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Comparative Evaluation of Haemodynamic Response to Endotracheal Intubation with Intubating Laryngeal Mask Airway and Intubation with Macintosh Blade

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Abstract: ***Objectives**: Intubating laryngeal mask airway (ILMA) offers a new approach for endotracheal intubation and is expected to produce less cardiovascular stress responses. However, the available studies provide inconsistent results. The present study was designed to compare the haemodynamic response during intubation by conventional direct laryngoscopy and intubation by ILMA. **Materials and methods**: After obtaining approval from the ethics and scientific committee, 100 ASA grades I —II, aged 18 - 60 years of either sex scheduled for elective surgery under general anaesthesia requiring endotracheal intubation, were randomly allocated into two groups. Patients of Group M were intubated using Macintosh laryngoscope and Group I with intubating laryngeal mask airway respectively. The general anaesthesia technique was standardized. Time to intubation, heart rate, systolic, diastolic, mean arterial blood pressure and rate pressure product were noted at various time intervals. All analysis was 2 tailed and P value of <0.05 was considered significant. **Results**: The two groups were comparable in terms of demographic variables. The haemodynamic parameters were higher in both the groups post endotracheal intubation when compared to the baseline values. Heart rate and rate pressure product were significantly higher in laryngoscopy group as compared to ILMA group. Systolic, diastolic and mean arterial blood pressure were higher in direct laryngoscopy group when compared to Intubating laryngeal mask airway group, but it was not statistically significant. Time to intubation was significantly higher in the Intubating laryngeal mask airway group than direct laryngoscopy group (55.0±12.1 s versus 18.8±3.8 s, P<0.001). Complications like sore throat and hoarseness were higher in direct laryngoscopy group as compared to Intubating laryngeal mask airway group. **Conclusion**: Use of intubating laryngeal mask airway results in significantly lower haemodynamic response as compared to direct laryngoscopy for tracheal intubation.***

Keywords: Intubating laryngeal mask airway, laryngoscopy, endotracheal intubation, hemodynamic response

1. Introduction

The pressor response to direct laryngoscopy (DL) and endotracheal intubation, precipitating a significant increase in heart rate and systemic blood pressure is an established phenomenon and thus, a cause of concern for anaesthesiologists all over. The mechanism of hemodynamic response to laryngoscopy and orotracheal intubation is proposed to be by somatovisceral reflexes. Stimulation of proprioceptors at the base of the tongue during laryngoscopy induces impulse dependent increase in systemic blood pressure, heart rate and plasma catecholamine concentrations. Subsequent orotracheal intubation recruits additional receptors that elicit augmented hemodynamic and epinephrine responses as well as some vagal inhibition of the heart.[1]

The cardiovascular response is a reflex phenomenon. This is mediated by vagus (X) & Glossopharyngeal (IX) cranial nerves. Vagus & Glossopharyngeal nerves carry the afferent stimulus from epiglottis & infraglottic region & activate the vasomotor centre to cause a peripheral sympathetic adrenal response to release adrenaline & noradrenaline.

The increase in pulse rate and blood pressure are usually transitory, variable & unpredictable. Normal, healthy persons tolerate this response, but in susceptible individuals, this transient sympathetic response can evoke life – threatening complications.

Factors like degree of distortion or physical stimulus to oropharyngeal structures decide the extent of hemodynamic response to conventional laryngoscopy and endotracheal intubation and use of various other airway devices like laryngeal mask airway. The pressor response to laryngoscopy and intubation can be reduced by either pharmacological methods or using alternative endotracheal tube guiding devices such as fibre - optic scope, light wand or laryngeal mask airway (LMA).

The intubating laryngeal mask airway (ILMA) is a device used for blindly introducing a tracheal tube. It is an anatomically curved, soft silicone - coated, metal tube with a guiding handle. Since it does not require direct exposure of the larynx, tracheal intubation via an ILMA may be less stimulating than conventional laryngoscopy. Although introduction of LMA and inflation of the cuff stimulates and exerts pressure on anterior pharyngeal wall, the increase in blood pressure and pulse rate is transient and not related to continuous pressure exerted by the sealing cuff. The cardiovascular effect of inserting a laryngeal mask airway (LMA) has been shown to be similar to that of establishing an oropharyngeal airway.[2, 3]

There are limited studies which observed the haemodynamic response associated with the use of ILMA. Since the design of ILMA suggests less haemodynamic response during endotracheal intubation, we decided to conduct a study to compare the haemodynamic response during direct laryngoscopy and ILMA.

