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(Research Article)

HEMODYNAMIC RESPONSES AFTER LARYNGEAL MASK AIRWAY OR ENDOTRACHEAL TUBE PLACEMENT IN SHORT ELECTIVE SURGERY: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Endotracheal tube (ETT) placement may provoke transient cardiovascular stimulation, whereas a laryngeal mask airway (LMA) avoids tracheal passage. Published comparisons remain procedure specific, and the magnitude of any immediate hemodynamic difference under routine anesthesia is uncertain.

Methods: This prospective, non-blinded two-group comparative study reanalysed complete individual-level data from 56 low-risk adults undergoing short elective surgery (LMA, n=26; ETT, n=30). Heart rate, systolic and diastolic blood pressure, and peripheral oxygen saturation were recorded before induction, after induction, immediately after airway placement, and at 3 and 5 minutes. The primary analytic contrast was the change from post-induction to immediate post-insertion. Change-score comparisons, participant fixed-effects trajectory models, and baseline-adjusted sensitivity models were used.

Results: The groups differed in sex distribution and in pre-induction heart rate and systolic blood pressure. From post-induction to immediate post-insertion, the LMA–ETT difference in change was −0.88 beats/min for heart rate (95% confidence interval [CI], −2.81 to 1.06; P=0.366), 2.98 mmHg for systolic blood pressure (95% CI, 0.31 to 5.65; P=0.030), and 1.01 mmHg for diastolic blood pressure (95% CI, −1.31 to 3.33; P=0.385). The systolic finding reflected a greater decrease in the ETT group. Serial device-by-time interactions were not significant for heart rate (P=0.055), systolic blood pressure (P=0.115), diastolic blood pressure (P=0.694), or oxygen saturation (P=0.312). At 0 minutes, adjusted

ETT−LMA differences were not significant for heart rate (2.13 beats/min; 95% CI, −0.19 to 4.44), systolic blood pressure (−1.04 mmHg; 95% CI, −4.70 to 2.61), or diastolic blood pressure (−0.53 mmHg; 95% CI, −2.86 to 1.80).

Conclusions: In this cohort, both devices-maintained oxygenation and no statistically significant adjusted immediate hemodynamic advantage of LMA over ETT was demonstrated. The results support a claim of superior peri-insertion hemodynamic stability with LMA in this setting.

Keywords: Laryngeal Mask Airway; Endotracheal Intubation; Hemodynamics; General Anesthesia; Perioperative Monitoring

1 INTRODUCTION

Airway instrumentation is a pivotal transition during general anesthesia. Direct laryngoscopy and tracheal passage can activate upper-airway and tracheal mechanoreceptors, producing a transient sympathetic response that may increase heart rate and arterial pressure. The response is not determined by the laryngoscope alone: anesthetic depth, opioid administration, the timing of measurement, and pharmacologic attenuation can materially alter the observed values. Recent randomized and synthesis studies of laryngoscopy and tracheal intubation therefore show that the physiologic signal is highly context dependent (1–5).

The laryngeal mask airway (LMA) is a supraglottic device that can establish ventilation without routine tracheal passage. In selected procedures, it may reduce mechanical airway stimulation and offer recovery-related advantages; however, direct comparisons with an endotracheal tube (ETT) have been performed across heterogeneous operations, devices, ventilation strategies, and patient populations. Contemporary studies include randomized, matched, observational, and meta-analytic evidence from elective short surgery, laparoscopic abdominal and gynecologic procedures, tracheal surgery, transesophageal echocardiography-guided interventions, and arthroplasty (6–15). Device choice cannot be reduced to an anticipated pressure or pulse response. Supraglottic airway performance is influenced by seal, ventilation requirement, and the applied positive end-expiratory pressure; postoperative pharyngolaryngeal outcomes and procedure-specific recovery considerations also differ across settings (16–18). A meaningful physiologic comparison must consequently distinguish absolute post-placement values from change within the same patient and must account for pre-instrumentation differences between groups.

