Original Article

Use of Proseal Laryngeal Mask Airway (PLMA) and Endotracheal Tube (ETT) in Cardiac Compromise Patients with LVEF <45% Undergoing Laparoscopic Cholecystectomy : A Comparison of Hemodynamic Parameters

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Abstract:

Background: The major cause of sympatho-adrenal response to tracheal intubation is due to the stimulation of supraglottic region by tissue irritation induced by direct laryngoscopy. Direct laryngoscopy by activating proprioceptors, induces arterial hypertension, tachycardia and increased catecholamine con-centration proportional to the intensity of stimulus exerted against the base of the tongue. In cardiac compromised patient, use of endotracheal tube (ETT) is associated with various hemodynamic complications, which are minimally affected during ProSeal laryngeal mask airway (PLMA) use.

Objective: This prospective study was conducted with the objective of demonstrating the advantages of PLMA over ETT in the patients undergoing laparoscopic cholecystectomy surgeries.

Methodology: This prospective, interventional study was carried out in 60 patients who underwent laparoscopic cholecystectomy surgeries. Patients were randomized in equal numbers to either ETT group or PLMA group, and various hemodynamic changes were observed at different time points.

Results: Patients in PLMA group had mean systolic blood pressure 134.785±03.765 mm Hg compared to the patients of ETT group 146.675±05.764 mmHg. Pulse rate in the PLMA group was less (94.267 ± 05.678per min) ($P < 0.05$) compared to ETT group (115.34±10.236).Thus, hemodynamic changes were significantly lower ($P < 0.05$) in PLMA than in ETT group. The incidence of adverse events was also lower in PLMA group.

Conclusion: PLMA offers advantages over the ETT in airway management in the patients undergoing laparoscopic cholecystectomy surgeries in cardiac compromise patients.

Key word: PLMA. LVEF <45%, laparoscopic cholecystectomy , hemodynamic parameters.

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Introduction

The major cause of sympatho-adrenal response to tracheal intubation is due to the stimulation of supraglottic region by tissue irritation induced by direct laryngoscopy.[1] Direct laryngoscopy by activating proprioceptors, induces arterial hypertension, tachycardia and increased catecholamine con-centration proportional to the intensity of stimulus exerted against the base of the tongue.[2]

Till date, the cuffed tracheal tube was considered as the gold standard for providing a safe glottis seal, especially for laparoscopic procedures under general anaesthesia.[3] The disadvantages of tracheal intubation, which involves rigid laryngoscopy, are in terms of concomitant haemodynamic responses and damage to the oropharyngeal structures at insertion.

In 1981, Dr. A.I.J Brain designed the Laryngeal Mask Air-way (L.M.A. classic) at London hospital, Whitechapel, London which changed the scenario from "cannot intubate, cannot ventilate" to "cannot intubate, can ventilate".[4] The Laryngeal Mask Airway is designed to establish effective seal around the laryngeal inlet with an inflatable cuff. It is a useful advancement in airway management.[4]

ProSeal laryngeal mask airway (PLMA) was introduced as an improvement over LMA by Brain in 2000.[5] It has a dorsal cuff that presses the ventral cuff more firmly into the periglottic tissues leading to a better seal. A better seal coupled with a drain tube extends the range of surgical procedures for which this LMA device can be used.[5]

The patient with moderate to severe cardiac compromise with LVEF < 45% is a high risk group of developing perioperative myocardial infarction. The main causes of this group of patients developing perioperaive myocardial infarction is myocardial oxygen supply demand mismatch. Haemodynamic instability is the main cause of myocardial oxygen supply demand mismatch.

Therefore, an alteration of the anesthetic technique is preferable to non - pharmacological means to blunt the pressor response on considering haemodynamic stability and effect on myocardial oxygen supply and demand in this class of patients. The Proseal laryngeal mask airway (PLMA) is preferred in such patients because insertion as well as removal of PLMA causes a transient rise of systolic blood pressure, diastolic blood pressure, heart rate and mean arterial pressure (MAP) similar to endotracheal intubation (ETT) in normotensive patients but of lesser severity and remains for a shorter period.[6-8]

The PLMA is one of the most promising non-pharmacolog-ical methods to attenuate the sympathoadrenal response to tracheal intubation, causing less sympathetic response and catecholamine release.[8] The PLMA causes less pressure response during insertion compared to tracheal intubation and the increase in heart rate is very short lived.[9] The PLMA also results in minimal coughing and produces a smooth emergence.[8- 10]

Inspite of its popularity, no study so far has been done in moderate to severe cardiac compromise with LVEF < 45% patients compare the hemodynamic response using PLMA rather than a standard tracheal tube. With this background, the present study was undertaken to compare the haemodynamic responses to PLMA and ETT insertion and removal in moderate to severe cardiac compromise patients.