2. Materials and Methods

This prospective randomized and comparative study was conducted after Institute Ethics Committee approval.100 ASA grades I—II, aged 18 - 60 years of either sex scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were randomly allocated into two groups. Patients with hypertension, hepatic, renal, and cardiac dysfunction and patients with expected difficult airway (Mallampatti grade III and IV) were excluded from the present study. Written informed consent was obtained from all the participants.

All patients were randomly allocated using computer generated numbers into Group M and Group I. Patients of Group M were intubated with Macintosh laryngoscope and Group I with intubating laryngeal mask airway respectively. Allocation concealment was maintained with opaque - sealed envelope.

All selected patients underwent through pre - anaesthetic assessment, including detailed history, physical and systemic examination and investigations as per the need of the surgery. All patients were kept fasting for 6 hours prior to surgery.

In the pre - operative room, patients were connected to standard monitors, including non - invasive blood pressure, electrocardiogram, and pulse oximeter. Haemodynamic parameters: heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), Rate pressure product (RPP) and oxygen saturation (SPO2) were recorded as baseline values after 10 minutes. Intravenous (IV) access was secured.

In the operative room, anaesthesia was induced using intravenous fentanyl 2mcg/kg and propofol 2 - 3mg/kg, followed by intubating dose of atracurium 0.5mg/kg intravenously. The patients were manually ventilated by face mask with 100% oxygen for 3 minutes till muscle relaxation was achieved. In ILMA group, a size 3 or 4 well lubricated (posterior surface) intubating laryngeal mask (3 for female, 4 for male) was inserted with the head in neutral position and the cuff inflated with 20 - 30 ml of air (size 3: 20 ml, size 4: 30 ml). The ILMA was then attached to the anesthesia breathing system and adequate ventilation judged by bilateral equal chest wall movement and capnography (waveform). After confirmation that ventilation with the ILMA is unobstructed, the position was maintained firmly by holding the handle. A size 7.0 or 7.5, well lubricated reinforced, cuffed, tracheal tube was passed through the intubating laryngeal mask until it reached 15 cm depth marker and then advanced to 8 - 9cm beyond this mark gently into the trachea without applying undue forces. When no resistance is felt, the cuff was inflated and the circuit reconnected. The correct tube placement was confirmed by the presence of bilateral breath by auscultatory method and by capnography. If resistance was encountered or oesophageal intubation occurred, adjusting maneuvers were applied.

Tracheal intubation attempt was considered to be failed if it could not be accomplished within 3 min or when all adjusting maneuvers had failed and such patients were excluded from the study. These patients were then intubated by direct laryngoscopy. After the tracheal intubation was successful, the ILMA device was removed using 25 cm stabilizing rod to maintain the tube in place to prevent accidental extubation.

Cuffed Portex, polyvinylchloride (PVC) tracheal tubes with internal diameter of 7.5 mm for female patients and 8.5 mm for male patients were used for endotracheal intubation in group M. Endotracheal intubation was performed by a trained anesthetist by direct laryngoscopy using size 3 or 4 Macintosh blade.

Anaesthesia was maintained with sevoflurane, nitrous oxide and oxygen with an aim to maintain a Minimum Alveolar Concentration (MAC) of 1. Fentanyl and Atracurium top ups were given as required. SBP, DBP, MAP, RPP, HR and SPO2 were recorded immediately after endotracheal intubation and for 5 successive recordings at one minute intervals and at 10 minute. Standard intra - operative monitoring was used for all patients which included electrocardiogram, end tidal carbon - dioxide (EtCO2), SPO2, noninvasive blood pressure, gas analysis, temperature and airway pressure. Painting and sterile draping was done, and surgical incision was taken only after 10 minutes of endotracheal intubation. Procedural complications like mucosal injury, lip injury, dental injury and sore throat were recorded. “Time to intubation” (TTI) was defined as the time interval from the time of insertion of laryngoscope/ intubating laryngeal mask airway to the time of removal of laryngoscope/ intubating laryngeal mask after passing the endotracheal tube (ETT) in the trachea; was noted.

The following haemodynamic parameters were noted: -
- Heart rate.
- Systolic, diastolic and mean blood pressure (NIBP).
- Rate pressure product (RPP)
- Any ECG changes
- SPO2

Parameters were recorded at following times: -
- Before induction (baseline haemodynamic parameters)
- Just after induction but before tracheal intubation
- Just after tracheal intubation
- At regular interval of 1 minute for 5 minutes after tracheal intubation and then at 10 minutes after intubation.

