

Comparative Evaluation of the ProSeal Laryngeal Mask Airway and King Laryngeal Tube Suction for Insertion Characteristics and Airway Dynamics in Adult Patients Undergoing Elective Surgery: A Prospective Randomised Comparative Study

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How to citation this article: Subia Zafreen, Sania Noorani, Nadim Akhtar, “Comparative Evaluation of the ProSeal Laryngeal Mask Airway and King Laryngeal Tube Suction for Insertion Characteristics and Airway Dynamics in Adult Patients Undergoing Elective Surgery: A Prospective Randomised Comparative Study”, IJMACR– September – 2026, Volume – 9, Issue – 5, P. No. 906 – 913.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Second-generation supraglottic airway devices provide ventilation while incorporating design features intended to improve airway sealing and permit gastric drainage. The ProSeal Laryngeal Mask Airway (PLMA) and King Laryngeal Tube Suction (KLTS) differ in their anatomical position, cuff configuration and mechanism of airway sealing, which may influence insertion and ventilatory performance.

Objective: To compare insertion characteristics, airway seal pressure, peak airway pressure, haemodynamic variables, ventilation parameters and airway-related complications between PLMA and KLTS in adults undergoing elective surgery under general anaesthesia.

Results: Mean insertion time was shorter with PLMA than with KLTS (46.0 ± 7.4 versus 50.0 ± 4.9 seconds; $p = 0.017$). First-attempt success was achieved in 90.0% and 66.7% of patients, respectively ($p = 0.028$), while smooth insertion occurred in 86.7% and 56.7% ($p = 0.009$). Airway seal pressure was higher with PLMA (33.0 ± 4.5 versus 30.0 ± 2.8 cmH₂O; $p = 0.003$), and peak airway pressures were lower with PLMA at all recorded intervals. Most haemodynamic and ventilation measurements were comparable, although isolated differences in diastolic blood pressure occurred at baseline, 5 minutes and 10 minutes. Airway-related complications were numerically less frequent with PLMA.

Conclusion: Both devices provided effective ventilation during elective surgery. PLMA was associated with shorter insertion time, higher first-attempt success, smoother insertion, higher airway seal pressure and lower peak airway pressure. The observed complication frequencies favoured PLMA descriptively but were not tested as statistically significant differences.

Keywords: Proseal Laryngeal Mask Airway, King Laryngeal Tube Suction, Supraglottic Airway Device, Airway Seal Pressure, General Anaesthesia.

Introduction

Effective airway management is fundamental to maintaining oxygenation and ventilation during general anaesthesia. Although tracheal intubation provides a secure airway, laryngoscopy and intubation may produce sympathetic stimulation, airway trauma and postoperative discomfort. Supraglottic airway devices have consequently become important alternatives for routine anaesthetic practice and rescue airway management^{1,2}.

Second-generation supraglottic airway devices incorporate improved sealing mechanisms and gastric drainage channels, enabling controlled positive-pressure ventilation while reducing gastric insufflation and facilitating gastric access^{3,4}. Their performance depends upon reliable placement, adequate airway seal, low resistance to gas flow and minimal airway trauma.

The ProSeal Laryngeal Mask Airway (PLMA) forms a perilaryngeal seal and includes a drainage tube for gastric access. The King Laryngeal Tube Suction (KLTS) separates the respiratory and alimentary pathways through pharyngeal and oesophageal cuffs and also provides a gastric drainage channel. Differences in their anatomical configuration and ventilation apertures may affect insertion success, seal pressure, peak airway

pressure and the requirement for corrective manoeuvres⁵⁻¹⁰.

Previous comparisons have produced variable findings. Some investigators reported higher seal pressures or more favourable insertion characteristics with PLMA, whereas others observed comparable success and ventilatory performance between PLMA and laryngeal tube devices.⁵⁻¹⁰ Later comparative studies also indicated that PLMA may provide shorter insertion time, higher seal pressure and lower peak airway pressure in selected elective surgical populations.^{11,12}

Airway seal pressure is clinically relevant because it reflects the ability of a supraglottic airway device to support positive-pressure ventilation without substantial leakage. Insertion time, first-attempt success and the need for repositioning are equally important because repeated airway manipulation may delay ventilation and increase mucosal trauma.

The present prospective randomised comparative study therefore evaluated PLMA and KLTS in adult patients undergoing elective surgery under general anaesthesia. The study compared insertion characteristics, additional manoeuvres, airway seal pressure, serial peak airway pressure, haemodynamic and ventilation variables, and perioperative airway-related complications.

Materials and Methods

Study Design and Setting

This single-centre prospective randomised comparative clinical study was conducted in the Department of Anaesthesiology and Critical Care, Chhatrapati Shivaji Subharti Hospital associated with Netaji Subhash Chandra Bose Subharti Medical College, Meerut, Uttar Pradesh, India, from November 2018 to August 2020. Approval was obtained from the Institutional Ethics

Committee, and written informed consent was obtained from all participants.