This study evaluated heart rate, systolic blood pressure, diastolic blood pressure, and peripheral oxygen saturation around LMA or ETT placement in adults undergoing short elective surgery. The primary analytic objective for this report was to compare the within-patient change from the post-induction measurement to the immediate post-insertion measurement. Secondary objectives were to describe serial values through five minutes after placement and to determine whether any apparent immediate difference persisted after adjustment for post-induction values, age, and sex.

2 MATERIALS AND METHODS

2.1 Study design, setting, and ethics

This prospective, non-blinded two-group comparative study was conducted in the Department of Anaesthesiology at SRM Medical College Hospital and Research Centre, Potheri, Kattankulathur, Tamil Nadu, India. The Institutional Ethics Committee approved the study (SRMIEC-ST0723-819), and written informed consent was obtained before participation. The report is presented as a comparative observational analysis because the available study documentation did not permit verification of an independently randomized and blinded analytic framework.

The protocol target was 60 participants, with 30 planned in each airway group. The supplied source workbook contained complete serial observations for 56 participants and was used as the complete-case analytic dataset: 26 in the LMA group and 30 in the ETT group. Four planned records were not available as complete individual-level data. No values were reconstructed and no imputation was performed.

2.2 Participants and perioperative management

Adults aged 18–60 years with American Society of Anesthesiologists physical status I or II who were scheduled for an elective procedure expected to last less than 60 minutes under general anesthesia were eligible. The protocol specified Mallampati class I or II airways. Patients with an anticipated difficult airway, full stomach, morbid obesity, relevant cardiovascular disease, or a contraindication to the proposed airway technique were excluded. Airway group was defined by the device used for the procedure. Because selection or allocation was not fully auditable in the supplied records, device group may have reflected clinical and procedural factors.

Participants fasted before anesthesia and received a common induction approach comprising intravenous midazolam and fentanyl, preoxygenation with 100% oxygen for three minutes, propofol (2 mg/kg), and atracurium (0.5 mg/kg). In the ETT group, a cuffed tube was inserted using direct laryngoscopy; the protocol specified 7.0-mm internal diameter tubes for women and 8.0-mm tubes for men. LMA size was selected according to clinical requirements. Correct placement was assessed clinically and by capnography. Anesthesia was maintained with oxygen/nitrous oxide and a volatile agent according to routine practice.

2.3 Outcomes and data collection

Heart rate, systolic blood pressure, diastolic blood pressure, and peripheral oxygen saturation were recorded before induction (baseline), after induction but before airway instrumentation, immediately after successful airway placement (0 minutes), and at 3 and 5 minutes after placement. Standard electrocardiography, non-invasive blood pressure monitoring, and pulse oximetry were used. The primary analytic endpoint was the between-group difference in change from post-induction to 0 minutes for heart rate. Corresponding changes in the other three variables and serial trajectories were secondary outcomes.

The supplied dataset did not contain device insertion duration, number of attempts, end-tidal anesthetic concentration, end-tidal carbon dioxide, vasoactive treatment, detailed procedure category for covariate adjustment, or systematically coded postoperative airway complications. These outcomes were not reconstructed or treated as comparative endpoints.

2.4 Statistical analysis

Analyses used the individual-level complete-case dataset. Continuous data are reported as mean ± standard deviation and categorical data as count (percentage). Age and unadjusted between-group values were compared with Welch two-sample t tests; sex distribution was assessed using a chi-square test. For each variable, the immediate change was calculated as the 0-minute value minus the post-induction value, then compared between groups using Welch two-sample t tests. Mean differences are reported with 95% confidence intervals and Hedges g. To account for repeated observations, participant fixed-effects linear models included time, airway group-by-time interaction terms, and a unique intercept for each participant, with post-induction as the time reference. The global group-by-time interaction assessed whether serial trajectories differed by airway group. As a sensitivity analysis, linear models estimated the adjusted group difference at 0 minutes after inclusion of the post-induction value, age, and sex. Tests were two-sided with nominal alpha=0.05. Secondary analyses were interpreted cautiously because of the modest sample size and multiple time-point comparisons.

