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# Comparative Study of Intraocular Pressure and Haemodynamic Changes Subsequent to Insertion of Laryngeal Mask Airway and Endotracheal Tube.

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## ABSTRACT

**Background:** To compare IOP changes and haemodynamic changes subsequent to LMA insertion and endotracheal tube insertion. **Material and Methods:** The present study was carried out on 60 adult patients in the age group of 18-50 years of ASA grade I and II posted for elective non ophthalmic surgery. They were randomly divided in two groups of 30 patients each, receiving anaesthesia via laryngeal mask airway (Group L) or endotracheal tube (Group E). We compared both the groups for the changes in IOP, heart rate and mean arterial pressure just prior to insertion and at 0,1,3 and 5 minutes after ETT/LMA insertion. **Results:** The mean IOP, mean heart rate and mean arterial pressure increased after insertion of airway devise in both the groups but the rise was significantly greater after endotracheal intubation at 0, 1, 3 min after insertion. The parameters were comparable at 5 min after insertion. The duration of increase was longer after ETT intubation than LMA insertion. **Conclusion:** We can conclude that the LMA is an excellent technique to minimize the increase in IOP and haemodynamic response to tracheal intubation in patients posted for ocular surgeries and in the patients with compromised cardiovascular status.

***Keywords:*** Intraocular Pressure, Laryngeal Mask Airway, Endotracheal tube, Haemodynamic changes.

## INTRODUCTION

One of the fundamental responsibilities of the anesthesiologist is to mitigate the adverse effects of anaesthesia on the respiratory system by maintaining airway patency and ensuring adequate ventilation and oxygenation. The term airway management refers to this practice and is a cornerstone of anaesthesia.[1] In the past facemask was the only available alternative used to deliver an entire anaesthesia. The complications associated with its use includes more episodes of desaturation, increased work of breathing, pressure effects on the face and eyes, corneal abrasion, transient sensory and motor dysfunction due to stretching nerve injury, foreign body aspiration, gastric inflation, latex allergy, environmental pollution, user fatigue and postoperative jaw pain.[2]

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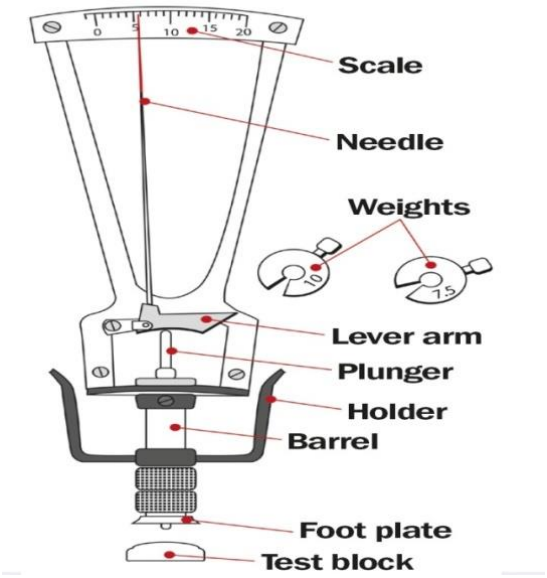
The Endotracheal tube (ETT) is a rapid safe and non-surgical technique that achieves all the goals of airway management. But it causes transient sympathoadrenal stimulation, transient rise in intraocular pressure and intracranial pressure, trauma and edema to the airway structures, failure to pass the tube into trachea, inadvertent endobronchial intubation, postoperative sore throat, hoarseness, neurological injuries, vocal cord dysfunction or grannuloma and tracheal stenosis.[3] Supraglottic airway devices like Classic Laryngeal mask airway (LMA), Unique LMA, Flexible LMA, Fastrach, CTrach and ProSeal are new development in the management of airway, filling a niche between facemask and tracheal tubes in terms of both anatomical position and degree of invasiveness. LMA is less invasive and results in less sympathoadrenal response, requires less anaesthesia for its tolerance and there is no need of neuromuscular block. It can be inserted easily and faster than ETT even in inexperienced hands, in any position where an access to mouth is possible. LMA is also useful in cannot intubate and cannot ventilate scenario.[4] Laryngoscopy with endotracheal intubation and Laryngeal Mask Airway insertion both cause increase in heart rate, blood pressure and intraocular pressure (IOP). But the increase in all the three parameters is less marked and of shorter duration with LMA insertion than those associated