Other parameters that were recorded are: -
- Number of attempts
- Intubation time
- Any episode of desaturation (<95%)
- Mucosal/dental trauma
- Any arrhythmias

Statistical analysis:
The data was collected, compiled and analysed using Microsoft Excel. All data were categorized and expressed in terms of percentages or in terms of mean and standard deviations. Difference between two proportions was analysed using chi square or fisher exact test. Difference between two means was tested using student t test. All

analysis was 2 tailed and P value of <0.05 was considered significant and <0.001 as considered highly significant.

3. Results

100 patients were enrolled in this study. There was no significant difference in patients of two groups with respect to age, gender, weight, ASA grade and MPC class (Table1).

Table 1: Demographic characteristics and airway assessments of patients in the groups.

Variable	Group M (n=50)	Group I (n=50)	p - value
Age (years) #	36.26 ±9.80	35.34±9.41	0.6872
Gender (F/M)	26/24	28/22	0.6882
Weight (kg) #	65.82 ± 9.30	69.06 ± 9.54	0.0887
Height (cm) #	164.68 ± 8.43	166.18 ± 7.47	0.3485
ASA Grade (I/II)	26/24	30/20	0.4502
Mallampati scores (n; 1/2/3/4)	24/26/0/0	20/30/0/0	0.4502
Intubation Attempts (n; 1/2/3)	49/1/0	47/3/0	0.3074
Intubation time (s) #	18.80 ± 3.86	55.00 ±12.04*	<0.001

#: Values are expressed as mean ± SD.
Group M = Macintosh laryngoscope group.
Group I = Intubating laryngeal mask airway group.
*: p<0.05 considered statistically significant.

The first attempt success rate in group I and group M group was 94% and 98% respectively and this difference was not statistically significant. The mean intubation time in group M was 18.80±3.86 seconds and in group I it was 55±12.04 seconds and this difference was statistically highly significant (P<0.001) (table1).

In Group M 98% of patients were intubated in the first attempt and 2% of patients required a second attempt for successful intubation while it was 94% and 6% respectively in group I. There was 1 case in which intubation could not be attained even after the third attempt with ILMA. Probably size 4 ILMA was small for this patient. The patient was ventilated with bag and mask with Oxygen - Nitrous oxide and Sevoflurane and then intubated using direct laryngoscopy (this patient was excluded from the study).

The haemodynamic data are presented in the table2. No significant differences were observed between the groups with respect to heart rate or blood pressure values prior to anaesthetic induction and insertion of device

Table 2: Haemodynamic parameters of the groups

Variable	Group M (n=50)	Group I (n=50)	p Value
Heart rate (bpm)			
Baseline	77.92 ± 10.69	78.88 ± 10.01	0.645
After induction	68.66 ± 11.19*	65.08 ± 8.29*	0.0721
After intubation	85.74 ± 12.83*	82.36 ± 9.82*	0.1424
Postintubation (min)			
1	91.40 ± 14.81*	83.60 ± 8.94*#	0.0017
2	92.96 ± 14.65*	82.72 ± 7.87*#	<0.001
3	89.34 ± 16.09*	80.76 ± 8.07#	0.0011
4	85.66 ± 14.35*	78.98 ± 7.66#	0.0045
5	82.48 ± 12.58	77.80 ± 7.31#	0.0251
10	81.16 ± 13.62	77.20 ± 9.23	0.092
Systolic BP (mmHg)			
Baseline	115.54 ± 13.72	117.02 ± 14.37	0.5996
After induction	101.5 ± 10.10*	100.51 ± 9.41*	0.6151
After intubation	125.42 ± 13.84*	122.58 ± 12.72*	0.288
Postintubation (min)			
1	128.14 ± 14.12*	124.68 ± 14.16*	0.2241
2	129.04 ± 17.03*	125.76 ± 16.72*	0.3336
3	124.1 ± 14.93*	118.98 ± 16.60	0.1081
4	120.6 ± 14.46	115.4 ± 15.86	0.0899
5	118.18 ± 14.53	114.04 ± 13.80	0.1473
10	115.42 ± 14.14	114.04 ± 13.63	0.6205
Diastolic BP (mmHg)			
Baseline	71.6 ± 10.61	74.92 ± 10.92	0.1264
After induction	64.06 ± 7.47*	62.78 ± 8.15*	0.4148
After intubation	79.36 ± 10.24*	78.8 ± 10.10	0.7836
Postintubation (min)			
1	79.98 ± 10.23*	79.92 ± 9.42*	0.9757
2	80.98 ± 12.34*	78.8 ± 11.28	0.3587
3	76.88 ± 11.07*	76.74 ± 10.07	0.9474
4	74.18 ± 10.91	74.34 ± 9.99	0.9392