3 RESULTS

3.1 Analysis population and baseline profile

The complete-case analysis included 56 participants: 26 managed with an LMA and 30 with an ETT. Mean age was 38.65 ± 14.62 years in the LMA group and 43.00 ± 10.78 years in the ETT group (P=0.218). Sex distribution differed substantially: 23 of 26 LMA recipients were women (88.5%), compared with 14 of 30 ETT recipients (46.7%; P=0.003). Before induction, the ETT group had higher mean heart rate and systolic blood pressure than the LMA group, whereas baseline diastolic blood pressure and oxygen saturation were similar (Table 1).

Table 1: Participant characteristics and pre-induction observations

Characteristic	LMA (n=26)	ETT (n=30)	P value
Age, years	38.65 ± 14.62	43.00 ± 10.78	0.218
Female sex, n (%)	23 (88.5)	14 (46.7)	0.003
Male sex, n (%)	3 (11.5)	16 (53.3)	-
Heart rate, beats/min	72.54 ± 2.47	77.53 ± 7.07	0.001
Systolic blood pressure, mmHg	119.35 ± 4.42	124.10 ± 11.89	0.049
Diastolic blood pressure, mmHg	77.38 ± 6.16	78.27 ± 7.30	0.626
Peripheral oxygen saturation, %	99.38 ± 0.85	99.00 ± 0.91	0.108

Values are mean ± standard deviation unless otherwise stated. P values are from Welch two-sample t tests for continuous variables and the chi-square test for sex distribution. Baseline refers to the pre-induction observation.

3.2 Immediate post-insertion change

At the post-induction measurement, mean heart rate was 73.65 ± 2.42 beats/min in the LMA group and 76.37 ± 5.50 beats/min in the ETT group. At 0 minutes, corresponding means were 72.58 ± 2.30 and 76.17 ± 5.11 beats/min. Heart rate changed by −1.08 beats/min after LMA placement and by −0.20 beats/min after ETT placement. The LMA–ETT difference in change was −0.88 beats/min (95% confidence interval [CI], −2.81 to 1.06; P=0.366; Hedges g=−0.23), providing no evidence of a material acute between-group difference.

Systolic blood pressure changed by −0.15 mmHg in the LMA group and by −3.13 mmHg in the ETT group from post-induction to 0 minutes. The LMA–ETT difference in change was 2.98 mmHg (95% CI, 0.31 to 5.65; P=0.030; Hedges g=0.58). This direction indicates a greater short-term decrease in the ETT group rather than a pressor response after ETT insertion. Diastolic blood pressure changed by −1.15 mmHg after LMA placement and by −2.17 mmHg after ETT placement; the between-group difference was 1.01 mmHg (95% CI, −1.31 to 3.33; P=0.385). Oxygen saturation increased slightly in both groups, with no significant difference in change (−0.25 percentage points; 95% CI, −0.68 to 0.17; P=0.233) (Table 3).

Table 2: Change from post-induction to immediate post-insertion measurement (primary analytic contrast)

Outcome	LMA mean change	ETT mean change	LMA–ETT difference (95% CI)	P value	Hedges g
Heart rate, beats/min	−1.08	−0.20	−0.88 (−2.81 to 1.06)	0.366	−0.23
Systolic BP, mmHg	−0.15	−3.13	2.98 (0.31 to 5.65)	0.030	0.58
Diastolic BP, mmHg	−1.15	−2.17	1.01 (−1.31 to 3.33)	0.385	0.23
Peripheral oxygen saturation, percentage points	0.35	0.60	−0.25 (−0.68 to 0.17)	0.233	−0.31

Change was calculated as the 0-minute value minus the post-induction value for each participant. A positive LMA–ETT difference indicates a larger increase (or smaller decrease) in the LMA group. CI, confidence interval; BP, blood pressure.

3.3 Serial trajectory and adjusted analysis

Serial unadjusted observations are shown in Table 2. Mean heart rate, systolic blood pressure, and diastolic blood pressure generally decreased rather than exhibiting an acute surge in either group over the five-minute observation period. In participant fixed-effects models, the global airway group-by-time interaction was not statistically significant for heart rate (P=0.055), systolic blood pressure (P=0.115), diastolic blood pressure (P=0.694), or oxygen saturation (P=0.312).