with tracheal intubation.[5] Based on the above facts the present study is conducted to assess haemodynamic and intraocular pressure responses to ETT intubation and LMA insertion. IOP is measured using Schiotz tonometer. It is based on principal-indentation of corneal surface is indirectly proportional to IOP. It measures the depth produced on surface of cornea by a load of known weight which in turn is used to estimate IOP.

## MATERIALS AND METHODS

The present study was prospective, randomized, clinical comparative study carried out on 60 adult patients in the age group of 18-50 years of ASA grade I and II posted for elective non ophthalmic surgery. The patients having significant cardio respiratory disease, acute or chronic eye disease, anticipated difficult intubation or known allergy to any anesthetic agent were excluded from the study. Simple random sampling was done with lottery method to divide the patients in two groups of 30 each: Group E- Anesthesia with Endotracheal tube and Group L- Anesthesia with Laryngeal Mask Airway. Preoperative IOP in both the eyes was measured using Schiotz tonometer after instilling two drops of 0.5% Proparacaine hydrochloride in each eye and average IOP was taken as reading. Also preoperative heart rate, mean arterial pressure, $SpO_2$ was noted.




**Schiotz tonometer**

Patients were premeditated with Inj Ondansetron 0.08mg/kg, inj. Midazolam 20ug/kg, inj. Fortwin 0.3mg/kg. All patients were preoxygenated for 3 minutes. Induction was done with inj. Thiopentone sodium 6mg/kg and intubating dose of inj. Atracurium 0.6mg/kg. Patients were ventilated with Bain's coaxial circuit using a facemask for 3 minutes followed by tracheal tube insertion or laryngeal mask airway insertion. Following successful LMA/ETT insertion anaesthesia was maintained with 40%$O_2$, 1-3% Sevoflurane, $N_2O$ and maintenance dose of Inj Atracurium 0.1mg/kg. IOP, Heart rate (HR), Mean Arterial Pressure (MAP) and $SpO_2$ were recorded before premedication, after premedication, after induction just prior to insertion, immediately after insertion of LMA or tracheal tube at 0 min and thereafter at 1 min, 3 min and 5 min. The changes in IOP HR and MAP were compared in both the groups. The anaesthesia was continued as per the standard clinical practice

**Statistical Analysis**

The collected data was compiled in EXCEL sheet and Master sheet was prepared. For analysis of this data SPSS (Statistical Software for social Sciences) software version 20th was used. For comparison of quantitative data of two groups unpaired t-test was used and for comparison in within group paired t-test was used. P-value was checked a 5 % level of significance.

## RESULTS

Laryngoscopy and endotracheal intubation is commonest definitive method of securing an airway. However it is a painful procedure and hence causes sympathoadrenal stimulation. This in turn leads to vasoconstriction and venoconstriction resulting in an increase in central venous pressure which will raise the IOP. Laryngoscopy and tracheal intubation increases the basal metabolic rate and causes hypercarbia, hypoxemia which may cause choroidal vessel dilatation and further increase in the IOP. It also causes hypertension and tachycardia. These changes are associated with increase in plasma nor-adrenaline level confirming a predominantly sympathetic response to it.[6-8]

The technique of insertion of LMA is absolutely different from that the insertion of an endotracheal tube. It involves no use of laryngoscopy as vocal cords do not need to be visualized and LMA does not enter trachea but instead sits on the hypopharynx when positioned correctly. So, considering these differences, the pressor responses to LMA insertion was expected to be different from that of laryngoscopy and tracheal intubation. So we have compared the intraocular pressure changes and the pressor response after placement of LMA with that after direct laryngoscopy guided endotracheal intubation.