Study Population and Sample Size

The preliminary sample size was calculated with 80% power and an alpha error of 0.05. Assuming a standard deviation of 5 cmH₂O and a minimum detectable difference of 4 cmH₂O in airway pressure, the required sample was 60 patients, with 30 patients in each group.

Sixty-three patients were initially considered for participation. One patient declined participation on the day of surgery, and two patients were excluded following two unsuccessful KLTS insertion attempts. Sixty patients completed the study and were included in the comparative analysis: 30 in the PLMA group and 30 in the KLTS group.

Eligibility Criteria

Patients of either sex, aged 18–60 years, with American Society of Anesthesiologists physical status I or II, height 155–180 cm, weight 30–60 kg, Mallampati grade I or II and scheduled for an elective surgical procedure of up to 75 minutes under general anaesthesia were eligible.

Exclusion Criteria

Patients with ASA physical status III or IV, age below 18 years, a full stomach, inter-incisor gap below 30 mm, BMI above 35 kg/m², temporomandibular joint ankylosis, restricted cervical-spine movement, edentulous state, gastro-oesophageal reflux disease, hiatus hernia, previous oesophagectomy, oropharyngeal pathology or surgery, planned laparoscopic surgery, upper-respiratory-tract symptoms within the preceding 10 days, cardiovascular disease, device-cuff malfunction or refusal to participate were excluded.

Randomisation

Randomisation was performed using a computer-generated allocation sequence delivered through

sequentially numbered, sealed opaque envelopes. Participants completing the study were analysed in the PLMA group (n = 30) or KLTS group (n = 30). The airway device could not be blinded to the operator; outcome data were analysed by an independent observer.

Pre-anaesthetic Assessment

A detailed history and clinical examination were completed before surgery. Age, sex, height, weight, BMI, ASA physical status, heart rate, blood pressure and respiratory rate were recorded. Airway evaluation included Mallampati grading, inter-incisor gap and cervical-spine flexion and extension. Routine laboratory investigations, electrocardiography and chest radiography were performed as clinically required.

Anaesthetic Technique

Patients remained nil by mouth overnight. Intravenous access was established, and aspiration prophylaxis was administered with intravenous ranitidine 50 mg and metoclopramide 10 mg. Intravenous tramadol 2 mg/kg and paracetamol 10 mg/kg were administered 15 minutes before induction. Standard monitoring included electrocardiography, heart rate, non-invasive blood pressure, peripheral oxygen saturation and capnography. Following preoxygenation, patients received intravenous midazolam 0.05 mg/kg and fentanyl 2 µg/kg. Anaesthesia was induced with propofol 2 mg/kg, and neuromuscular blockade was achieved with vecuronium 0.1 mg/kg. After three minutes of bag-and-mask ventilation and confirmation of complete neuromuscular blockade, the allocated device was inserted.

In the PLMA group, a size-3 PLMA mounted on its metal introducer was inserted with the cuff completely deflated and its posterior surface lubricated. After placement in the hypopharynx, the introducer was removed and the cuff was inflated with 20 mL of air. In the KLTS group, a size-

4 KLTS was inserted with its cuffs deflated and lubricated. After positioning with the reference line at the upper incisors, the cuffs were inflated with 60–80 mL of air, and a size-14 gastric tube was inserted through the drainage channel.

Following device placement, volume-controlled ventilation was initiated using a tidal volume of 7 mL/kg, an inspiratory-to-expiratory ratio of 1:2 and a respiratory rate of 12 breaths/min. Anaesthesia was maintained with nitrous oxide and oxygen in a 50:50 ratio, isoflurane at 1.0–1.5 minimum alveolar concentration and a total gas flow of 2 L/min. A maximum of two device-insertion attempts was permitted.

Outcome Definitions

Insertion time was measured from the moment the distal tip of the device was positioned at the incisor level until a square-wave capnograph appeared after connection to the breathing circuit. An insertion attempt was counted when the distal edge crossed the incisors and the device was either advanced into position or withdrawn. Ease of insertion was recorded as smooth or associated with resistance. Additional manoeuvres included jaw lowering, head hyperextension, depth adjustment and bougie guidance.

Airway seal pressure was measured after positioning and cuff inflation by switching to manual ventilation, completely closing the adjustable pressure-limiting valve and using a fresh gas flow of 5 L/min. The pressure at which an audible leak occurred was recorded, and airway pressure was not allowed to exceed 40 cmH₂O.

