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A Comparative Study of Positive Pressure Ventilation Via Laryngeal Mask Airway and Endotracheal Tube

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Abstract

Objective: To investigate the use of Laryngeal Mask Airway (LMA) and its comparison with the endotracheal tube for positive pressure ventilation.
Setting: A tertiary care teaching hospital.
Methods: Fifty adult ASA I and II patients undergoing peripheral limb surgery were randomly allocated to 2 groups for LMA or endotracheal tube insertion. A standardized anaesthetic technique was used. The groups were then compared regarding haemodynamic changes on insertion as well as removal of LMA and ETT and any complications that occurred were noted.
Results: The haemodynamic response to insertion was significantly attenuated (p<0.05) in LMA group as compared to Efl group. The cardiovascular response to extubation was not significantly different between the groups. A higher incidence of coughing and mild hypoxaeniia at exiubation was noted in Efl group as compared to LMA group (p
Conclusion: It is concluded that the use of LMA during positive pressure ventilation is sale in selected cases. There is an attenuated haemodynamic response to insertion of LMA as compared to endotracheal tube which will be beneficial in certain patients e.g., those with ischaemic heart disease, vascular disease and hypertensives (JPM A 50;333, 2000).

Introduction

Since its advent in 1983[1], Larngeal Mask Airway (LMA) has been increasingly used for the maintenance of airway during general Anesthesia as an alternative equipment to face mask and endotracheal tube. A number of studies have been conducted where LMA was compared with other methods of maintaining the airway, but a majority of these have featured spontaneous breathing instead of positive pressure ventilation[2-5].
There is value in using LMA during positive pressure ventilation because of its advantages over endotracheal intubation and a lesser incidence of complications. Successful use of LMA with positive pressure ventilation was first reported by Brain in 1983[1]. However, its full utility during positive pressure ventilation has yet to be determined by controlled studies[6].
The objective of this study was to compare and evaluate two methods of airway management i.e.. LMA and Endotracheal intubation during positive pressure ventilation in peripheral limb surgery with regard to haemodynamic responses at the time of insertion and removal and complications at the time of insertion, intra-operatively and at the time of removal.

Patients and Methods

After approval from the human protection committee of the institution. 50 adult patients of ASA tatus I and 11 undergoing peripheral limb urgery were randomly assigned to the LMA (Group I) and Endotracheal group (Group 11) by a coin flip method. Patients with ischaemic heart disease, hypertention, recent history of myocardial infarction (within 6 months), hiatus hernia, gastro-oesophageal reflux, pregnancy, or on drugs which altered the haemodynamic parameters and emergency cases were excluded.
Midazolam 7.5 nig orally was given as a premedicant approximately half to oneS hour before the surgery. Baseline values of blood pressure, pulse and oxygen saturation were taken 5 minutes before induction. Alter pre-oxygenation, patients were induced with Pethidine 0.8 mg/kg (given over a period