**Changes in Intraocular Pressure At Various Time Intervals**

The IOP increased by 34.67% after ETT insertion and by 9.02% after LMA placement. The IOP came back to preinsertion level in LMA group in 1 min

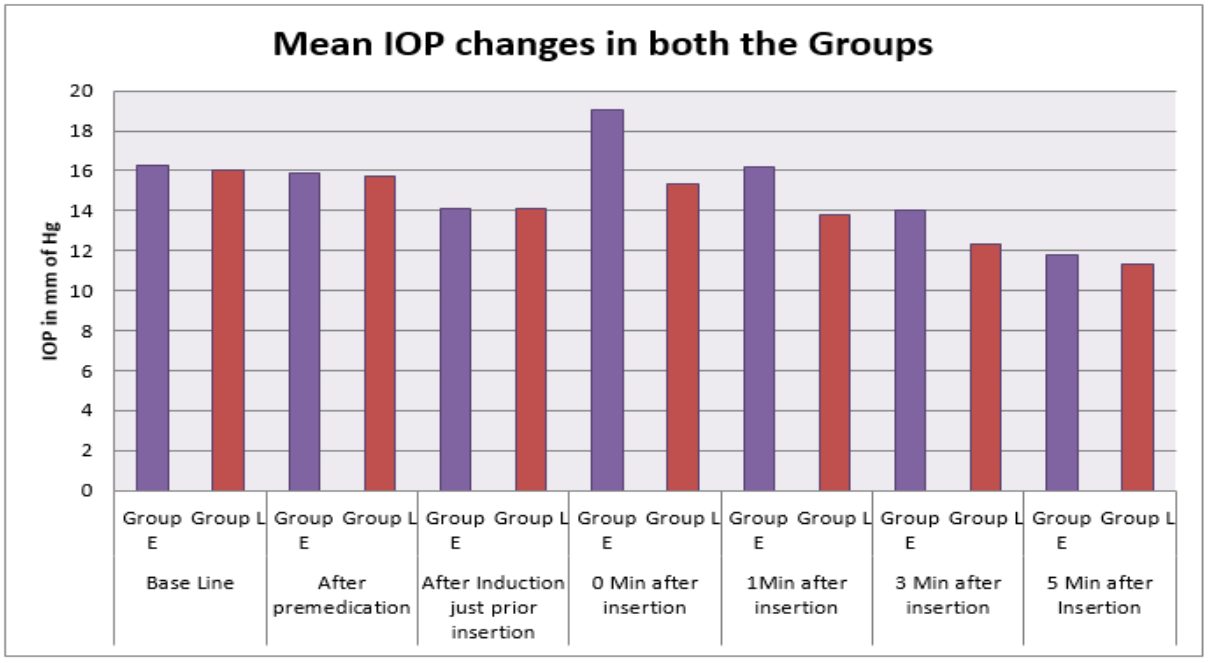
and in ETT group in 3 min. This suggests that IOP remained high for a longer duration in ETT group. IOP was comparable at 5 min after insertion of ETT/LMA. Mean IOP in both groups were below the pre-insertion values at 5 min after insertion, possibly due to effect of Sevoflurane, Nitrous oxide and Atracurium, used for maintenance of anaesthesia which decrease the IOP.[9,10]

**Table 1: Comparison of Mean IOP at various time interval in both the groups**

| | | Mean | SD | t-value | P-value |
|---|---|---|---|---|---|
| Base Line | Group E | 16.25 | 2.46 | 0.361 | P=0.720 NS |
| | Group L | 16.03 | 2.17 | | |
| After premedication | Group E | 15.88 | 2.80 | 0.212 | P=0.834 NS |
| | Group L | 15.74 | 2.03 | | |
| After Induction & just prior to insertion | Group E | 14.13 | 2.65 | 0.089 | P=0.930 NS |
| | Group L | 14.07 | 1.94 | | |
| 0 Min after insertion | Group E | 19.03 | 2.92 | 5.66 | P<0.0001 S |
| | Group L | 15.34 | 2.06 | | |
| 1 Min after insertion | Group E | 16.19 | 3.22 | 3.53 | P<0.0001 S |
| | Group L | 13.82 | 1.76 | | |
| 3 Min after insertion | Group E | 14.01 | 2.81 | 2.85 | P=0.006 S |
| | Group L | 12.34 | 1.49 | | |
| 5 Min after Insertion | Group E | 11.80 | 1.98 | 1.03 | P=0.308 NS |