Peak airway pressure was recorded immediately after positioning and at 5, 10, 15, 30, 45 and 60 minutes. End-tidal carbon dioxide was recorded immediately after positioning and at the same scheduled intervals. Heart rate, systolic blood pressure, diastolic blood pressure,

mean blood pressure and oxygen saturation were monitored before induction, immediately after positioning and subsequently at five-minute intervals for up to 60 minutes. Airway-related complications included mucosal bleeding, sore throat, hoarseness and dysphagia.

Statistical Analysis

Data were analysed using SPSS version 22.0. Continuous variables were expressed as mean $\pm$ standard deviation and compared using the unpaired t-test. Categorical variables were presented as frequencies and percentages and compared using the chi-square test. A two-tailed p-value below 0.05 was considered statistically significant.

Results

Sixty patients completed the study and were included in the final analysis, with 30 patients in each group. Baseline variables were comparable between the groups (Table 1).

Table 1: Baseline Characteristics of the Study Groups

Variable	PLMA (n = 30)	KLTS (n = 30)	P - value
Age (years)	35.3 $\pm$ 12.5	36.1 $\pm$ 11.5	0.813
Weight (kg)	54.2 $\pm$ 5.5	53.1 $\pm$ 4.2	0.403
Height (cm)	163.0 $\pm$ 6.7	160.5 $\pm$ 4.8	0.109
BMI (kg/m ²)	20.4 $\pm$ 1.7	20.7 $\pm$ 1.3	0.367
Male/Female	12/18	16/14	0.301
ASA I/II	20/10	21/9	0.791
Duration of surgery (minutes)	62.2 $\pm$ 6.8	60.5 $\pm$ 5.2	0.282

The mean inter-incisor gap and Mallampati distribution were also comparable. Insertion time was significantly shorter with PLMA, while first-attempt success and smooth insertion were more frequent with PLMA (Table 2). Additional manoeuvres were recorded more frequently during KLTS placement; however, the thesis

did not provide inferential p-values for individual manoeuvres.

Table 2: Insertion Characteristics and Additional Manoeuvres

Variable	PLMA (n = 30)	KLTS (n = 30)	p-value
Inter-incisor gap (mm)	32.5 ± 1.5	32.2 ± 1.4	0.387
Mallampati I/II	18/12	19/11	0.791
Insertion time (seconds)	46.0 ± 7.4	50.0 ± 4.9	0.017
First-attempt success	27 (90.0%)	20 (66.7%)	0.028
Second-attempt success	3 (10.0%)	10 (33.3%)	0.028
Smooth insertion	26 (86.7%)	17 (56.7%)	0.009
Resistance during insertion	4 (13.3%)	13 (43.3%)	0.009
Jaw lowering	5 (16.7%)	12 (40.0%)	Not reported
Head hyperextension	5 (16.7%)	12 (40.0%)	Not reported
Depth adjustment	2 (6.7%)	9 (30.0%)	Not reported
Bougie use	1 (3.3%)	3 (10.0%)	Not reported

Airway seal pressure was significantly higher in the PLMA group. Peak airway pressure was significantly lower with PLMA immediately after positioning and at every recorded follow-up interval (Table 3).

Table 3: Airway Seal Pressure and Serial Peak Airway Pressure

Variable/Time	PLMA (n = 30)	KLTS (n = 30)	p-value
Airway seal pressure (cmH ₂ O)	33.0 ± 4.5	30.0 ± 2.8	0.003
Peak pressure immediately after positioning (cmH ₂ O)	15.6 ± 1.5	16.8 ± 1.4	0.003
Peak pressure at 5 minutes (cmH ₂ O)	16.4 ± 1.6	17.5 ± 1.4	0.005
Peak pressure at 10 minutes (cmH ₂ O)	16.6 ± 1.6	17.5 ± 1.4	0.004
Peak pressure at 15 minutes (cmH ₂ O)	16.8 ± 1.6	18.1 ± 1.4	0.004
Peak pressure at 30 minutes (cmH ₂ O)	17.2 ± 1.9	18.4 ± 1.4	0.009
Peak pressure at 45 minutes (cmH ₂ O)	17.6 ± 1.6	18.6 ± 1.4	0.006
Peak pressure at 60 minutes (cmH ₂ O)	17.8 ± 1.9	19.0 ± 1.8	0.011

Heart rate, systolic blood pressure, mean blood pressure, oxygen saturation and end-tidal carbon dioxide were generally comparable between groups. Diastolic blood pressure differed significantly at baseline (p = 0.013), 5 minutes (p = 0.006) and 10 minutes (p = 0.010), but not

at the other reported intervals. Both devices maintained satisfactory oxygenation and ventilation.

Airway-related complications were numerically more frequent with KLTS (Table 4). No p-values were reported for these individual comparisons in the thesis; therefore, these findings were interpreted descriptively.

