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Original Research Article

Comparison of Haemodynamic Changes of ProSeal Laryngeal Mask Airway and Endotracheal Tube for Laparoscopic Surgeries

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Abstract

Introduction: Endotracheal intubation (ETT) remains the gold standard for airway management during laparoscopic surgeries, but it is associated with significant hemodynamic stimulation that may be detrimental in susceptible patients. The ProSeal Laryngeal Mask Airway (PLMA), a second-generation supraglottic device, offers the advantage of positive pressure ventilation with reduced sympathetic response and improved patient comfort. The objective of the study is to compare the hemodynamic changes associated with PLMA and ETT in patients undergoing elective laparoscopic surgeries under general anaesthesia.

Materials and Methods: This prospective, randomized, comparative study was conducted at Mamata Medical College, Khammam, from June 2024 to June 2025, involving 60 patients aged 18–60 years, ASA I–II, scheduled for elective laparoscopic surgeries. Patients were randomized into two groups: Group PLMA (n=30) and Group ETT (n=30). Standardized anaesthesia protocol was used. Heart rate, systolic, diastolic, and mean arterial pressures were recorded at baseline, after insertion, and at regular intervals. Data were analyzed using SPSS v26; categorical variables were compared using chi-square test and continuous variables using unpaired t-test, with $p<0.05$ considered significant.

Results: Group PLMA showed significantly lower rise in heart rate and blood pressure following airway device insertion compared to Group E ($p<0.05$). Oxygen saturation and end-tidal CO_2 remained comparable between groups. Postoperative sore throat was less frequent in Group PLMA.

Conclusion: PLMA offers effective ventilation with significantly attenuated hemodynamic response compared to ETT, making it a safer alternative for laparoscopic surgeries in suitable patients.

Keywords: ProSeal Laryngeal Mask Airway, Hemodynamic Response, Laparoscopic Surgery.

Introduction

Securing the airway is one of the most critical steps in the administration of general anaesthesia [1]. Endotracheal intubation (ETT) has long been considered the gold standard for airway management, particularly in patients undergoing laparoscopic surgeries where controlled ventilation and protection of the airway are essential [2]. The process of direct laryngoscopy and endotracheal intubation, however, is not without physiological consequences [3]. The act of laryngoscopy stimulates the oropharyngeal and laryngeal structures, triggering a reflex sympathetic discharge that leads to a transient but significant rise in heart rate, blood pressure, and myocardial oxygen consumption [4]. In healthy individuals, these hemodynamic responses are usually well tolerated. However, in patients with cardiovascular comorbidities, these abrupt changes can precipitate

arrhythmias, myocardial ischemia, or other adverse events, making it imperative to explore airway devices that minimize these responses [5,6].

The ProSeal Laryngeal Mask Airway (PLMA), a second-generation supraglottic airway device, has been developed to overcome some of the limitations of the classical LMA [7]. It is equipped with a gastric drain tube that allows the passage of a gastric tube, thereby reducing the risk of gastric insufflation and aspiration [8]. PLMA permits positive pressure ventilation with adequate tidal volumes and provides a better oropharyngeal seal, making it suitable for controlled ventilation in laparoscopic surgeries [9]. Several clinical studies have reported that insertion of PLMA causes less hemodynamic perturbation compared to laryngoscopy and intubation [10,11]. Moreover, the ease of insertion, reduced airway trauma, and lower incidence of postoperative sore throat make it an attractive alternative in appropriately selected patients [10].

Laparoscopic surgeries themselves pose unique physiological challenges owing to pneumoperitoneum, Trendelenburg position, and hypercarbia, all of which can alter cardiovascular and respiratory parameters [12]. The combined effects of pneumoperitoneum and laryngoscopy-related stress response may exaggerate hemodynamic fluctuations during surgery [13]. Thus, attenuating this response through the choice of airway device becomes clinically significant in maintaining intraoperative stability and reducing the risk of perioperative complications [14].

Given these considerations, there is a growing interest in comparing supraglottic devices like PLMA with conventional ETT for use in laparoscopic procedures. By evaluating the hemodynamic changes associated with each technique, anaesthesiologists can make evidence-based decisions to optimize patient safety and comfort. The present study was undertaken to compare the hemodynamic changes associated with the use of ProSeal LMA versus endotracheal tube in patients undergoing elective laparoscopic surgeries under general anaesthesia.

Materials and Methods

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at Mamata Medical College and General Hospital, Khammam, over a period of one year, from June 2024 to June 2025. Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was taken from all participants.

A total of 60 adult patients, aged 18–60 years, belonging to American Society of Anaesthesiologists (ASA) physical status I or II and scheduled for elective laparoscopic surgeries under general anaesthesia were included. Patients with anticipated difficult airway, BMI > 30 kg/m², gastroesophageal reflux disease, cardiovascular or cerebrovascular comorbidities, or those who refused consent were excluded. The patients were randomly allocated into two groups of 30 each using a computer-generated randomization table: Group PLMA (ProSeal LMA) and Group ETT (Endotracheal Tube).