of 15 seconds), Thiopentone 5 mg/kg (given over a period of 30 seconds) and Vecuronium 0.1 mg/kg. Patient\'s lungs were ventilated with 50% oxygen, 50% nitrous oxide and 1% enflurane for 3 minutes prior to insertion of LMA or endotracheal tube (ETT) and during the surgical procedure. In Group I patients LMA of size 3 for adult females and size 4 for adult males was selected and lubricated with a water based gel. The primary investigator used his right hand for insertion, pushing the LMA against the hard palate and posterior pharyngeal wall without introducing the index finger into the mouth. In Group II patients a polyvinyl chloride endotracheal tube size 8.0 was selected for females and size 9.0 for males, which was inserted following laryngoscopy. In order to standardize the insertions, all insertions and intubations were done by the principal investigator only. A tidal volume of 10 ml/kg was set for all patients initially and respiratory rate was adjusted according to end tidal C02, maintaining it within nominal limits. At the end of procedure, LMA or ETT was removed after adequate reversal of neuromuscular blockade and presence of airway reflexes.
Lead II was used for continuous monitoring of ECG. Heart rate and oxygen saturation were also monitored continuously. Non-Invasive blood pressures (systolic, diastolic and mean) were recorded before induction and at I minute interval for up to 10 minutes after insertion of LMA or ETT and thereafter at 5 minutes interval by using a Datex monitor. Peak airway pressures were also recorded every 5 minutes. End Tidal C02 was monitored continuously and kept between 35 and 40 mm of Hg. At extubation, pulse and non-invasive blood pressure (systolic, diastolic and mean) were recorded at 1 minute interval for 5 minutes.
The number of attempts at insertion, failure to insert, malpositions and complications e.g., damage to lip, tongue or mucosa, laryngospasm, tube malfunction, cuff
perforation, unintentional displacement, excessive leak, aspiration, coughing, l aryngospasm and hypoxaem ia were recorded at insertion, intra-operatively and on extubation. These complications were noted until 5 minutes following removal of LMA or ETT. Hypoxaemia was noted according to the following categories, mild (90-95%), moderate (85-89%) and severe (<85%). The time of occurrence of hypoxaemia was also noted. Statistical Analysis: Epi-lnfo-6 and SPSS software programmes were used for statistical analysis. The mean change in systolic, diastolic, mean blood pressures and heart rate were compared in both the groups during insertion as well as at removal using the student-t test and analysis of variance. Percentage change from baseline readings in both the groups for mean systolic, diastolic, mean arterial pressure and heart rate were also calculated. Complications in both the groups were compared using the Fisher Exact test.

Results

Fifty patients were enrolled in the study with 25 patients in each group. There was no significant difference between age, weight or sex between the groups. One patient in group I (LMA) developed excessive leak around LMA after insertion. The leak persisted after 3 attempts of insertion after which the LMA was changed with ETT. This case was excluded from statistical analysis.

Haemodynamic variables at time of insertion

Mean arterial pressure: The baseline readings in both groups were comparable. The pressure dropped 11% below the baseline three minutes after induction in LMA group. It rose after insertion but still remained 7% below the baseline. The pressure fell further to a maximum of 15% below the baseline 6 minutes after insertion. In the ETT group the pressure dropped 9% below the after induction. After insertion of ETT, it significantly increased ($p<0.05$) to a maximum of 13% above the baseline value 1 minute after intubation and dropped to near baseline values after 3 minutes. It then fell to a maximum of 15% below the baseline at 8 minutes post insertion.
On comparison between the two groups a significant difference was observed at I ,2,3 and 4 minutes post-insertion. These changes are shown in Figure 1.

