7.62	96.96±6.14	86.76±5.62
4 min	**	**	88.82±7.9	86.07±4.58
5 min				

**Not observed. MAP: Mean arterial pressures

There was a statistically significant ($P = 0.001$) fall in the mean MAP after induction in both the groups. At the time of ETT intubation or LMA insertion, there was an increase in mean MAP values in both the groups. This rise was marked in group ETT (107.76 ± 7.91 mmHg) as compared to group LMA (90.76 ± 6.55 mmHg). This rise was statically significant in Group - I(ETT) (P=0.000) as well as in Group - II (LMA) (P=0.031). The mean MAP values in Group - I (ETT) at 1 min, 3 min, and 5 min after ETT intubation were 105.87 ± 7.33, 96.96 ± 6.14, and 88.82 ± 7.97 mmHg, respectively, whereas mean MAP values at 1, 3, and 5 min after LMA insertion in Group - II (LMA) were 89.33 ± 6.79, 86.78 ± 5.62, and 86.07 ± 4.58 mmHg, respectively. Thus, mean MAP values in Group - I (ETT) were significantly higher as compared to those of Group - II (LMA) at 1 min ($P = 0.000$) and 3 min ($P = 0.000$) after ETT intubation or LMA insertion. At 5 min, the mean MAP values were statistically comparable in both the groups ($P = 0.117$). Further, it was observed that the mean MAP values increased markedly at ETT insertion in group ETT, whereas the same values increased marginally in group LMA. The mean MAP values returned to pre-induction levels after 3 min in group ETT as compared to within 1 min in group ETT. The results pertaining to changes in MAP in the present study are in accordance with those of a similar study conducted by Bukhari et al.[17] who observed a significant increase in mean arterial blood pressure in group ETT at 1 and 2 min after insertion as compared to group LMA ($P < 0.01$) [Table 15].

There was no evidence of desaturation in patients belonging to any of the groups in the present study as well as in a study carried by Bukhari et al.[17] and Joad et al.[18]

In the present study, no other complications were observed except, sinus tachycardia (HR >110 bpm), the incidence of which was higher in group ETT (70%) as compared to group LMA (53.3%). In addition to the comparative study above review of literature also showed a similar study by Braude et al. who concluded that significant differences between the two groups were evident in arterial DBP immediately after insertion and again 2 min later. They opined that use of the laryngeal mask may, therefore, offer some limited advantages over tracheal intubation in the anesthetic management of patients where the avoidance of the pressor response is of particular concern.

A study by Braude et al.,[19] and Kiran et al.,[20] in 2015, observed that the hemodynamic response to laryngeal mask insertion is transient. No untoward incidents with airway management by LMA occurred in their study. Khalid et al.[21] concluded that the attenuated response of the LMA was desirable as the time taken to insert an LMA was significantly shorter and insertion was easier as compared

to laryngoscopy and ETT insertion. These factors might be contributory to the higher hemodynamic changes seen with laryngoscopy and ETT insertion. In a randomized clinical trial by Khan et al.[22] found that LMA removal was found to be accompanied with lesser pressor responses as compared to endotracheal tube extubation in controlled hypertensive patients. Malti et al.[23] concluded from their study that LMA is advantageous in penetrating eye injuries, glaucoma, and strabismus in whom elevation of intraocular pressure is likely to be detrimental. They found the rise in intra-ocular pressure was minimal with LMA insertion. Sara et al.[24] in a prospective randomized clinical trial observed that with LMA the advantage of promoting smaller hemodynamic response during its management and lower incidence of sore throat and dysphagia in the 1st h after surgery.

CONCLUSIONS

The pressor response to LMA insertion is much less than that of laryngoscopy and endotracheal intubation. Duration and magnitude of the pressor response are transient during LMA insertion. LMA may be useful in airway management during anesthesia in situations where marked pressor response would be deleterious, for example, patients with hypertension and coronary artery disease. However, large-scale studies are required to confidently ascertain the findings of present study.

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