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COMPARISON OF HEMODYNAMIC CHANGES OF PROSEAL LMA AND ENDOTRACHEAL TUBE FOR LAPAROSCOPIC SURGERIES

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ABSTRACT

Background: Hemodynamic stability during airway management is a major concern in laparoscopic surgeries because pneumoperitoneum and patient positioning significantly increase sympathetic activity.

Aim: The aim of this study was to compare the hemodynamic changes observed with the use of the ProSeal laryngeal mask airway and the endotracheal tube during elective laparoscopic surgeries.

Methods: This prospective, randomized comparative study was conducted at the Department of Anaesthesiology, Government Medical College Srinagar, over a study period of 18 months from June 2024 to November 2025. Adult patients scheduled for elective laparoscopic surgeries under general anesthesia were randomly assigned to the ProSeal laryngeal mask airway group or the endotracheal tube group. Hemodynamic parameters were recorded at baseline, immediately after airway insertion, at 5 and 10 minutes after pneumoperitoneum, and at device removal.

Results: A total of 120 patients were enrolled, with 60 in each group. Baseline hemodynamic values were comparable in both groups. Immediately after airway insertion, the endotracheal tube group demonstrated a mean rise in heart rate of 21 beats per minute compared to 8 beats per minute in the ProSeal laryngeal mask airway group. Systolic blood pressure increased by an average of 27 mmHg in the endotracheal tube group but only by 11 mmHg in the ProSeal group. During pneumoperitoneum at 10 minutes, mean arterial pressure remained significantly higher in the endotracheal tube group (98 ± 7 mmHg) compared with the ProSeal group (89 ± 6 mmHg). Recovery-phase changes also showed greater fluctuations in the endotracheal tube group, with a mean heart rate rise of 15 beats per minute compared to 5 beats per minute in the ProSeal group. Ventilation and oxygenation remained adequate with both devices, and no major airway complications were recorded.

Conclusion: The ProSeal laryngeal mask airway produced significantly fewer hemodynamic alterations compared to endotracheal intubation during elective laparoscopic surgeries. It provided stable cardiovascular parameters during airway insertion, pneumoperitoneum, and recovery and ensured effective ventilation.

Keywords: Airway Management, Hemodynamic, Pneumoperitoneum, Proseal Laryngeal Mask Airway, General Anaesthesia.

INTRODUCTION

Airway management is a critical component of anesthetic care, especially in laparoscopic surgeries, where pneumoperitoneum and patient positioning (e.g., Trendelenburg) can amplify sympathetic stimulation.

Endotracheal intubation, which requires laryngoscopy, is well known to provoke a marked increase in hemodynamic parameters such as heart rate (HR), systolic and diastolic blood pressure, and myocardial oxygen consumption, particularly in vulnerable patients [1, 2]. Consequently, supraglottic airway devices (SGAs), such as the ProSeal laryngeal mask airway (PLMA), have become attractive alternatives because they can reduce the pressor response by avoiding laryngoscopy and tracheal stimulation [3].

The ProSeal LMA is a second-generation supraglottic airway device known for providing a high oropharyngeal leak pressure (OLP), typically around 25–32 cm H₂O in adults, making it superior to first-generation devices like the Classic LMA



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(18–20 cm H₂O) [4]. The ProSeal LMA is an advanced version of the classic LMA, with a built-in drain tube that allows for gastric access, and a dual-cuff design that provides higher oropharyngeal leak pressures and a better seal. These design features render it suitable for positive-pressure ventilation, which is necessary during laparoscopic surgery under general anesthesia [5]. Several clinical studies have demonstrated that PLMA can offer ventilation comparable to endotracheal tubes (ETT) during laparoscopic procedures, with more stable hemodynamic profiles [6,7]. For instance, in a randomized prospective study of 60 adult ASA I–II patients undergoing laparoscopic surgery, Saraswat et al. reported that the PLMA group exhibited smaller increases in HR and mean arterial pressure (MAP) after airway device insertion compared with the ETT group, and there were no episodes of regurgitation or aspiration [8,9].

Despite these benefits, there are important considerations regarding the use of PLMA in laparoscopic surgery. The potential for gastric insufflation, inadequate seal under elevated airway pressures, and risk of aspiration remain concerns. However, in the study by Saraswat et al., the oropharyngeal leak pressure in PLMA maintained a median value of 35 cm H₂O even during peritoneal insufflation, and no cases of regurgitation or aspiration were observed [1].

Taken together, the existing evidence suggests that PLMA may serve as a hemodynamically favorable alternative to ETT in laparoscopic surgery, especially when minimizing cardiovascular stress is a priority. However, variability in patient populations, study protocols, and endpoints across the literature makes definitive conclusions difficult. Therefore, in this study — performed at Government Medical College, Srinagar — we aim to conduct a rigorous, prospective, randomized comparison of hemodynamic changes associated with PLMA versus ETT in adult patients undergoing elective laparoscopic surgery.