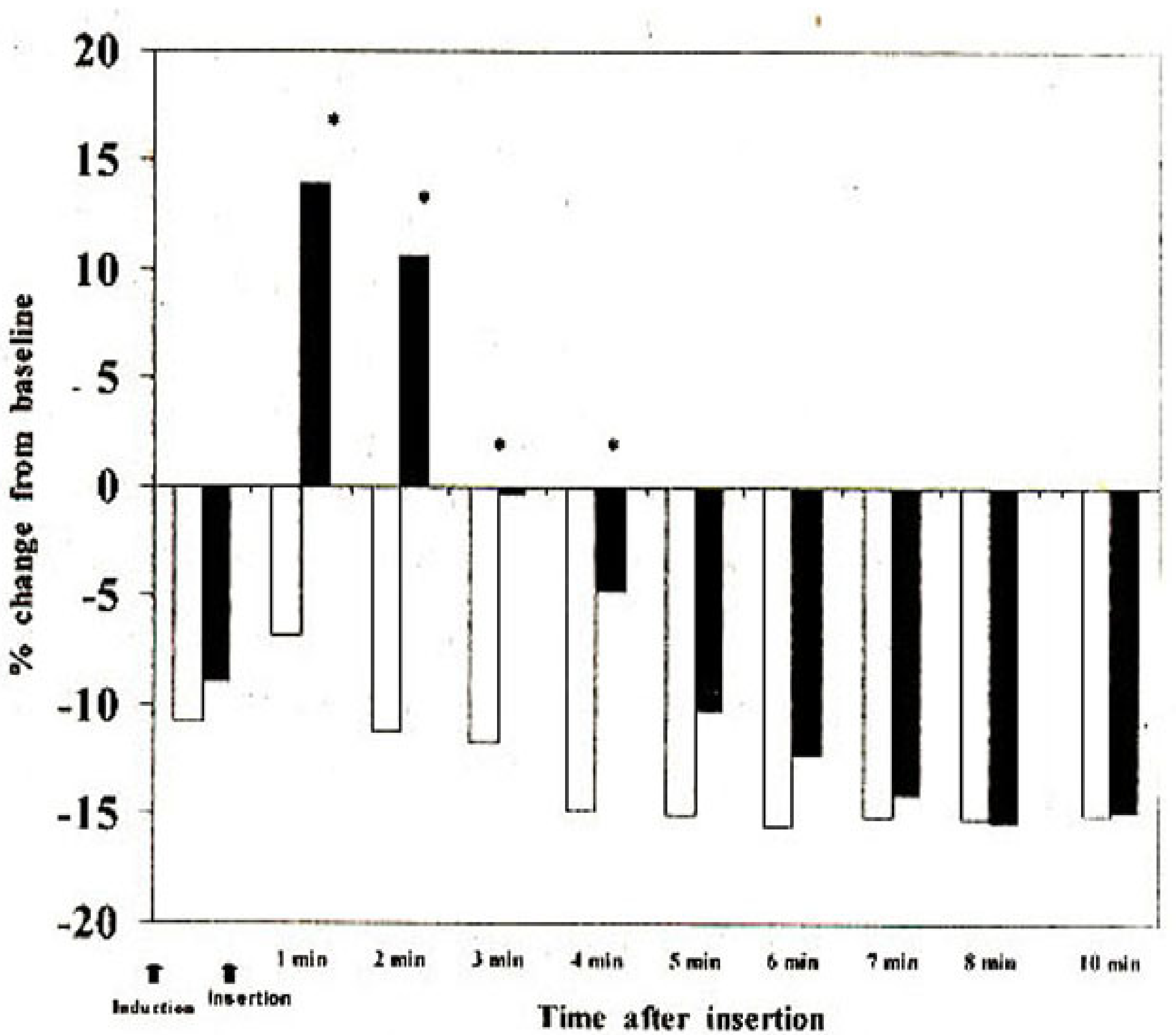

Figure 1 Percentage changes of mean arterial pressure during insertion of y device Group 1 (LMA), F Group II (ETT), * P-value <0.05 on comparison bn groups

Systolic arterial pressure and diastolic arterial pressure changes mirrored the changes seen with mean arterial pressure.

Mean Heart Rate

The baseline readings in both groups were comparable. It did not change significantly in both the groups after induction of anesthesia and remained within 2% of the baseline value. In group I it increased slightly after insertion of LMA and was only 2% above the baseline value at 1 minute post-insertion. The heart rate then dropped to a maximum of 15% below the baseline value at 10 minute post-insertion. In the ETT group, heart rate significantly increased to a maximum of 19% above the baseline value 1 minute after intubation. It then dropped to near baseline value after 6 minutes of intubation. In ETT group, the mean heart rate fell to a maximum of 7% below baseline value at 10 minutes pot-intubation.

On comparison between the two groups, there was a statistically significant ($p<0.05$) difference in mean heart rate between the groups at 1,2,3,4,5,6 and 7 minutes postintubation. These changes are shown in Figure 2.