Methods

This prospective, randomized study was carried out after approval of the hospital ethics committee. A total of 60 moderate cardiac compromise with LVEF < 45% American Society of Anesthesiologists II- III patients aged 45-75 years undergoing elective laparoscopic cholecystectomy surgery were included in this study and were divided into the following groups: Group ETT, consisting of 30 patients in whom ETT was performed; and Group PLMA, with 30 patients in whom PLMA was used.

Only controlled hypertensive patients were included in this study. Patients with a history of angina, with electrocardiographic evidence of recent ischemic heart disease, with obesity, with chronic obstructive airway disease, or with any other associated chronic medical problem were excluded from the study. All antihypertensive drugs were continued during the perioperative period, except angiotensin-converting-enzyme inhibitors, angiotensin receptor blockers, and diuretics. These drugs were withheld on the morning of surgery (in the case of angiotensin receptor blockers, 24 hours prior to surgery). All patients received an midazolam 7.5 mg tablet at bedtime the night before surgery. On the morning of the surgery, the patients received 40 mg pantoprazole intravenously (IV), 60 minutes before surgery. All patients were monitored for heart rate, blood pressure (systolic and mean), electrocardiography, and oxygen saturation.

Patients received IV Ringer's lactate before the induction of anesthesia.

Blood pressure (systolic , diastolic and mean) was recorded just before induction as baseline values. An injection of fentanyl 2 microgm/kg was given IV to the patient just before induction. Anesthesia was induced with IV propofol (1% solution) 2 mg/kg followed by IV Atracuronium bromide 0.5 mg/kg to facilitate endotracheal intubation or PLMA insertion in a randomized manner with a coin flip.

An appropriate sized PLMA or ETT was used. Watersoluble jelly was applied to both PLMA and ETT. An index finger was used to insert PLMA. Recommended volumes of air were injected into a pilot balloon of PLMA/ETT to achieve a seal.

Blood pressure and heart rate were recorded at during intubation / PLMA insertion, 1 minute, 2 minutes, 3 minutes, 5 minutes and10 minutes after intubation / PLMA insertion and at the time of ETT extubation/PLMA removal

Once tracheal intubation/PLMA insertion was completed, anesthesia was maintained with halothane 0.5-0.8% and N2O:O2 (60:40). Ventilation was controlled manually and was adjusted to Maintain ETCO2 at 35-45 mmHg. Top-ups of Atraquronium bromide with 25% of the original loading dose were administered every 20 minutes. At the end of surgery, N2O and halothane were discontinued. Neuromuscular block was reversed by administration of a premixed combination of atropine and neostigmine. Before extubation or PLMA removal oropharyngeal secretions were sucked out. Patients were assessed for their ability to breathe spontaneously and open their eyes upon command. After extubation/PLMA removal, patients received 100% oxygen by facemask for 10 minutes.

The data are expressed as mean ± standard deviation. All Data were analysed using INSTAT 3 (GraphPad Software, California, USA). The continuous data were statistically analyzed using two-sample independent t test and paired t test, and categorical data by Chi-square/ Fisher's exact test as appropriate. A p value <0.05was considered to be statistically significant

Result :

Sixty patients were entered into the study. There were no differences between the groups with respect to sex, weight, height, age, and antihypertensive use (Table 1).

Baseline values of hemodynamic variables were comparable between the two groups.

Increase of heart rate was observed in both the groups but the rise of heart rate in the ETT group was significant at during ETT/PLMA insertion, 1 minute, 2 minutes, 3 minutes, and 5 minutes after intubation and during extubation as compared to PLMA ($p < 0.005$). The difference was not significant at 10 minutes after ETT/PLMA insertion (Table 2).

MAP also increased significantly in the ETT group as compared to the PLMA group and the rise was also significant at ETT/PLMA insertion,1 minute, 2 minutes, 3 minutes, and 5 minutes after intubation and just after extubation as compared to PLMA (Table 3; $p < 0.005$). But less difference in 10 minutes after intubation.

No patient in either group had any complication; PLMA insertion was successfully accomplished in all patients.

Table 1 *Patient characteristics*

Characteristics	Group ETT (n=30)	Group PLMA (n=30)	P-Value
Age (y)	55±5	56±6	0.331
Sex ratio (F:M)	19:11	18:12	0.555
Height (cm)	154 ± 6	155±8	0.127
Weight (kg)	62±7	61±8	0.255

All values are expressed as mean _ standard deviation; $p < 0.05$ was considered significant. ETT = Endotracheal tube group; PLMA = ProSeal laryngeal mask airway group.