Table 3: Serial physiological observations by airway group

Outcome	Time point	LMA (n=26)	ETT (n=30)	P value
Heart rate, beats/min	Baseline	72.54 ± 2.47	77.53 ± 7.07	0.001
	Post-induction	73.65 ± 2.42	76.37 ± 5.50	0.019
	0 min	72.58 ± 2.30	76.17 ± 5.11	0.001
	3 min	71.62 ± 1.68	73.97 ± 5.24	0.026
	5 min	71.42 ± 2.27	72.93 ± 4.33	0.103
Systolic BP, mmHg	Baseline	119.35 ± 4.42	124.10 ± 11.89	0.049
	Post-induction	120.27 ± 4.07	125.17 ± 6.01	0.001
	0 min	120.12 ± 4.65	122.03 ± 7.26	0.239
	3 min	119.42 ± 5.19	120.47 ± 7.33	0.538
	5 min	118.04 ± 4.30	118.67 ± 6.35	0.663
Diastolic BP, mmHg	Baseline	77.38 ± 6.16	78.27 ± 7.30	0.626
	Post-induction	77.38 ± 4.88	78.33 ± 5.86	0.511
	0 min	76.23 ± 4.34	76.17 ± 4.86	0.959

	3 min	75.31 ± 4.02	74.57 ± 5.02	0.542
	5 min	74.27 ± 5.00	73.53 ± 5.28	0.595
SpO_2, %	Baseline	99.38 ± 0.85	99.00 ± 0.91	0.108
	Post-induction	99.62 ± 0.64	99.23 ± 0.90	0.069
	0 min	99.96 ± 0.20	99.83 ± 0.46	0.174
	3 min	100.00 ± 0.00	99.93 ± 0.37	0.326
	5 min	100.00 ± 0.00	99.93 ± 0.37	0.326

Values are mean ± standard deviation. P values are unadjusted between-group comparisons at each time point using Welch two-sample t tests. BP, blood pressure; ETT, endotracheal tube; LMA, laryngeal mask airway.

The baseline-adjusted sensitivity analysis at 0 minutes yielded the same overall interpretation. Adjusted ETT–LMA differences were 2.13 beats/min for heart rate (95% CI, −0.19 to 4.44; P=0.071), −1.04 mmHg for systolic blood pressure (95% CI, −4.70 to 2.61; P=0.569), and −0.53 mmHg for diastolic blood pressure (95% CI, −2.86 to 1.80; P=0.651) (Table 4).

Table 4: Baseline-adjusted sensitivity analysis at the immediate post-insertion measurement

Outcome	Adjusted ETT–LMA estimate	95% confidence interval	P value
Heart rate, beats/min	2.13	−0.19 to 4.44	0.071
Systolic BP, mmHg	−1.04	−4.70 to 2.61	0.569
Diastolic BP, mmHg	−0.53	−2.86 to 1.80	0.651

Linear models included the post-induction value of the respective outcome, age, sex, and airway group. A positive estimate indicates a higher adjusted value in the ETT group. BP, blood pressure.

4 DISCUSSION

4.1 Principal findings

In this complete-case analysis of low-risk adults undergoing short elective surgery, the observed data did not demonstrate an immediate adjusted hemodynamic advantage of LMA placement over ETT placement. Both groups had small decreases, rather than a measured tachycardic or hypertensive surge, after airway placement. Although the unadjusted systolic blood-pressure change differed between groups, the ETT group showed the larger decrease, and the difference was not retained in the adjusted analysis. Oxygenation was preserved in both groups.

This conclusion is more conservative than one based on post-placement mean values alone. The ETT group began with higher heart rate and systolic blood pressure, and the groups had a marked sex imbalance. Accordingly, an absolute value after insertion could represent pre-existing case-mix differences rather than a physiologic device effect. Within-patient change and baseline-adjusted estimates better address the present clinical question, although neither approach can remove unmeasured confounding in a non-blinded comparative dataset.

4.2 Interpretation in the context of recent evidence

The absence of a captured pressor response after ETT placement should not be interpreted as evidence that direct laryngoscopy is non-stimulating. Opioid, hypnotic, and neuromuscular-blocking agents may blunt the response, and non-invasive pressure measurements at scheduled intervals can miss a transient peak occurring in the seconds after instrumentation. Comparative reports in septoplasty, thyroid surgery, transsphenoidal pituitary surgery, thoracoscopic surgery, and craniotomy similarly illustrate that airway-device outcomes depend on the surgical setting, outcome timing, and recovery endpoint rather than on a single device label (17–21).