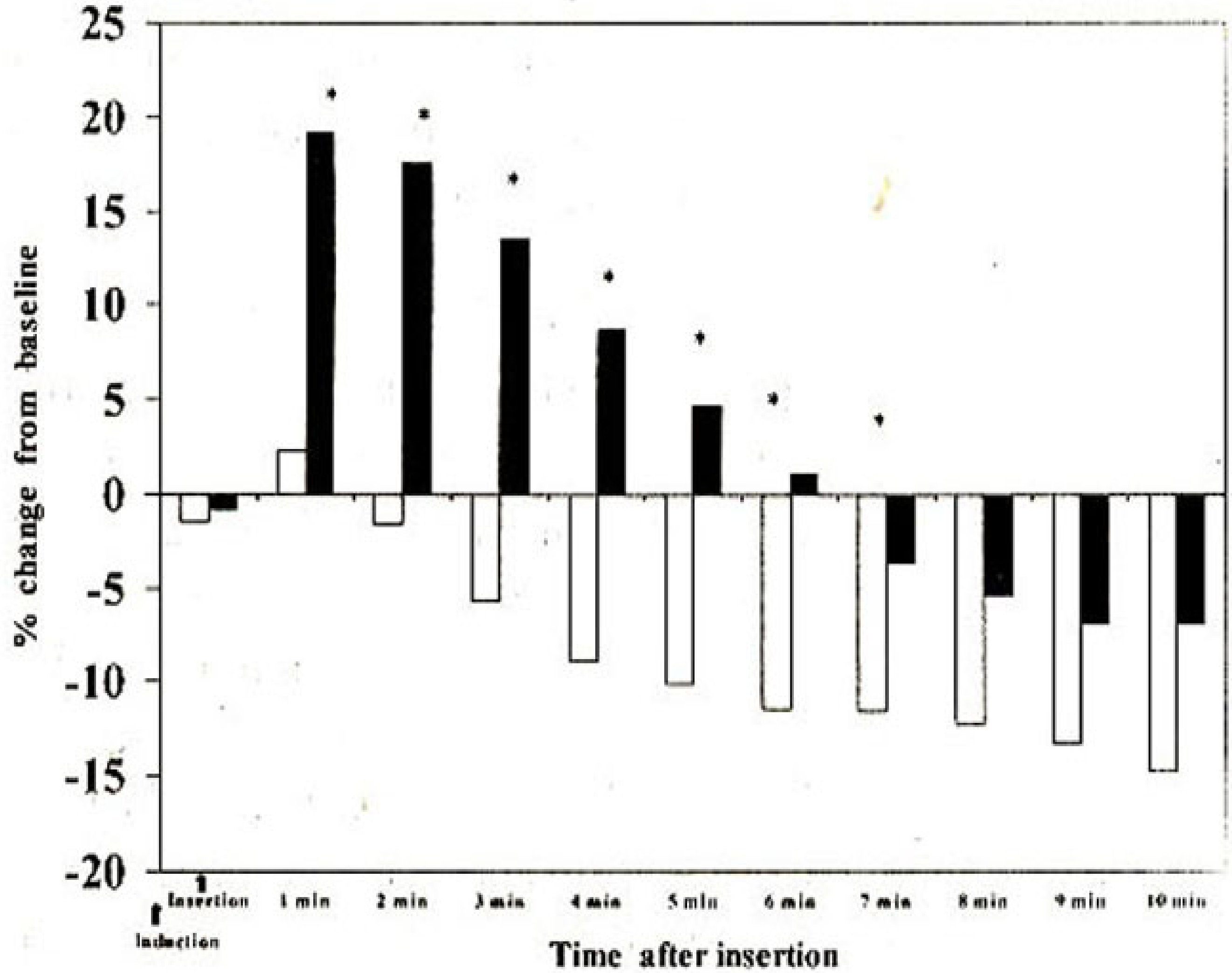

Figure 2. Percentage changes of heart rate during insertion of airway device. D Group I (LMA), F Group II (ETT), * P-value <0.05 on comparison between groups.

Haemodynamic variables at the time of extubation.

The mean arterial pressure between the two groups was not statistically different just before extubation and at 1,2,3,4 and 5 minutes after removal (Figure 3).