Table II *Comparison of mean heart rate between endotracheal tube group (ETT) and ProSeal laryngeal mask airway group (PLMA).*

Heart rate (beats/min)	ETT (n - 30)	PLMA (n - 30)	p-value
Base Line	89.56 ± 10.569	86.85 ±10.099	0.314
During intubation / PLMA insertion	99.56 ±10.569	86.85 ± 10.099	0.314
1 min after intubation/ PLMA insertion	104.43± 12.127	95.23± 09.345	0.0125
2 min after intubation/ PLMA insertion	115.34±10.236	94.267 ± 05.678	0.0213
3 min after intubation/ PLMA insertion	110.456± 10.342	93.256± 04.876	0.0167
5 min after intubation/ PLMA insertion	102.234±06.245	90.897±06.542	0.0432
10 min after intubation/ PLMA insertion	87.106±10.459	85. 678±10.342	0.228
During Extubation / removal of PLMA	115.675±10.897	90.321±08.432	0.0432

All values are expressed as mean _ standard deviation ; $p < 0.05$ was considered significant. ETT = Endotracheal tube group; PLMA = ProSeal laryngeal mask airway group.

Table-III *Comparison of systolic blood pressure between endotracheal tube group (ETT) and ProSeal laryngeal mask airway group (PLMA).*

Systolic Blood pressure (SBP)	ETT (n=30)	PLMA (n=30)	P- Value
Base Line	130.231 ±05.567	129.456±o6.876	0.345
During intubation / PLMA insertion	135.123±05.765	131.541±05.543	0.431
1 min after intubation/ PLMA insertion	140.432±07.987	132.329±04.645	0.023
2 min after intubation/ PLMA insertion	145.346±09.674	134.653±06.785	0.013
3 min after intubation/ PLMA insertion	146.675±05.764	134.785±03.765	0.023
5 min after intubation/ PLMA insertion	145.436±06.345	133.765±06.985	0.043
10 min after intubation/ PLMA insertion	131.453±04.874	131.231±04.674	0.065
During Extubation / removal of PLMA	142.421±10.654	130.543±09.543	0.043

All values are expressed as mean _ standard deviation ; $p < 0.05$ was considered significant. ETT = Endotracheal tube group; PLMA =ProSeal laryngeal mask airway group.

Table-IV *Comparison of diastolic blood pressure (DBP) between endotracheal tube group (ETT) and ProSeal laryngeal mask airway group (PLMA).*

Diastolic Blood pressure (DBP)	ETT (n=30)	PLMA (n=30)	P- Value
Base Line	85.125± 05.675	84.876±06.986	0.3218
During intubation / PLMA insertion	90.321±05.213	86.453±05.142	0.0421
1 min after intubation/ PLMA insertion	95.213±06.432	87.432±05.675	0.0354
2 min after intubation/ PLMA insertion	102.432±05.234	86.453±05.987	0.0234
3 min after intubation/ PLMA insertion	97.543±06.987	86.06±05.765	0.0258
5 min after intubation/ PLMA insertion	95.256±05.432	85.432±06.453	0.0236
10 min after intubation/ PLMA insertion	86.236±07.453	85.345±06.321	0.453
During Extubation / removal of PLMA	88.543±05.876	85.897±05.786	0.034

All values are expressed as mean _ standard deviation ; $p < 0.05$ was considered significant. ETT = Endotracheal tube group; PLMA = ProSeal laryngeal mask airway group.

Table-V *Comparison of mean blood pressure between endotracheal tube group (ETT) and ProSeal laryngeal mask airway group (PLMA).*

Mean Blood pressure	ETT (n=30)	PLMA (n=30)	P- Value
Base Line	100.346±05.432	99.453±06.654	0.456
During intubation / PLMA insertion	105.877±06.325	103.675±06.543	0.0241
1 min after intubation/ PLMA insertion	111.666±06.345	102.954±05.765	0.0342
2 min after intubation/ PLMA insertion	116.336±04.234	102.335±06.432	0.0123
3 min after intubation/ PLMA insertion	113.330±04.654	101.666±05.643	0.0231
5 min after intubation/ PLMA insertion	111.668±04.321	101.332±05.654	0.0342
10 min after intubation/ PLMA insertion	101.345±06.654	100.045±04.654	0.3212
During Extubation / removal of PLMA	106.543±04.674	100.054±05.432	0.0431

All values are expressed as mean _ standard deviation, $p < 0.05$ was considered significant. ETT = Endotracheal tube group; PLMA = ProSeal laryngeal mask airway group.