S: Significant NS: Not Significant

**Figure 1: Bar Diagram Showing Mean IOP Changes At Various Intervals**




X- Axis: Group-E: Anaesthesia with ETT, Group-L: Anaesthesia with LMA
Y axis: IOP in mm of Hg

**Changes in Heart Rate at Various Time Intervals**

We noted that the increase in heart rate with laryngoscopy and tracheal intubation was significantly higher than that with the LMA placement. Also the mean HR changes were highly significant after ETT/ LMA insertion at 0, 1 and 3 minutes in the two groups but the difference was not significant at 5 min. The heart rate remained higher than the pre-insertion values in both the groups at 5 min after ETT/ LMA insertion.

**Changes in Mean Arterial Pressure at Various Time Intervals**

Among the two groups the mean arterial pressure was significantly higher after ETT intubation at 0 min, 1 min, and 3 min as compared to that after LMA insertion. The mean arterial pressure came back to preinsertion value at 1 min after LMA placement and at 5 min after endotracheal intubation. This shows that a lesser pressure response was seen after LMA placement as compared to ETT insertion. Thus we observe that the increase in intraocular pressure and haemodynamic parameters (heart rate and mean arterial pressure) was of greater magnitude after endotracheal intubation as compared to LMA insertion. Also the duration of rise was longer after ETT intubation than LMA insertion.

**Table 2: Comparison of Mean HR in both Groups at various intervals:**

| | | Mean | SD | t-value | P-value |
|---|---|---|---|---|---|
| Base Line | Group E | 80.13 | 10.33 | 0.012 | P=0.990 NS |
| | Group L | 80.10 | 10.86 | | |
| After premedication | Group E | 75.26 | 8.58 | 0.728 | P=0.470 NS |
| | Group L | 77.03 | 10.145 | | |
| After Induction & just prior to insertion | Group E | 82.30 | 9.12 | 1.95 | P=0.059 NS |
| | Group L | 77.03 | 10.14 | | |
| 0 Min after insertion | Group E | 110.03 | 10.75 | 3.64 | P=0.001 S |
| | Group L | 100.10 | 10.37 | | |
| 1 Min after insertion | Group E | 103.96 | 10.50 | 4.12 | P<0.0001 S |
| | Group L | 93.53 | 9.14 | | |
| 3 Min after insertion | Group E | 95.90 | 10.00 | 3.18 | P=0.02 S |
| | Group L | 88.36 | 8.22 | | |
| 5 Min after Insertion | Group E | 89.00 | 9.38 | 1.23 | P=0.224 NS |
| | Group L | 86.20 | 8.23 | | |