5	72.84 ± 10.36	74.04 ± 8.85	0.535
10	70.96 ± 10.77	73.32 ± 9.74	0.2533
Mean Arterial BP (mmHg)			
Baseline	86.26 ± 11.18	88.9 ± 11.55	0.2484
After induction	76.5 ± 7.50*	75.84 ± 7.52*	0.6613
After intubation	94.72 ± 11.03*	93.38 ± 9.72*	0.5208
Postintubation (min)			
1	96.06 ± 11.14*	94.86 ± 10.21*	0.5757
2	97.06 ± 13.70*	94.48 ± 12.63*	0.33
3	92.62 ± 11.91*	90.84 ± 11.76	0.4539
4	89.66 ± 11.72	88.06 ± 11.46	0.4916
5	87.98 ± 11.37	87.42 ± 9.95	0.7938
10	85.76 ± 11.49	86.86 ± 10.44	0.6176
Rate pressure product RPP (mmHg) (mmHg. beat/min)			
Baseline	8967.22 ± 1210.56	9155.56 ± 1151.56	0.4273
After induction	6927.6 ± 1081.45*	6537.66 ± 892.59*	0.0522
After intubation	10686.28±1532.82*	10029.8 ± 1109.64*#	0.0161
Post - intubation (min)			
1	11665.62± 883.90*	10347.26 ± 024.27*#	<0.001
2	11954.6 ± 2022.07*	10335.08 ± 233.49*#	<0.001
3	11008.16± 831.29*	9541.9 ± 1190.84#	<0.001
4	10266.38±1621.04*	9063.14 ± 1180.57#	<0.001
5	9683.96 ± 1419.30	8829.64 ± 1038.12#	<0.001
10	9301.64 ± 1467.96	8736.6 ± 988.67	0.0265
All values are expressed as the mean ± SD. Group M = Macintosh laryngoscope group, Group I = ILMA group. *: p<0.05 compared with baseline #: p<0.05 versus group M			

In a nutshell, the HR and RPP were significantly higher in group M when compared to group I. The SBP, DBP and MAP were higher in group M when compared to group I, but it was not statistically significant

On comparing the two groups, it was observed that maximum increase in HR for Group I was 5.98% and for group M it was 19.30% from baseline. After intubation the heart rate was significantly higher in group M till 10 minutes when compared with group I. Increase in HR values was seen in both the groups, but the difference was significantly higher in group M (figure 1).

In group M, an increase in SBP was observed for 5 minutes after intubation which returned to baseline value by 10 minutes. Whereas in group I, the increase in SBP was observed for only first 3 minutes and returned to baseline value by 4 minutes. When comparing the mean systolic blood pressure there was no statistical difference between them at all the intervals (figure2).