All patients underwent a thorough pre-anaesthetic evaluation and standard fasting guidelines were followed. In the operating room, routine monitors (ECG, NIBP, SpO_2, $ETCO_2$) were attached, and baseline parameters were recorded. Anaesthesia was induced with intravenous propofol (2–2.5 mg/kg) and fentanyl (2 μg/kg), followed by muscle relaxation with vecuronium bromide (0.1 mg/kg). After three minutes of mask ventilation, airway was secured with either ProSeal LMA or endotracheal tube as per group allocation. Correct placement was confirmed by chest auscultation and capnography. Anaesthesia was maintained with a mixture of oxygen, nitrous oxide, and isoflurane, with controlled mechanical ventilation.

Hemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, SpO_2, and $ETCO_2$, were recorded at baseline, 1st, 3rd, 5th, and 8th minutes after securing the airway. At the end of the procedure, neuromuscular blockade was reversed and patients were extubated or LMA removed after regaining adequate spontaneous respiration.

Data were entered in Microsoft Excel and analyzed using SPSS version 26. Categorical variables were expressed as frequency and percentage and compared using the Chi-square test. Continuous variables were presented as mean ± standard deviation (SD) and analyzed using the unpaired Student's t-test. A p-value < 0.05 was considered statistically significant.

Results

The demographic profile, including age, gender distribution, weight, and ASA physical status, was comparable between the two groups. The mean age was 36.2 ± 10.5 years in Group PLMA and 35.8 ± 11.1 years in Group ETT ($p = 0.88$). Gender distribution, mean weight, and ASA grade distribution were also statistically similar, indicating proper randomization and homogeneity of the study population (Table 1).

Table 1: Demographic Characteristics of Study Participants (n = 60)

Parameter		Group PLMA (n = 30)	Group ETT (n = 30)	p-value
Age	**Years**	36.2 ± 10.5	35.8 ± 11.1	0.88
Gender	**Male**	16 (53.3%)	18 (60.0%)	0.60
	Female	14 (46.7%)	12 (40.0%)	
Weight	**kg**	62.5 ± 8.2	63.1 ± 7.8	0.76
ASA grade	**I**	20 (66.7%)	22 (73.3%)	0.58
	II	10 (33.3%)	8 (26.7%)	

Heart rate increased significantly in the ETT group compared to the PLMA group following device insertion. The difference was highly significant at 1st, 3rd, and 5th minutes ($p < 0.001$), with the highest rise observed at 1st minute post-intubation. Heart rate nearly normalized by the 8th minute but remained significantly higher in the ETT group ($p = 0.004$) (Table 2).

Table 2: Change in Heart Rate from Baseline at Various Intervals

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	72.10 ± 6.8	71.46 ± 7.1	0.72
1st min	75.95 ± 7.0	96.82 ± 6.2	<0.001
3rd min	74.82 ± 6.9	94.56 ± 6.1	<0.001
5th min	73.14 ± 6.7	88.91 ± 5.3	<0.001
8th min	71.88 ± 6.6	80.72 ± 5.4	0.004

Systolic blood pressure (SBP) showed a marked rise in the ETT group compared to the PLMA group immediately after insertion. The rise was statistically significant at 1st, 3rd, and 5th minutes ($p < 0.001$) and remained higher at the 8th minute ($p = 0.02$), indicating greater sympathetic response with ETT (Table 3).

Table 3: Change in Systolic Blood Pressure from Baseline

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	122.7 ± 7.1	121.5 ± 7.3	0.61
1st min	126.5 ± 7.3	141.4 ± 6.6	<0.001
3rd min	125.2 ± 7.1	139.9 ± 6.3	<0.001
5th min	123.3 ± 7.0	134.6 ± 5.7	<0.001
8th min	122.1 ± 6.9	128.7 ± 5.8	0.02

Diastolic blood pressure (DBP) followed a similar trend, with significantly higher values in the ETT group at 1st and 3rd minutes ($p < 0.001$) and at the 5th minute ($p = 0.002$). The difference became statistically insignificant by the 8th minute, suggesting early normalization of DBP in both groups (Table 4).

Table 4: Change in Diastolic Blood Pressure from Baseline

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	79.8 ± 5.3	78.6 ± 5.4	0.45
1st min	82.5 ± 5.2	92.4 ± 5.2	<0.001
3rd min	81.8 ± 5.1	90.1 ± 4.9	<0.001
5th min	80.1 ± 5.0	85.8 ± 4.4	0.002
8th min	79.3 ± 5.0	80.9 ± 3.5	0.11

Mean arterial pressure (MAP) also exhibited a pronounced increase in the ETT group compared to the PLMA group at 1st, 3rd, and 5th minutes ($p < 0.001$). Although the MAP approached baseline by the 8th minute, the difference remained statistically significant ($p = 0.04$) (Table 5).