S: Significant NS: Not Significant

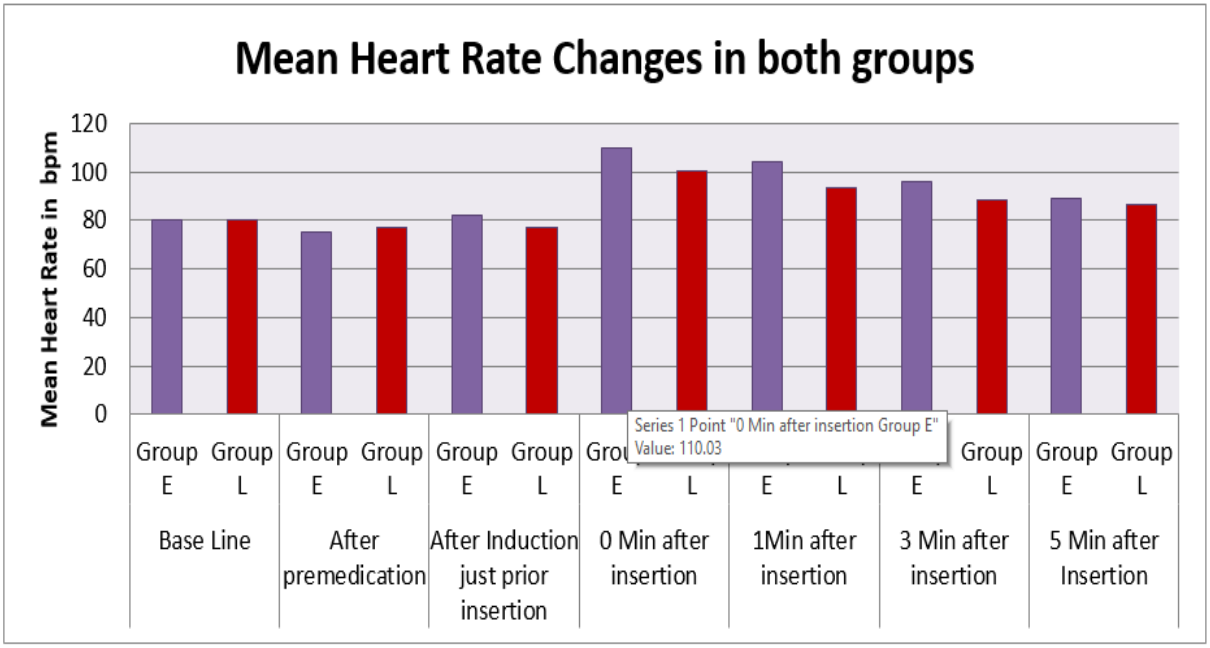



**Figure 2: Bar Diagram Showing Heart Rate Changes At Various Time Intervals.**

X Axis: Group-E: Anaesthesia with ETT, Group-L: Anaesthesia with LMA
Y Axis: Mean Heart rate in bpm (beats per minute)

**TABLE-3: Comparison of Mean MAP at various time intervals in both the Groups**

| | | Mean | SD | t-value | P-value |
|---|---|---|---|---|---|
| Base Line | Group E | 78.36 | 7.12 | 1.16 | P=0.247 NS |
| | Group L | 80.80 | 8.89 | | |
| After premedication | Group E | 76.00 | 6.86 | 0.967 | P=0.337 NS |
| | Group L | 78.00 | 8.99 | | |
| After Induction & just prior to insertion | Group E | 73.10 | 6.89 | 0.972 | P=0.333 NS |
| | Group L | 75.06 | 8.61 | | |
| 0 Min after insertion | Group E | 86.86 | 7.75 | 3.01 | P=0.04 S |
| | Group L | 80.73 | 8.02 | | |
| 1Min after insertion | Group E | 80.23 | 6.43 | 1.87 | P=0.032 S |
| | Group L | 75.20 | 7.54 | | |
| 3 Min after insertion | Group E | 76.26 | 6.79 | 2.78 | P=0.007 S |
| | Group L | 72.00 | 6.97 | | |
| 5 Min after Insertion | Group E | 72.23 | 7.06 | 2.40 | P=0.020 NS |
| | Group L | 71.80 | 6.87 | | |