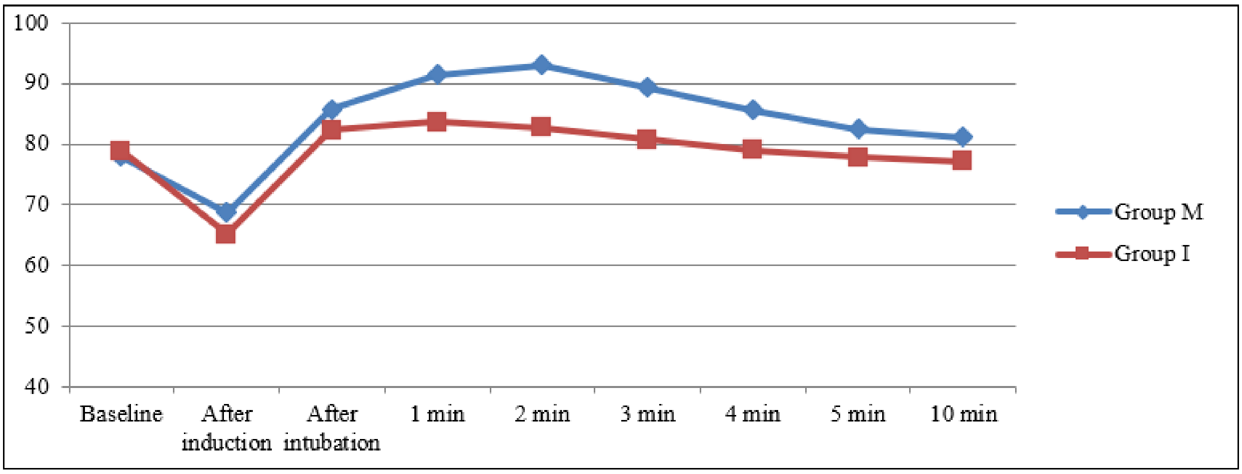

Figure 1: Comparison of heart rate at different intervals

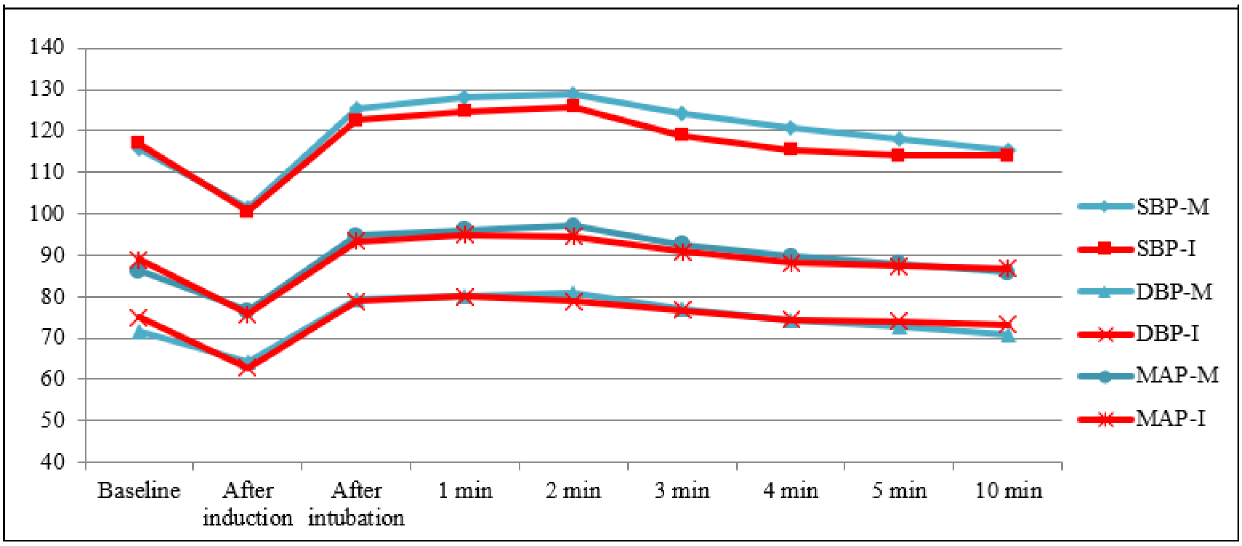

Figure 2: Comparison of blood pressure values at different intervals

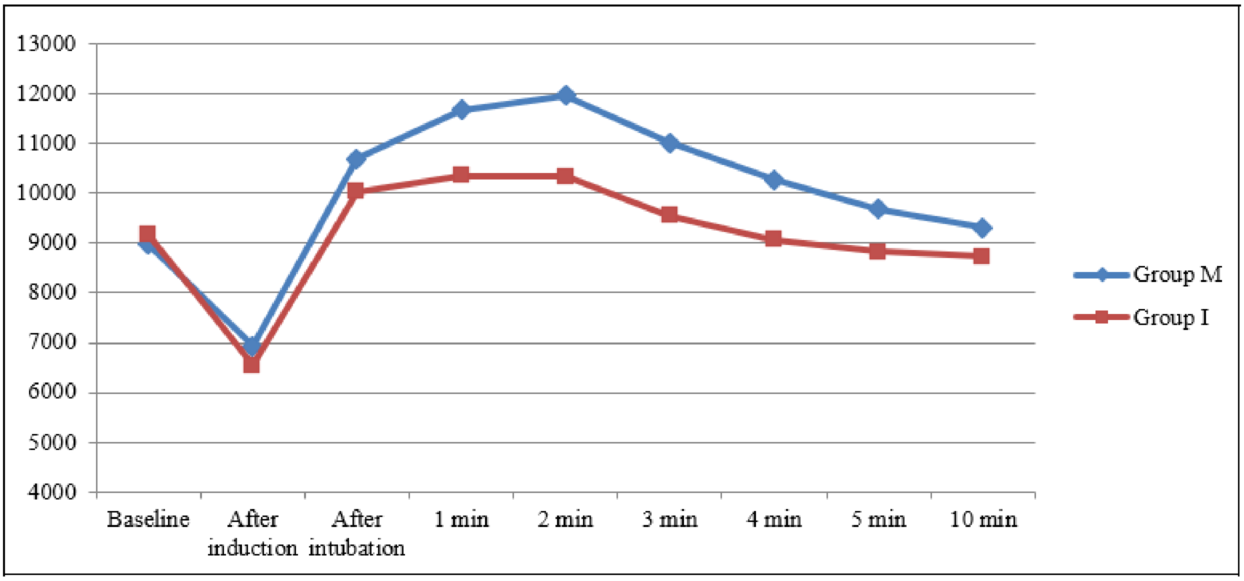

Figure 3 Comparison of Rate Pressure product at different intervals

Similarly, the diastolic blood pressure and mean arterial pressure were higher among group M when compared to group I at all different time intervals after intubation. But, this difference was statistically not significant (figure 2).

On comparing both the groups, the RPP levels were higher in group M than group I at all different time intervals after intubation (Figure 3). The difference was statistically highly significant till 5 minutes after intubation (P<0.001).

In the group M, 6 patients had sore throat compared to 3 in group I. This was found to be statistically significant. There was no significant difference with the incidence of mucosal injury and hoarseness.

4. Discussion

Any airway manipulation, particularly by laryngoscopy and endotracheal intubation, changes cardiovascular physiology both via reflex responses and the physical presence of an endotracheal tube. Although these are only transient cardiovascular stress responses, they are life threatening to the patients suffering from the cardiovascular and cerebrovascular diseases. Mechanical stimulation of oropharyngolaryngeal structures caused by laryngoscopy and tracheal intubation is considered as the major cause of the haemodynamic responses to laryngoscopy and tracheal intubation. Many studies have been done to attenuate the cardiovascular stress response.

The Intubating laryngeal mask airway is one such device which was primarily developed for difficult laryngoscopy and intubation. Theoretically avoidance of direct laryngoscopy would cause less oropharyngeal stretch and stimulation, thus attenuating the hemodynamic stress response. With this background, we conducted a comparative study to evaluate the different parameters and haemodynamic responses with the conventional Macintosh laryngoscope and Intubating laryngeal mask airway.