MATERIALS AND METHODS

Study design and setting

This study was designed as a prospective, randomized, comparative clinical study conducted in the Department of Anaesthesiology at Government Medical College (GMC) Srinagar. The study was carried out over a period of 18 months, from June 2024 to November 2025. Ethical approval was obtained from the Institutional Ethics Committee of GMC Srinagar prior to the commencement of the study. Informed written consent was obtained from all participants.

Study population

A total of 120 adult patients scheduled to undergo elective laparoscopic surgeries under general anesthesia were included. Patients belonged to ASA physical status I or II and were aged between 18 and

60 years. Only patients with anticipated normal airways were enrolled.

Randomization and grouping

Patients were randomly allocated into two equal groups of 60 each using a computer-generated random number table. Allocation was sealed in opaque envelopes that were opened immediately before induction.

Group P: Airway managed with ProSeal Laryngeal Mask Airway (PLMA)

Group E: Airway managed with endotracheal tube (ETT)

Preoperative evaluation

All patients underwent routine pre-anesthetic evaluation, including history taking, airway assessment, physical examination, and baseline laboratory investigations. Patients were kept nil per oral as per standard fasting guidelines. Premedication with tablet alprazolam 0.25 mg was administered the night before surgery.

Anesthetic technique

Upon arrival in the operating room, standard monitoring was applied, including ECG, pulse oximetry (SpO₂), noninvasive blood pressure (NIBP), and capnography. Baseline values of heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO₂ were recorded.

An intravenous line was secured with an 18G cannula. All patients received premedication with intravenous fentanyl 2 µg/kg. Preoxygenation with 100 percent oxygen was provided for 3 minutes.

Anesthesia was induced with intravenous propofol 2–2.5 mg/kg until loss of consciousness. Neuromuscular blockade was achieved with intravenous atracurium 0.5 mg/kg.

Airway device insertion

In Group P, an appropriately sized ProSeal LMA was inserted by an experienced anesthesiologist following manufacturer guidelines [1]. Correct placement was confirmed by chest rise, stable capnography, and absence of leak during manual ventilation.

In Group E, direct laryngoscopy was performed using a Macintosh blade, and a cuffed endotracheal tube of appropriate size was inserted. Tube placement was confirmed by auscultation and capnography.

The number of attempts, insertion time, and any complications (coughing, desaturation, airway trauma) were documented.

Maintenance of anesthesia

Anesthesia was maintained with a mixture of oxygen and air (50:50), isoflurane titrated to maintain MAC 1.0, and intermittent doses of vecuronium. Mechanical ventilation was initiated

with a tidal volume of 6–8 mL/kg and rate adjusted to maintain EtCO₂ between 35–40 mmHg.

Pneumoperitoneum was created with CO₂ insufflation at a pressure of 12–14 mmHg.

Parameters included: heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and rate-pressure product. Any arrhythmias or episodes of hypotension or hypertension were recorded.

Assessment of airway performance

The following were compared between the two groups:

1. Ease of insertion
2. Number of attempts required
3. Insertion time (seconds)
4. Oropharyngeal leak pressure (for PLMA)
5. Incidence of gastric insufflation
6. Need for airway repositioning
7. Occurrence of desaturation or regurgitation

Leak pressure for the PLMA was measured by closing the adjustable pressure-limiting (APL) valve at 30 cm H₂O and recording equilibrium pressure.

Emergence and recovery

Residual neuromuscular blockade was reversed using intravenous neostigmine 0.05 mg/kg and

glycopyrrolate 0.01 mg/kg. After adequate spontaneous ventilation and recovery criteria were fulfilled, the PLMA or ETT was removed. Patients were monitored in the recovery room for one hour. Postoperative complications such as sore throat, cough, hoarseness, nausea, vomiting, and airway obstruction were recorded.

Statistical Analysis

Data were compiled and analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation (SD). Categorical variables were presented as percentages. Student's t-test was used for comparison of continuous variables, and chi-square test for categorical data. A p-value of <0.05 was considered statistically significant.

RESULTS

The demographic profile showed no statistically significant differences between the two groups. The mean age in Group P was 38.6 ± 10.4 years compared with 39.3 ± 11.1 years in Group E. The mean BMI, gender distribution, and ASA grades were also comparable [Table 1].