S: Significant; NS: Not Significant

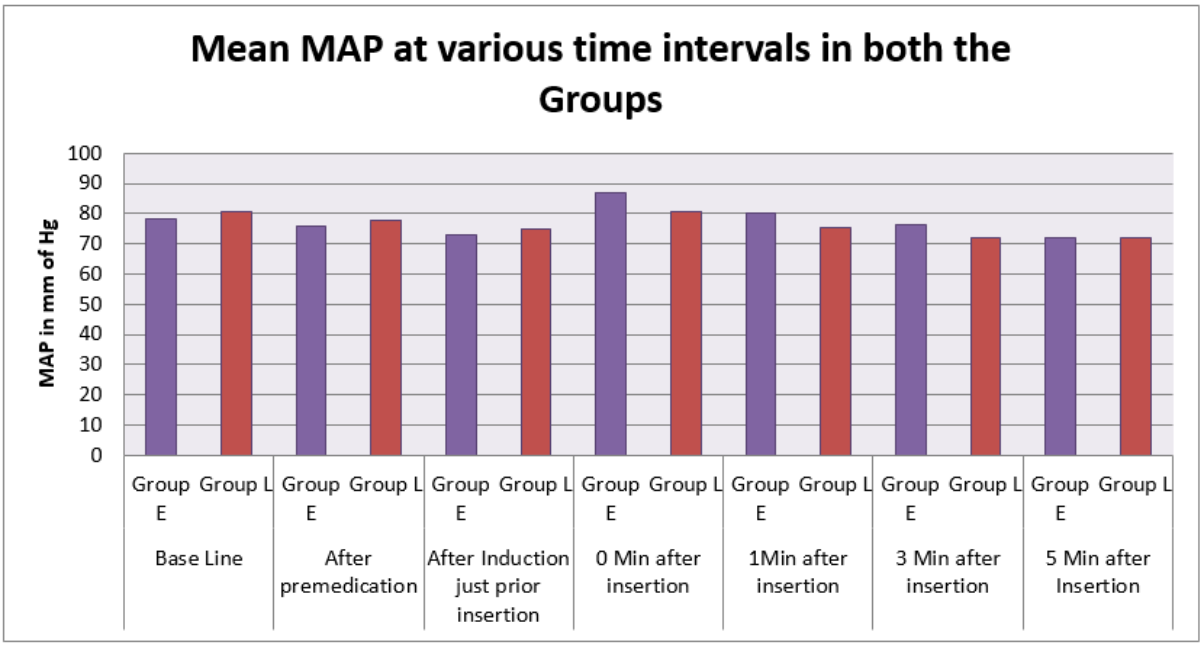



**Figure 3: Bar Diagram Showing Changes in Map At Various Time Intervals**

X Axis: Group-E: Anaesthesia with ETT, Group-L: Anaesthesia with LMA
Y Axis: MAP in mm of Hg

## DISCUSSION

The tissue pressure of intraocular contents is called intraocular pressure. Normal range is 12 to 22 mm Hg. Central venous pressure (CVP), extraocular muscle tone, intraocular blood flow and intraglobal mass are the factors influencing IOP. Central venous pressure is most important factor affecting IOP. Raised CVP raises the episcleral venous pressure which in turn hampers the aqueous drainage and causes vitreous chamber venous engorgement resulting in rise in IOP. An increase in ocular blood flow causes choroidal blood vessel to dilate as they do not have myogenic autoregulation. This will increase aqueous humor formation and will cause increase in intraocular pressure. Also vasodilatation secondary to hypoxemia, hypercarbia and increased metabolic rate will increase intraocular tissue perfusion and raise intraocular pressure.[11]

Laryngoscopy and ETT intubation is a painful procedure and causes transient rise in IOP, mean blood pressure and heart rate. Transient rise in intraocular pressure in patients with low ophthalmic artery pressure may jeopardize retinal perfusion and cause retinal ischemia. E.g. in patients with deliberate hypotension, arteriosclerotic involvement of retinal artery, patients with glaucoma. Increased IOP in a setting of open globe e.g. open eye injuries, foreign body removal, cataract extraction, corneal laceration repair may cause extrusion of vitreous or drainage of aqueous with possible resultant blindness. In the same way transitory hypertension and tachycardia are of no consequence in healthy individuals but either or both may be hazardous to the patients with hypertension, myocardial insufficiency or cerebrovascular disease. The life threatening complications which can occur due to this response are left ventricular failure, myocardial ischemia and cerebrovascular accident.[12]