Discussion

Our results showed that patients in whom PLMA was used had an attenuated haemodynamic response at the time of its insertion as compared to patients in whom ETT was used. The observed tachycardia at the time of intubation /PLMA insertion in the two groups revealed a significant difference between these two groups at 1 minute, 2 minutes, 3 minutes and at the time of extubation /PLMA removal of this study (Table 2).

Similarly, the changes in SBP, DBP as well as MAP were of lesser magnitude and of shorter duration in the PLMA group as compared to the ETT group (Tables 3, 4 and 5) and these findings were consistently observed in all patients of this study.

Cardiac compromised & hypertensive patients exhibit an exaggerated hemodynamic response to tracheal extubation and intubation compared to that seen in patients without hypertension.

Although these hemodynamic changes during intubation /PLMA insertion or extubation/PLMA removal are short lived, they can be of dangerous consequences in geriatric patients, especially those patients who have coexisting coronary artery disease, and signifying increased myocardial oxygen demand. Therefore, the prevention of these hemodynamic changes during tracheal intubation /PLMA insertion 0r extubation/ PLMA removal is of particular clinical importance in patients with hypertension.[10-13]

Hypertension along with ischemic heart disease is common in the elderly. In addition, decreased autoregulation and sympathetic tone and increased peripheral vascular resistance result in a decreased adaptability of the circulatory system to stress.[14]

LMA, designed by Brain in 1983, was found to be helpful in such patients as cardiovascular responses to its insertion as well as removal are minimal, which may be related to lack of direct laryngeal and tracheal stimulation, and lesser stimulation of the pharynx.[15] The effectiveness of LMA in preventing the increase in heart rate, SBP, DBP and MAP and thus increased myocardial oxygen demand in both normotensive and hypertensive patients has been shown by Fuji et al.[7]

PLMA has become popular owing to its design, where in the flat dorsal component of the cuff of PLMA is designed to press the ventral cuff more firmly into the periglottic tissues and a wedge shaped proximal component designed to plug gaps in the proximal pharynx. A better seal coupled with a drain tube extends the range of surgical procedures for which this type of LMA device can be used.

In addition, it also allows positive pressure ventilation in patients with high airway pressures. Therefore, it can be used inpatients undergoing laparoscopic surgery.[16]

Cardiac compromised patients tend to have diminished cardiac reserves, and alterations in autonomic function, and blunting pressor response by pharmacological means, such as opioids and anesthetic drugs is associated with adverse effects in this population.[17,18]

Therefore, an alteration of anesthetic technique is preferable to pharmacological means to blunt pressor response in this class of patients to stable haemodynamic status.

Habib et al studied the effects of remifentanil and alfentanil on the cardiovascular responses to induction of anesthesia and tracheal intubation in the cardiac patient. They came to the conclusion that, although both remifentanil and alfentanil attenuate the pressor response to laryngoscopy and intubation, the incidence of hypotension confirms that both drugs should be used with caution in elderly cardiac compromised patients. They also concluded that the cardiac patient are susceptible to marked fluctuations of arterial pressure and heart rate.[17]

Splinter and Cervenko observed that the cardiovascular response to tracheal intubation was attenuated by fentanyl but with a marked incidence (35%) of hypotension.[19]

A study by Harris et al [17] also showed that cardiac compromise hypertensive patients are highly sensitive to anesthetic drugs and that close titration of dosages of drugs is essential. Thus, an alteration of anesthetic technique is preferable to pharmacological means to blunt pressor response in this subset of patients.

Güler et al studied the effects of dexmedetomidine on cardiovascular changes and quality of extubation during extubation in elderly patients undergoing cataract surgery and found that emergence from anesthetic effects and extubation are equally crucial, as is the laryngoscopy, intubation, and surgical period, as the depth of anesthesia decreases abruptly and the rising levels of catecholamines can be deleterious for elderly high-risk patients.

They observed that dexmedetomidine enables a smooth transition from the time of administration of reversal to the postextubation phase by suppressing CNS sympathetic activity, leading to a high quality of extubation.[20]

Conclusion

Although both endotracheal intubation /PLMA insertion or extubation and PLMA removal are associated with increased cardiovascular responses in hypertensive cardiac compromise patients, response with PLMA insertion / removal is of lesser severity and persists for a shorter period haemodynamic changes compared to endotracheal intubation/ extubation.

Therefore, PLMA should be preferred in cardiac compromised hypertensive patients over the ETT in airway management in the patients undergoing laparoscopic cholecystectomy surgeries.

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