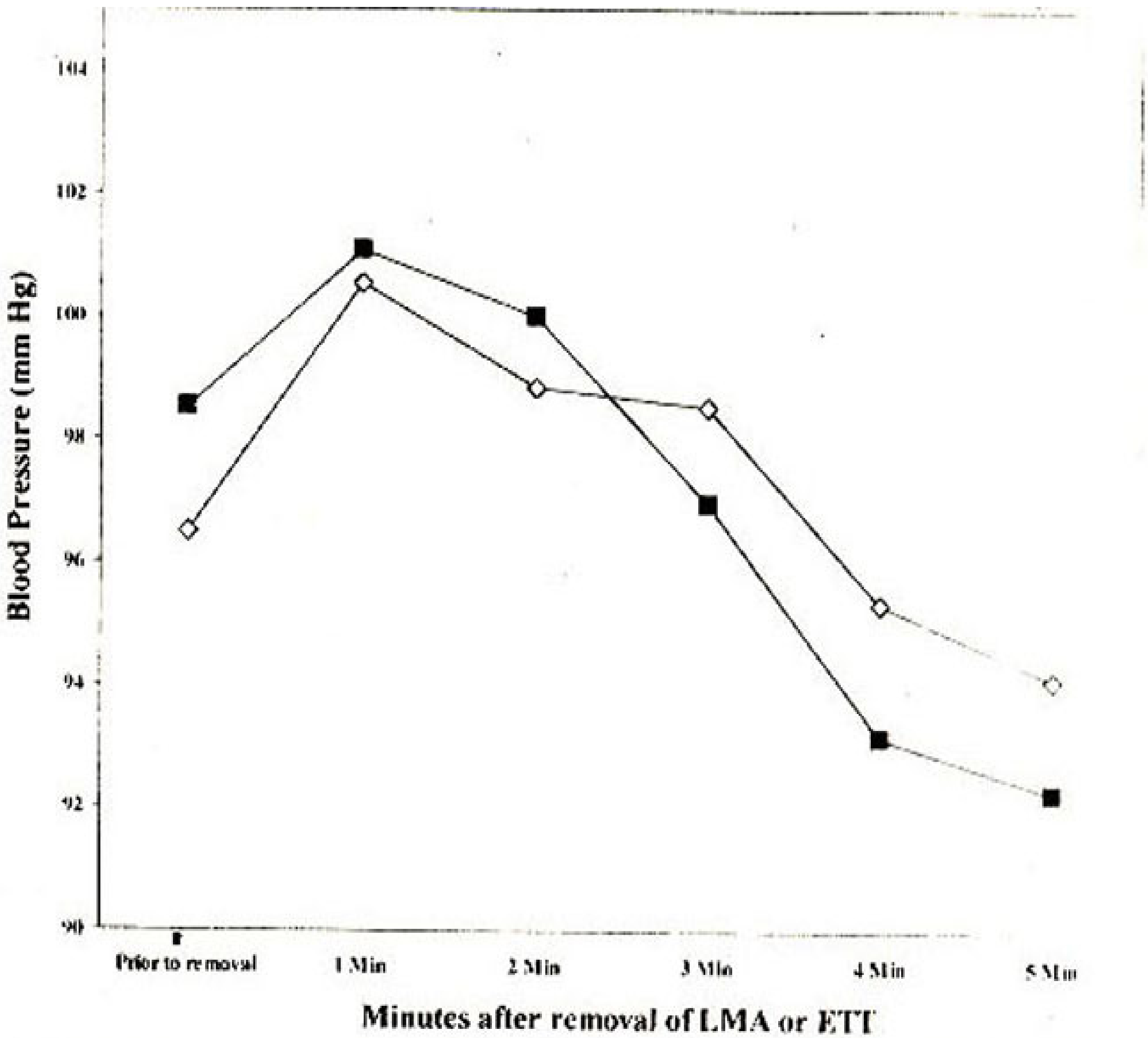

Figure 3. Mean arterial pressure changes during removal of LMA or ETTd. Group I (LMA), F Group II (ETT)

The heart rate in group 2 was statistically higher compared to group I just before extubation. This difference was preserved at 1,2 and 3 minutes after removal (Figure 4).