Various pharmacological and non-pharmacological methods have been tried to limit the pressor responses and IOP changes following the insertion of endotracheal tube including use of deeper anaesthesia, numerous drugs like beta blockers, vasodilators, calcium channel blocker, alpha2 agonist like Dexmeditomedine, opioids. Opioids are most commonly used drugs but are associated with side effects like nausea, vomiting, sedation and respiratory depression. These are also not cost effective. There has been a growing trend to find an effective substitute to minimize the sympathoadrenal pressor response to endotracheal intubation.[13]

One of the methods used to attenuate the pressor response and IOP changes subsequent to ETT intubation is use of LMA. Its insertion requires neither the visualization of vocal cords nor the penetration of larynx making the placement less stimulating than insertion of endotracheal tube and it may provoke less sympathetic response and catecholamine release.[14]

### Intraocular Pressure

In the present study the increase in mean IOP was greater at 0, 1 and 3 min after endotracheal intubation as compared to LMA insertion. The duration of increase was more in ETT group (3 min) than in LMA group (1min). Ghai B et al (2001) in a similar study noted mean maximum rise in IOP after ETT insertion was significantly high in ETT group than LMA group. The IOP returned to baseline value in 15-30 sec in LMA group and in ETT group it remained high in left eye up to 2 min and in right eye

up to 3 min.[15] Sayed Altaf Bhukari et al (2003) found the IOP increased by 78.32 % after ETT insertion and by 26.59% after LMA insertion.[7] Bharti N et al (2008) studied IOP changes subsequent to laryngoscopy guided endotracheal intubation and ILMA guided intubation. They noted that IOP increased by 133.33 % after laryngoscopy guided intubation and it did not return to preintubation value for up to 5 min while IOP increased by only 34% in LMA group[16]. The slight difference in the percentage of increase in IOP noted in above studies can be attributed to use of different anaesthetic agents in these studies.

Similar study conducted by JO Igboko et al (2009) on Nigerian populations and Pandya Malti et al (2012) on Indian population had results similar to our study.[18,19] Neerja Bharadwaj et al (2011) compared the IOP response to ETT and LMA insertion in 30 glaucomatous patients and concluded that LMA use was not associated with any significant IOP changes after LMA insertion whereas it increased significantly after tracheal tube insertion.[20] Mohammad Waseem Rubanni et al (2014) studied the IOP changes in elderly patients in 50-65 year age group and found that mean IOP increased by 71 % after ETT intubation and by 42 % after LMA placement.[23]

**Heart Rate**

The increase in heart rate with laryngoscopy and tracheal intubation was significantly higher in ETT group at 0, 1 and 3 minutes after insertion as compared to LMA group. In both the groups HR did not return to preinsertion values even at 5 min after insertion. The results of studies conducted by Babita Ghai et al (2001) Sayed Altaf Bhukari et al (2008), Bharti et al (2008), and JO Igboko et al (2009) are in accordance to our study.[15,7,16,18] Neerja Bhardwaj et al (2011) noted that heart rate increased significantly after tracheal intubation and returned to baseline in 4 min after intubation in glaucomatous children.[20] This difference might be consequence of different inhalational agents used for maintenance of anaesthesia in both the studies and difference in age of the study population. Maharajan S K et al (2012) studied the changes in heart rate after insertion of I-gel, LMA and ETT. They found that the increase in mean HR after ETT insertion was highest in ETT group and least in I-gel group. The heart rate increment was there at 3 min and 5 min after airway manipulation but the difference was not statistically significant.[21] Gauri Punjabi et al (2013) studied the cardiovascular changes subsequent to LMA insertion and found that mean pulse rate increased by 5-10/ min after LMA insertion and returned to baseline in 10 minutes.[22] In our study the mean rise in heart rate is 33/min but this difference can be due to the effect of Fentanyl, Propofol and Halothane used in the above study which can cause bradycardia.