The broader literature should also not be generalized uncritically to this adult cohort. Pediatric, neonatal, dental, and adenotonsillectomy studies address different airway anatomy, aspiration profiles, ventilation requirements, and clinical endpoints. Their findings may inform the breadth of device use but cannot establish adult peri-insertion hemodynamic superiority (22–30). In the present population, the data support only that no material differential immediate response was detected under the documented anesthetic conditions and observation schedule.

4.3 Clinical implications

An LMA should not be chosen solely to seek a presumed lower pulse or pressure response. Airway planning must continue to prioritize aspiration risk, predicted ventilation and intubation difficulty, patient physiology, surgical access, position, and a clear rescue strategy. Contemporary airway recommendations consistently emphasize structured assessment, immediate availability of appropriate equipment, confirmation of tracheal placement, and a planned escalation pathway (31–36). These priorities are particularly important when a brief physiologic advantage, if any, is unlikely to outweigh the need for a definitive tracheal tube.

The role of supraglottic devices is also broader than routine elective ventilation. Recent work describes their use as conduits for flexible bronchoscopic intubation and examines video-enabled or intubating supraglottic devices in simulated difficult-airway contexts (37–40). Those applications reinforce a practical distinction: the physiologic response observed after placement is only one component of airway-device selection.

4.4 Strengths and limitations

A strength of this report is the use of participant-level serial data rather than reliance on group summary values. The analysis explicitly compared within-patient change, reported confidence intervals and standardized effect sizes, and used repeated-measures and baseline-adjusted sensitivity analyses. These choices make the uncertainty around the estimated device effect visible.

Several limitations require emphasis. Only 56 complete records were available despite a protocol target of 60, and the reason for the four unavailable records could not be recovered. The groups were unblinded and differed markedly in sex distribution, creating a risk of confounding by procedure type and device selection. The source data did not contain body mass index, airway grade, detailed procedure category for adjustment, insertion attempts, time to secure the airway, end-tidal anesthetic concentration, end-tidal carbon dioxide, vasoactive drug use, or postoperative airway outcomes. Finally, scheduled non-invasive measurements may not capture the brief maximal sympathetic response. The study cannot establish device equivalence, prove absence of a stress response, or support a causal claim of LMA superiority.

4.5 Future research

A definitive comparison should use a prospectively specified allocation method or a carefully designed causal observational framework, with balance or stratification by procedure type and patient characteristics. The measurement protocol should capture the peri-instrumentation peak at approximately 15, 30, 60, 120, and 300 seconds, and record insertion attempts, laryngoscopy duration, depth of anesthesia, end-tidal carbon dioxide, vasoactive treatment, airway complications, and postoperative throat symptoms. Continuous electrocardiography and, where clinically appropriate, beat-to-beat arterial pressure monitoring would improve physiologic resolution.

5 CONCLUSION

Among 56 analyzable low-risk adults undergoing short elective surgery, LMA and ETT placement both preserved oxygenation and showed no statistically significant adjusted difference in immediate heart rate, systolic blood pressure, or diastolic blood pressure. The available data do not support a claim that LMA offers superior peri-insertion hemodynamic stability in this cohort. Future comparative trials should combine higher-resolution monitoring with prespecified airway rescue and escalation plans consistent with contemporary airway guidance (31–36).

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no competing interests.

Statement of ethical approval

The Institutional Ethics Committee of SRM Medical College Hospital and Research Centre approved the study (SRMIEC-ST0723-819).

Statement of informed consent

Written informed consent was obtained from all participants before enrolment.

Data availability

No data will be available post-publication. The source worksheet contains direct identifiers, and the study did not generate a de-identified dataset that can be shared.

Author contributions

Getsyal Lionel: conceptualization, investigation, data curation, project administration, and correspondence. Anusha Jaganathan: methodology and data curation. Mohamed Azarudeen Mushthakali: writing—original draft, review, and editing. All authors approved the final manuscript.

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