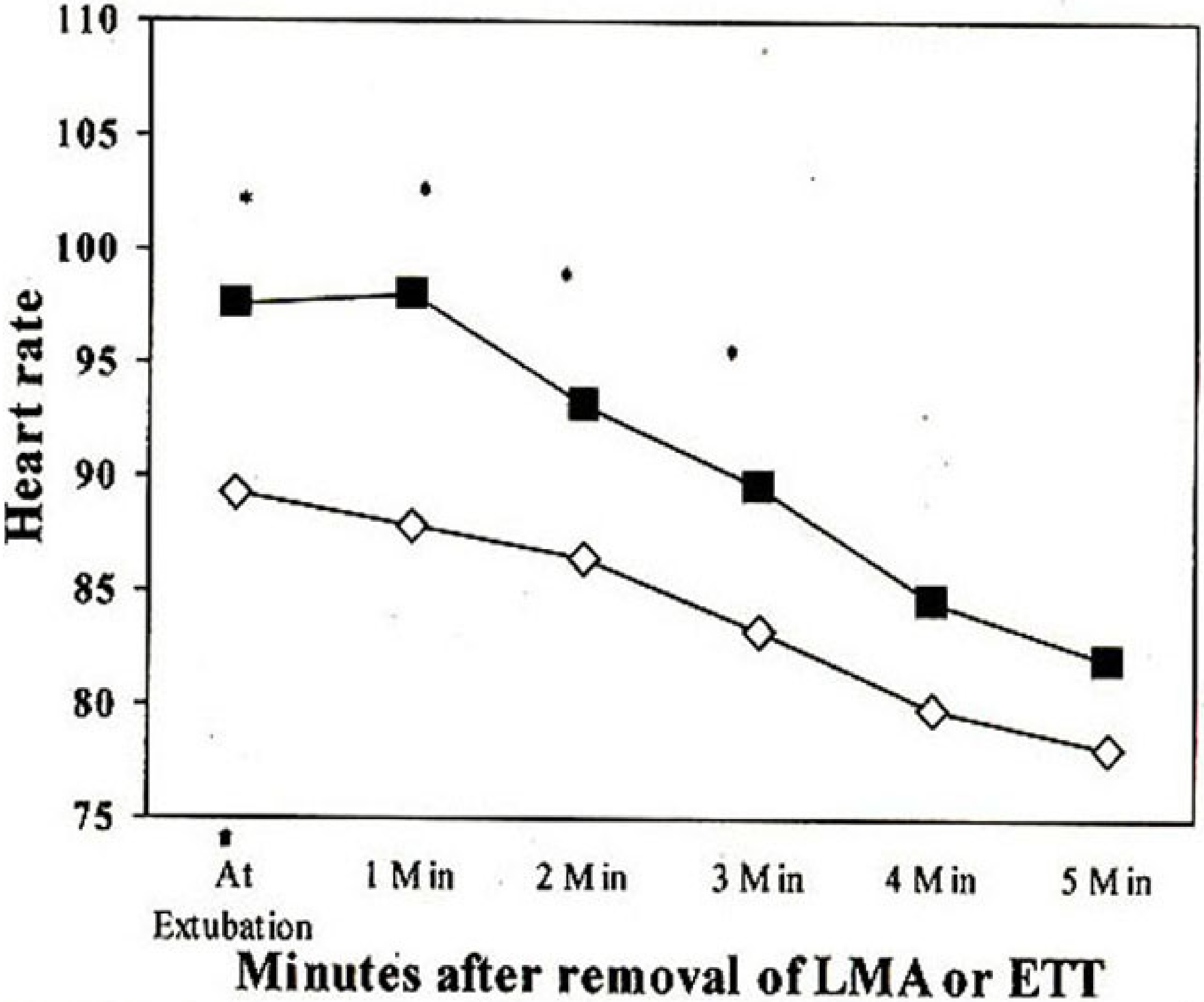

Figure 4. Heart rate changes during removal of LMA or ETTd. Group I (LMA), F Group II (ETT), * P-value <0.05

Complications

Table. Complications.