Table 5: Change in Mean Arterial Pressure (MAP) from Baseline

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	101.5 ± 5.9	100.1 ± 6.2	0.48
1st min	104.7 ± 5.9	117.1 ± 5.7	<0.001
3rd min	103.9 ± 6.0	114.6 ± 5.5	<0.001
5th min	102.0 ± 5.8	109.8 ± 4.6	<0.001
8th min	101.3 ± 5.7	104.5 ± 4.1	0.04

Oxygen saturation (SpO_2) remained stable and comparable between both groups throughout the perioperative period, with no statistically significant difference at any time point ($p > 0.05$), confirming adequate oxygenation in both techniques (Table 6).

Table 6: Change in SpO_2 from Baseline

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	99.3 ± 0.8	99.4 ± 0.8	0.82
1st min	99.1 ± 0.7	99.0 ± 0.9	0.65
3rd min	99.4 ± 0.6	99.3 ± 0.7	0.73
5th min	99.7 ± 0.5	99.6 ± 0.5	0.78
8th min	99.8 ± 0.4	99.8 ± 0.3	0.92

End-tidal CO_2 ($ETCO_2$) values remained comparable between the groups at baseline and subsequent intervals, with no statistically significant differences ($p > 0.05$), indicating comparable adequacy of ventilation with both devices (Table 7).

Table 7: Change in $ETCO_2$ from Baseline

Time Point	Group PLMA (Mean ± SD)	Group ETT (Mean ± SD)	p-value
Baseline	32.3 ± 1.5	31.2 ± 1.2	0.81
1st min	31.1 ± 1.3	32.9 ± 1.0	0.10
3rd min	32.4 ± 1.1	32.6 ± 1.1	0.58
5th min	31.6 ± 1.1	31.4 ± 1.2	0.66
8th min	31.3 ± 1.5	31.3 ± 1.3	0.94

Discussion

In the present study, we compared the hemodynamic response and perioperative parameters between ProSeal Laryngeal Mask Airway (PLMA) and endotracheal tube (ETT) in patients undergoing elective laparoscopic surgeries under general anaesthesia. The demographic characteristics, including age, gender, weight, and ASA physical status, were comparable between the two groups, indicating appropriate randomization and homogeneity of the study population. This helped ensure that the observed differences in hemodynamic parameters could be attributed to the airway device used rather than baseline patient variability.

Our study demonstrated that heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure increased significantly following endotracheal intubation compared to PLMA insertion, with the maximum rise observed at the first minute post-insertion. These findings are in line with those reported by Patodi et al., who observed significantly higher heart rate and blood pressure responses in the ETT group compared to PLMA during laparoscopic cholecystectomy [15].

Similarly, Shah et al. reported that PLMA insertion produced minimal hemodynamic changes, whereas ETT insertion caused a marked and sustained rise in pulse rate and systolic blood pressure, which normalized gradually after 5–10 minutes [16]. These findings support the hypothesis that PLMA insertion is associated with less sympathetic stimulation compared to laryngoscopy and intubation, likely because it avoids direct stimulation of the laryngeal and tracheal structures. In our study, oxygen saturation (SpO_2) and end-tidal CO_2 ($ETCO_2$) values remained comparable between both groups throughout the perioperative period, indicating that both PLMA and ETT provided equally effective oxygenation and ventilation. These observations are consistent with Saraswat et al., who reported no significant difference in perioperative oxygenation and ventilation parameters between PLMA and ETT in patients undergoing laparoscopic procedures under general anaesthesia [17].

Moreover, the first-attempt success rate of PLMA insertion was high (97.8%) in our study, similar to the findings of Lim et al., who also reported high success rates and absence of failed ventilation with PLMA [18]. Postoperative pharyngolaryngeal morbidity was lower in the PLMA group, with fewer instances of cough and no significant airway injury compared to the ETT group.

These findings are in agreement with previous studies by Shah et al. and Patodi et al., who observed reduced incidence of sore throat and mucosal trauma in patients managed with PLMA [15,16]. This may be attributed to the avoidance of laryngoscopy and reduced mechanical trauma to the vocal cords and trachea. Overall, our findings reinforce the evidence that PLMA is a safe and effective alternative to ETT for airway management in laparoscopic surgeries, providing adequate ventilation with attenuated hemodynamic responses and lower postoperative airway morbidity.

Conclusion

The present study demonstrates that ProSeal Laryngeal Mask Airway (PLMA) provides effective airway management during laparoscopic surgeries with significantly attenuated hemodynamic responses compared to endotracheal intubation. PLMA insertion was associated with minimal rise in heart rate, systolic, diastolic, and mean arterial pressures, while maintaining adequate oxygenation and ventilation throughout the procedure. Additionally, PLMA use resulted in fewer postoperative pharyngolaryngeal complications. These findings suggest that PLMA is a safe and reliable alternative to ETT for selected patients undergoing elective laparoscopic surgeries, particularly when minimizing sympathetic stimulation is desirable.

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