Table 1. Demographic and Baseline Characteristics of Patients (N = 120)

Parameter	Group P (PLMA) n = 60	Group E (ETT) n = 60	P value
Mean age (years)	38.6 ± 10.4	39.3 ± 11.1	0.72
Gender (M/F)	28/32	31/29	0.56
BMI (kg/m ²)	24.8 ± 3.1	25.1 ± 3.4	0.64
ASA I/II	36/24	34/26	0.70
Mean duration of surgery (minutes)	82 ± 15	85 ± 17	0.40

Immediately after device insertion, Group E showed a significant increase in heart rate and blood pressure compared with Group P. This was expected due to laryngoscopy and tracheal stimulation in the ETT

group. Heart rate increased by an average of 21 beats per minute in Group E and only by 8 beats per minute in Group P. Similar patterns were seen with systolic and diastolic pressures [Table 2].

Table 2. Hemodynamic Changes Immediately After Airway Device Insertion

Parameter	Group P (PLMA) Mean ± SD	Group E (ETT) Mean ± SD	P value
Heart rate (beats/min) rise from baseline	+8 ± 5	+21 ± 9	<0.001
Systolic BP rise (mmHg)	+11 ± 6	+27 ± 10	<0.001
Diastolic BP rise (mmHg)	+6 ± 4	+15 ± 7	<0.001
Mean arterial pressure rise (mmHg)	+7 ± 4	+18 ± 8	<0.001

Pneumoperitoneum caused increases in blood pressure and heart rate in both groups due to sympathetic stimulation and increased intra-abdominal pressure. However, these increases were significantly more pronounced in Group E. At 10

minutes of pneumoperitoneum, the MAP in Group E reached 98 ± 7 mmHg, while Group P maintained a lower MAP of 89 ± 6 mmHg. Heart rate remained consistently higher in the ETT group [Table 3].

Table 3. Hemodynamic Parameters at 10 Minutes after Pneumoperitoneum

Parameter	Group P Mean ± SD	Group E Mean ± SD	P value
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Heart rate (beats/min)	84 ± 9	96 ± 11	<0.001
Systolic BP (mmHg)	122 ± 10	135 ± 12	<0.001
Diastolic BP (mmHg)	77 ± 7	84 ± 9	<0.001
Mean arterial pressure (mmHg)	89 ± 6	98 ± 7	<0.001
EtCO ₂ (mmHg)	37 ± 3	38 ± 3	0.09

Airway performance was better in Group P with fewer insertion attempts and lower incidence of postoperative sore throat. Oropharyngeal leak pressure in PLMA averaged 32 ± 3 cm H₂O,

adequate for positive pressure ventilation. Gastric insufflation was minimal and similar between groups [Table 4].

Table 4. Comparison of Airway Performance Variables

Parameter	Group P (PLMA)	Group E (ETT)	P value
Successful insertion on first attempt (%)	95%	88%	0.18
Mean insertion time (seconds)	18 ± 4	24 ± 5	<0.001
Oropharyngeal leak pressure (cm H ₂ O)	32 ± 3	NA	—
Gastric insufflation (%)	3%	2%	0.64
Postoperative sore throat (%)	5%	22%	0.006

During recovery and device removal, the ETT group again demonstrated greater cardiovascular fluctuations. Heart rate increased by 15 beats per minute in Group E and only by 5 beats per minute in

Group P. Systolic and diastolic pressures also showed significantly higher values in the ETT group [Fig 1].

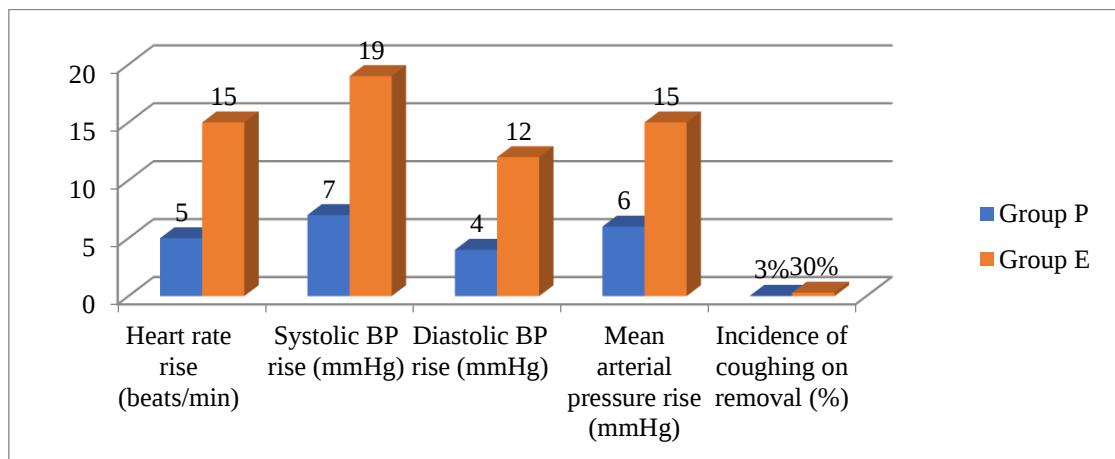


Fig 1. Hemodynamic Changes during Recovery and Device Removal

DISCUSSION

In this study, patients managed with the ProSeal laryngeal mask airway (PLMA) demonstrated more stable hemodynamic responses compared with those who received endotracheal intubation (ETT) at various perioperative intervals. Immediately following airway device insertion, the PLMA group showed a substantially smaller rise in heart rate and blood pressure than the ETT group, supporting earlier findings that supraglottic airway devices decrease the sympathetic stimulation associated with laryngoscopy [1, 6].