In 2013 Das[4] et al studied heart rate responses to endotracheal intubation using conventional laryngoscope and with the help of intubating laryngeal mask airway (ILMA) in patients with isolated mitral stenosis. They found that the rise in heart rate was significantly higher in

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laryngoscope group than ILMA for upto 5 minutes after intubation in patients with isolated mitral stenosis.

In 1991 Wilson[5] et al compared the cardiovascular responses induced by the intubation by laryngeal mask airway with laryngoscopic tracheal intubation. The mean maximum increase in systolic blood pressure after laryngoscopy and tracheal intubation was 51.3% compared with 22.9% for the ILMA insertion (p<0.01).

In 2007 Naveed Tahir Siddiqui[6]et al. compared hemodynamic response to intubation by ILMA and by direct laryngoscopy andfound equivalent increase in HR after intubation in both the groups which is contrary to our findings. The rise in systolic blood pressure in direct laryngoscopy group was 26% and 13% when compared with the baseline for first two minutes, while in ILMA group the increase was 8 - 12%. When both groups were compared statistically significant difference (P<0.05) was observed.

In the study of Joo and Rose[7], mean arterial pressure was higher in the patients who had laryngoscopic orotracheal intubation than in those who had ILMA - guided orotracheal intubation.

Kihara[8] et al. in 2000 administrated study on 150 adult patients in order to observe the hemodynamic response to tracheal intubation with Macintosh laryngoscopic versus ILMA. They concluded that blind ILMA - guided intubation offered no advantage over direct laryngoscopy about hemodynamic stress responses

In our study, RPP after endotracheal intubation with laryngoscope showed significant increase (maximum 14, 946) compared with ILMA (maximum 10, 580). This finding was supported by the work by Fulii[9]et al. who found that RPP after laryngoscopy was more than 20 000 in hypertensive patients, but with ILMA this critical increase in RPP was avoided. The levels of RPP in excess of 20000 are more commonly associated with angina and myocardial ischemia.