Table 4: Airway-Related Complications

Complication	PLMA (n = 30)	KLTS (n = 30)
Mucosal bleeding	1 (3.3%)	5 (16.7%)
Sore throat	1 (3.3%)	4 (13.3%)
Hoarseness	1 (3.3%)	2 (6.7%)
Dysphagia	0 (0.0%)	2 (6.7%)

Discussion

This prospective randomised comparative study found that both PLMA and KLTS provided effective ventilation during elective surgery. PLMA was associated with a shorter insertion time, higher first-attempt success, smoother insertion, higher airway seal pressure and lower serial peak airway pressures. Airway-related complications were numerically less frequent with PLMA, while most haemodynamic and ventilation measurements were comparable.

Insertion time was shorter with PLMA, and first-attempt placement was achieved in 90.0% of PLMA patients compared with 66.7% of KLTS patients. Smooth insertion was also more frequent with PLMA. Previous comparisons have produced varying results, possibly because of differences in operator experience, device generation and insertion technique. Cook and Cranshaw found small differences between PLMA and laryngeal tube performance during controlled ventilation⁵, while Gaitini et al. reported broadly comparable overall insertion success⁶. Klaver et al. evaluated both devices when used by inexperienced residents and observed

similar overall success, although device-specific placement problems differed.⁷ Kikuchi et al. reported more reliable placement with PLMA than with LTS II⁸. Additional manoeuvres were recorded more frequently during KLTS insertion. The KLTS depends upon alignment of both pharyngeal and oesophageal cuffs and its ventilation apertures with the laryngeal inlet. Repositioning may therefore be required when ventilation is inadequate. These data are descriptive because the source thesis did not report inferential comparisons for each manoeuvre.

PLMA generated a higher mean airway seal pressure than KLTS. The difference of 3 cmH₂O favoured PLMA and was statistically significant. Cook and Cranshaw similarly observed a higher seal pressure with PLMA, although the absolute difference in their study was small⁵. Zand et al. and Kikuchi et al. also reported more favourable sealing with PLMA^{8,9}, whereas Genzwuerker et al. found broadly comparable airway leak pressures¹⁰. Differences between studies may reflect device versions, cuff inflation, operator experience and methods used to measure leakage pressure.

Peak airway pressure was lower with PLMA at every recorded interval. This finding may reflect differences in the internal ventilation pathway: PLMA provides a relatively large airway tube, whereas the KLTS ventilates through smaller apertures. Cook and Cranshaw also described lower peak airway pressures with PLMA,⁵ and the findings are consistent with the later comparative study by Verma and Sharma¹².

Most haemodynamic values were comparable, but the statement that no between-group differences occurred at any time point would be inaccurate. Diastolic blood pressure differed at baseline, 5 minutes and 10 minutes. Because a baseline difference was already present, these

isolated measurements should be interpreted cautiously and should not be used to claim a consistent device-related haemodynamic effect. Oxygen saturation and end-tidal carbon dioxide remained satisfactory in both groups. Mucosal bleeding, sore throat, hoarseness and dysphagia occurred numerically more often after KLTS insertion. However, the study was not powered for uncommon complications, and the thesis did not report inferential p-values for these outcomes. The findings therefore indicate a descriptive trend rather than statistically established superiority in airway morbidity.

The study was strengthened by prospective data collection, random allocation, a standardised anaesthetic protocol and assessment of multiple insertion and ventilatory outcomes. Its limitations include the single-centre design, modest sample size, absence of operator blinding, restriction to ASA I–II adults undergoing short elective non-laparoscopic procedures and uncertainty in the source record regarding the precise numbers screened and randomised before the final 60-patient analysis. The results should not be generalised to difficult airways, emergency surgery, paediatric patients, morbid obesity or procedures requiring substantially higher airway pressures.

Conclusion

Both PLMA and KLTS maintained effective ventilation in the studied adult elective surgical population. PLMA demonstrated a shorter insertion time, a higher first-attempt success rate, smoother insertion, higher airway seal pressure and lower peak airway pressure. Most haemodynamic and ventilation variables were comparable, although isolated diastolic-pressure differences were observed. Airway-related complications were numerically less frequent with PLMA, but statistical superiority for these uncommon outcomes was not

established. Within the limits of this single-centre study, PLMA showed more favourable insertion and airway-dynamic characteristics than KLTS.

Acknowledgements

The authors acknowledge the Department of Anaesthesiology and Critical Care, Netaji Subhash Chandra Bose Subharti Medical College and Chhatrapati Shivaji Subharti Hospital, Meerut, and thank the participating patients.

Ethics Approval and Consent to Participate

The study was approved by the Institutional Ethics Committee of Netaji Subhash Chandra Bose Subharti Medical College and Chhatrapati Shivaji Subharti Hospital, Meerut.

Written informed consent was obtained before participation, and the study was conducted in accordance with the Declaration of Helsinki.

Data Availability

Study data are available from the corresponding author on reasonable request, subject to institutional and ethical requirements.

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