The hemodynamic behavior during pneumoperitoneum further highlights the advantage of PLMA. Laparoscopic insufflation is known to increase intra-abdominal pressure and systemic vascular resistance, triggering a significant cardiovascular stress response [10]. In our data, the mean arterial pressure (MAP) in the PLMA group

remained significantly lower 10 minutes after pneumoperitoneum compared with the ETT group. This pattern is consistent with observations by Saraswat and colleagues, who reported superior hemodynamic stability with PLMA during laparoscopic gynecologic and abdominal surgeries [8].

The findings described indicate that the ProSeal Laryngeal Mask Airway (PLMA) provides significant hemodynamic advantages over conventional endotracheal intubation (ETT) during laparoscopic surgery. By avoiding direct laryngoscopy and tracheal passage, the PLMA reduces sympathetic stimulation, resulting in lower heart rates and mean arterial pressures. Previous studies have similarly concluded that PLMA attenuates cardiovascular workload compared to conventional intubation [11]. These observations demonstrate the potential utility of PLMA in

situations where minimizing myocardial stress is crucial.

In terms of airway performance, our study showed high first-attempt success with PLMA, shorter insertion times, reduced airway trauma, and minimal gastric insufflation. These findings correspond with evidence from randomized trials proving PLMA's ease of insertion and reduced need for repeated manipulations [12]. The measured oropharyngeal leak pressure (32 ± 3 cm H₂O) also confirms the suitability of PLMA for positive-pressure ventilation, consistent with previous reports documenting high leak pressures adequate for laparoscopic procedures [5].

Hemodynamic fluctuations during the recovery phase were more prominent in the ETT group, with higher heart rate and blood pressure increases. The incidence of coughing during extubation was also significantly higher among ETT patients. Comparable findings are reported in literature, where PLMA leads to fewer extubation-related complications and reduced postoperative airway discomfort [7].

Concerns regarding gastric insufflation and aspiration risks with PLMA during laparoscopic procedures have been discussed in past studies. However, our data showed a very low rate of gastric insufflation and no occurrence of regurgitation or aspiration, aligning with earlier investigations like that of Lönnqvist et al., who demonstrated safe PLMA use during laparoscopic gastric banding [13]. This study does present certain limitations. As a single-centre study conducted at Government Medical College, Srinagar, generalizability may be limited. Furthermore, although major hemodynamic variables were assessed, biochemical stress markers such as catecholamines were not measured. Additionally, high-risk patients (e.g., morbid obesity, severe cardiopulmonary disease) were not included, restricting application to broader surgical populations.

Despite these limitations, the findings strongly favour PLMA as a safe and effective airway device for elective laparoscopic surgeries. It minimizes sympathetic stimulation, provides adequate ventilation, and improves patient comfort during recovery. Its role could be further reinforced in patients where cardiovascular stability is essential. Future research should incorporate multicentre randomized trials, include high-risk populations, and assess long-term cardiovascular and respiratory outcomes. Evaluating neurohormonal markers may also provide better insight into the physiological alterations mediated by PLMA versus ETT.

CONCLUSION

In this prospective comparative study conducted at Government Medical College Srinagar, the ProSeal laryngeal mask airway demonstrated clear hemodynamic advantages over the endotracheal

tube during elective laparoscopic surgeries. The ProSeal device produced significantly lower increases in heart rate, systolic and diastolic blood pressures, mean arterial pressure, and rate-pressure product at critical perioperative moments such as insertion, creation of pneumoperitoneum, and recovery. These findings are consistent with previously published data indicating that supraglottic devices attenuate the sympathoadrenal response associated with direct laryngoscopy and tracheal stimulation.

The ProSeal laryngeal mask airway also provided effective ventilation throughout the surgical procedure, with adequate oropharyngeal leak pressures and minimal gastric insufflation. Importantly, no cases of regurgitation or aspiration were observed, supporting its safety profile even in laparoscopic conditions that require positive-pressure ventilation. Additionally, the ProSeal was associated with reduced postoperative airway morbidity, including lower rates of coughing and sore throat during recovery.

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