Complications	Group I (LMA) n	%	Group II (ETT) n	%	P-value
At Insertion					
Excessive leak	1	4	0	NS	
During Procedure					
Within 5 minutes of removal					
Shivering	2	8	3	12	NS
Blood detected on device	4	16	0	NS	
Excessive salivation	3	12	1	4	NS
Retching	2	8	1	4	NS
Vomiting	1	4	2	8	NS
Coughing	1	4	6	24	<0.05
Laryngeal spasm	0		1	4	NS
Hypoxaemia (mild)	1	4	6	24	<0.05

NS = Not significant.

Table shows complications in two groups of patients. Except for the excessive leak in LMA group in one patient, no complication occurred in either of the group at insertion and during the surgical procedure. Statistically significant (p<0.05) proportion of patients in group II (6 patients compared to one patient in group I) suffered from mild hypoxaSmia. Significantly higher (P<0.05) number of patients suffered from coughing during extubation in group II as compared to group I. In 4 cases (16%) of group I blood was detected on LMA, while this complication was not found in group II. Vomiting, retching, shivering, excessive salivation and laryngeal spasm at extubation was seen in some patients hut on comparison results were not statistically significant (p<0.05) between the groups.

Airway pressures

Mean peak airway pressure were lower in group I (16.91±2.61 mniHg) than in group 11(17.88±2.87 mmHg), however the result was not statistically significant (p>0.05).

Discussion

The use of laryngeal mask airway has increased sharply over the last few years. A large survey of laryngeal mask airway usage in two hospitals of United Kingdom and Australia showed that during the 2 year study period, 29.29% patients who underwent general anesthesia had their airways managed with LMA. Of these 44% underwent positive pressure ventilation[7]. LMA usage has increased over the past few years especially with positive pressure ventilation because of the advantages it offers over the endo-tracheal tube. It is easier to insert technically, does not require a laryngoscope for insertion[8] causes less coughing, straining, breath holding and an attenuated pressor response has been reported with its use[2,8,9].

An initial fall in the mean blood pressure was seen in both LMA and ETF groups after induction in our study. This fall was more than what was reported by Wilson et al, who also compared the haemodynamic response related to insertion of laryngeal mask airway with the endotracheal tube[10] Systolic and diastolic blood pressures fell to greater extent in our study compared to Wilson's. This was probably due to the different combination of drugs used by us for induction. We used pethidine in a dose of 0.8 mg/kg with thiopentone 5 mg/kg and patient's lungs were ventilated with 1% enflurane and 50% nitrous oxide in oxygen, while Wilson et al did not use any analgesic and the patients were induced with thiopentone 4-5 mg/kg. Wood mentioned the effect of intravenous pethidine which causes a small increase in peripheral blood flow and a decrease in peripheral arterial and venous resistance that may lower blood pressure[11] The knowledge regarding the hypotensive response to the combination of opioid and hypnotics (thiopentone) is still deficient, but reduction in systemic vascular resistance seems to play a significant role[12]. Our results were consistent with findings of Barclay et al who used propofol (which also has a hypotensive effect) for induction while comparing the cardiovascular response to insertion of LMA and ETT[4].

The changes in systolic, diastolic and mean arterial pressure were insignificant ($p<0.05$) after insertion of LMA in group I and much less compared to those reported by Wilson et al in their study[10]. The changes in heart rate were similarly insignificant ($p<0.05$) after LMA insertion. These findings may again be due to different combination of drugs used for induction by us and a different technique of insertion of laryngeal mask airway i.e., without finger insertion which might have led to less pharyngeal stimulation and therefore a lesser haemodynamic response.