Elif and coworkers[10] found that systolic and diastolic blood pressures in the intubating laryngeal mask airway group were higher than those in the conventional laryngoscopy group at 1 and 2 min following intubation. The rate pressure product at 1 and 2 min following intubation in the intubating laryngeal mask airway group were higher than those in the conventional laryngoscopy group (p<0.05). They concluded that the intense and repeated oropharyngeal and tracheal stimulation resulting from intubating laryngeal mask airway induces greater pressor responses than does stimulation resulting from conventional laryngoscopy in hypertensive patients. This is in contrast to our study findings.

The findings of our study are similar to that proved by Bhawana[11] et al, Zeng[12] et al and Kavita[13]et al who found that the use of ILMA has been associated with fewer hemodynamic effects as compared with endotracheal intubation with laryngoscope.

The typical fall in the haemodynamic parameters from the baseline before laryngoscopy can be attributed to the vasodilatation resulting from induction of GA. Laryngoscopy and intubation are intensely stimulating procedures and produce marked sympathetic response. Orotracheal intubation using the direct vision laryngoscopy needs elevation of the epiglottis for laryngeal exposure. This traction on the supra glottic region during direct laryngoscopy is one of the factors responsible for producing the haemodynamic stress response. Maximum stimulus is generated by the stimulation of the epipharynx (i. e vallecula) by direct laryngoscopy and by tracheobronchial tree stimulation by the endotracheal tube. Insertion of the laryngeal mask airway does not require laryngoscopy, although introduction of the device and inflation of the cuff stimulates and exerts pressure on the anterior pharyngeal wall. This is almost certainly the mechanism by which the increases in blood pressure and pulse rate occur; the transient nature of the response suggests that this is not related to the continuous pressure exerted by the sealing cuff. The possible cause of lesser pressor response in ILMA group may be due to lesser oropharyngeal stimulation at supraglottic level and also at subglottic level due to soft tip and well lubricated silicone endotracheal tube which is used ith ILMA. This could be the possible explanation for the reduced haemodynamic response occurring with the ILMA in our study. The statistically insignificant hemodynamic parameters can be attributed to the shorter duration of laryngoscopy in group M compared to prolonged duration in group I.

TTI was significantly higher in Group I (55.00 ± 12.04 seconds) than in Group M (18.80±3.86 seconds) [P<0.001]. This can be attributed to multiple steps involved in intubation with ILMA and relative inexperience of anaesthetists in using it. Prolongation of duration of intubation has been reported to increase the hemodynamic changes after tracheal intubation. This can also be a reason for the rise in the hemodynamic parameters seen in Group I, but these were still lesser than in Group M.

In previous studies, the success rate of intubation through ILMA was varied from 76% to 99.3%. However in most of the studies it was found to be between 93 - 97%. S. Kihara[14] found that intubation time with ILMA (57 seconds) is longer than direct laryngoscopic intubation (33 seconds). Similarly Dr. Bharti Naik[15] et al found that intubation time with ILMA blind (59.8 seconds) was longer than Laryngoscopy group (35 seconds).

There was a significant difference among the proportions of sore throat among the two groups in our study. This could be attributed to the technique of insertion of the direct laryngoscope and also the force applied to the base of the tongue during direct laryngoscopy. Adequate precaution like adequate lubrication of ILMA has decreased the complications tremendously.

Barti[16] et al (2008) reported significantly higher incidence of mucosal injury in ILMA group as compared to direct laryngoscopy group. This could be due to high pressure exerted by ILMA against the pharyngeal mucosa.

Abdel[17] et al found that there was no significant difference between the numbers of patients in both groups in relation to the evaluation of complications, including sore throat, coughing, laryngospasm, and hoarseness.

5. Conclusion

Use of intubating laryngeal mask airway results in significantly lower haemodynamic response as compared to direct laryngoscopy for tracheal intubation. Time taken for intubation is longer with intubating laryngeal mask airway than with direct laryngoscopy, this may be attributed to the relative complexity with the use of ILMA. We therefore conclude that ILMA is a safer alternative to direct laryngoscopy especially in patients with coronary artery and cerebrovascular diseases where the haemodynamic fluctuations of direct laryngoscopy can be extremelydetrimental.

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