**Blood Pressure**

In the present study, among the two groups MAP is higher after ETT insertion at 0, 1, 3 min as compared to that after LMA placement. The MAP returns to preinsertion value in 1 min after LMA insertion and at 5 min after ETT insertion. Shafiq Tahir et al (2008) conducted a similar study and noted increase in both systolic BP and diastolic BP after ETT insertion than that after LMA insertion up to 5 min after insertion.[17] Maharajan S K et al (2012) observed that increment in systolic BP was highest after ETT insertion, moderate with LMA insertion and least with I-gel. However the difference in MAP was not statistically significant after airway manipulation in all the three groups.[21] The reason for this difference might be Fentanyl, Propofol and Vecuronium used in the above study more effectively attenuates the stress response than Fortwin, Thiopentone and Atracurium used in our study. The results of studies conducted by Gauri Punjabi et al (2013) and Masoomeh Tabari et al (2013) are similar to our study.[22, 24]

The short comings of the present study:

1. The Schiotz tonometer used for IOP measurement does not give precise measurement. Study with accurate IOP measurements will drastically increase the value of such a study.
2. The sample size of 60 is small and a large scale study is needed to draw definitive conclusion.
3. Present study has evaluated hemodynamic and IOP changes only and the definitive stress response markers like catecholamines and cortisol assays were not done.
4. The study does not assess the efficacy of LMA in terms of ease of insertion and adequacy of ventilation, leak pressure, unwanted effects like trauma, gastric distension and sore throat.

The duration of observation is short to comment on return of the heart rate to preinsertion value after ETT/LMA insertion.

## CONCLUSION

We can conclude from the present study that the mean IOP, heart rate and mean arterial pressure increased after insertion of airway devise in both the groups but the rise was significantly greater after ETT intubation at 0 min, 1 min and 3 min after insertion. These parameters were comparable at 5 min after ETT intubation/ LMA insertion.

The amplitude and duration of increase in IOP, heart rate and mean arterial pressure was significantly more after endotracheal intubation than LMA insertion. This reflects that stress response to endotracheal intubation is much more than LMA placement. Thus, LMA is an excellent alternative technique to minimize the increase in IOP and haemodynamic response to tracheal intubation in patients posted for ocular surgeries and in the patients with compromised cardiovascular status.

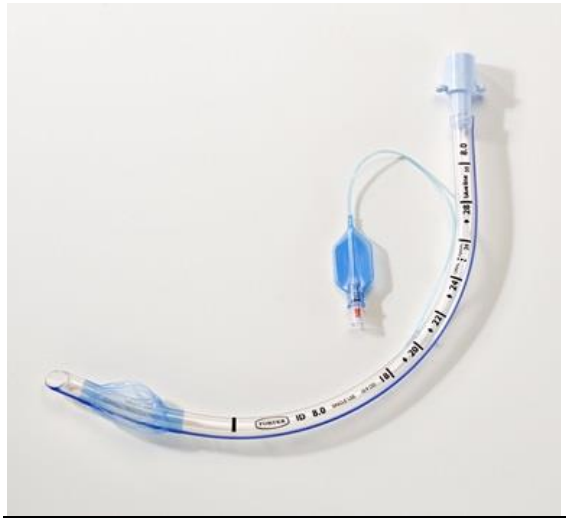


**Figure 1: Endotracheal Tube.**

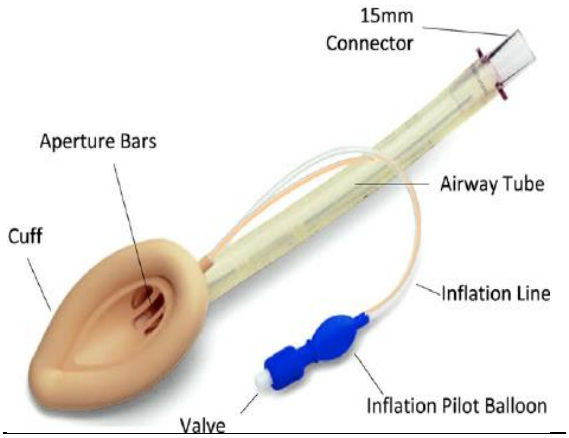



**Figure 2: Laryngeal Mask Airway.**

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