The cardiovascular response to intubation with endotracheal tube in group II was consistent with findings of Forbes and Daily and other workers who found that intubation and larygoscopy is associated with significant rise in systolic, diastolic and mean blood pressure as well as heart rate[13].

There was significant attenuation of cardiovascular response to insertion of LMA as compared to laryngoscopy and endotracheal intubation. These findings are consistent with most of the studies which have compared haemodynamic response to insertion of LMA with the endotracheal tube[2,10,14]. The explanation for smaller rise in systolic, diastolic, mean arterial pressure and heart rate in response to LMA insertion as compared to tracheal intubation was given by Wilson et al[10]. It reflects a smaller degree of total afferent stimulation rather than avoidance of tracheal stimulation. This effect of non-specific pharyngeal stimulation was also demonstrated by ilickey and colleagues who found that insertion of LMA produced similar kind of cardiovascular response as caused by insertion of a Guedel airway alone[9,10].

The changes in systolic, diastolic and mean blood pressure in both the groups were similar on extubation and no difference was observed between the groups. The mean heart rate was high ($p>0.05$) in the ETT group before extubation, hence a statistical analysis would be invalid. A possible explanation could be the presence and stimulation of the ETT in the trachea. This could have resulted in teachycardia as the patients were waking up from anesthesia, thus again pointing towards the haemodynamic stability of the LMA.

Varghese and Brimacombe reported 14 cases of inadequate seal around the cuff. In their opinion, with the use of large size mask (size 5 for males), it may be possible to reduce the incidence of functionally unacceptable leak[7]. We did not experience any difficulty in carrying out controlled ventilation through the laryngeal mask airway except for one case (4%) where there was excessive leak around the cuff. No other complications were encountered at insertion and during surgery with the use of LMA in our study. The incidence of mild hypoxaemia at extubation was significantly (p The number of patients who suffered from cough ing at extubation in ETT group was more than those in the LMA group. This finding is consistent with the finding of other workers. Akhtar et al and Holden et al also reported a higher frequency of coughing with the use of endotracheal tube[13,14]. Coughing is associated with rise in intraoccular and intracranial pressures. Its avoidance is beneficial in intraoccu lar and intracranial

surgeries. While endotracheal tube is a potent stimulus for coughing. the chances of it occurring is very low with the use of LMA[5]. This was confirmed in our study as well.
There were four cases (16%) in LMA group where blood was detected on the device after removal. This complication was also reported by Brimacombe and Khan et al[8,15] Brimacombe found that with increasing experience of LMA insertion, the incidence of this complication decreased. This complication may due to the injury and/or frictional damage to the mucosa during insertion and change of position of patient's head.
The incidence of other complications like vomiting, shivering and excessive salivation did not show any sign iticant difference between the groups. Swan et al found that the use of LMA with positive pressure ventilation in gynaecological laparoscopy surgery was associated with an increased incidence of nausea and vomiting post-operatively during the first 4 hours as compared to endotracheal tube[16]. The difference in our result as compared to Swan et al may be due to short observation time and the type of surgical procedure performed[16].
The mean peak airway pressures were slightly less (l6.91±2.61mmHg) in group I than in group II (I7.88+2.87mmHg), but the result was not statistically significant ($p<0.05$). The lower peak airway pressures in group I were due to larger caliber and less resistance to the passage of inhalational gases with the use of LMA.
In conclusion, base on our findings, the use of LMA during positive pressure ventilation is safe in selective ASA I and El adult patients. The haemodynamic response attenuated after insertion of LMA as compared to endotracheal tube. The significance of this attenuated insertion response is of little value in ASA I but it is of greater clinical importance in patients with ischemic heart disease, vascular disease, cerebral aneurysm, raised intracranial pressure, aortic aneurysm and hypertensive. It is in these cases where LMA may turn out to be beneficial. The haemodynamic response of extubation was not significantly different. The incidence of mild hypoxaemia and coughing at extubation was significantly high with the use of endotracheal tube.

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