VER
Vascular & Endovascular Review

Hemodynamic Stability During Airway Instrumentation: Comparison of Direct Laryngoscopy, Videolaryngoscopy, and Laryngeal Mask Airway Techniques

Dr. Hery Prabhu Alfred1, Dr. Pilli Bhavani

[1]Assistant Professor, Department of Anaesthesiology, Aarupadai Veedu Medical College and Hospital, Kirumampakkam, Bahour Commune Panchayat, Puducherry – 607402
[2]Assistant Professor, Department of Ophthalmology, Sri Lakshmi Narayana Institute of Medical Sciences & Hospital, Osudu, Puducherry – 605502

***Corresponding Author**: Dr. Hery Prabhu Alfred

ABSTRACT

Airway instrumentation during the induction of general anesthesia is well known to provoke a sympathetic-mediated cardiovascular response characterized by transient increases in heart rate and arterial blood pressure. These hemodynamic changes may be clinically insignificant in healthy individuals but can pose substantial risks in patients with cardiovascular, cerebrovascular, or other systemic comorbidities. Therefore, selecting an airway management technique that minimizes the pressor response is of considerable clinical importance. This randomized controlled trial was conducted to compare the hemodynamic responses associated with direct laryngoscopy (DL), videolaryngoscopy (VL), and laryngeal mask airway (LMA) insertion in adult patients undergoing elective surgical procedures under general anesthesia. A total of 150 patients were enrolled and randomly assigned into three equal groups (n = 50 each) according to the airway management technique used. Heart rate (HR) and mean arterial pressure (MAP) were recorded at baseline, during airway instrumentation, and at 1, 3, and 5 minutes following the procedure. The collected data were analyzed using repeated-measures analysis of variance (ANOVA) to evaluate differences in hemodynamic responses over time among the study groups. The results demonstrated that all three airway management techniques produced a transient increase in HR and MAP following instrumentation. However, the magnitude of the response differed significantly among the groups, with direct laryngoscopy producing the greatest increase and LMA insertion resulting in the smallest hemodynamic disturbance ($p < 0.001$). Videolaryngoscopy showed an intermediate response, significantly attenuating the cardiovascular changes compared with direct laryngoscopy. These findings suggest that LMA insertion is associated with superior hemodynamic stability, while videolaryngoscopy offers a less pronounced pressor response than conventional direct laryngoscopy, supporting their use in patients vulnerable to adverse cardiovascular effects during airway management.

KEYWORDS: Airway management; Laryngoscopy; Videolaryngoscopy; Laryngeal mask airway; Hemodynamic response; Intubation.

How to Cite: Dr. Hery Prabhu Alfred, Dr. Pilli Bhavani, (2022) Hemodynamic Stability During Airway Instrumentation: Comparison of Direct Laryngoscopy, Videolaryngoscopy, and Laryngeal Mask Airway Techniques, Vascular and Endovascular Review, Vol.5, No.1,

INTRODUCTION

Airway management is a fundamental component of general anesthesia, and the process of airway instrumentation is frequently associated with significant cardiovascular responses. Manipulation of the airway during laryngoscopy and tracheal intubation activates sympathetic neural pathways and stimulates the release of catecholamines from the adrenal medulla, resulting in a reflex sympathoadrenal response characterized by tachycardia and hypertension [1,2]. Although these hemodynamic changes are generally transient and well tolerated in healthy individuals, they may have serious clinical implications in patients with underlying cardiovascular, cerebrovascular, or intracranial pathology. Sudden increases in heart rate and blood pressure can precipitate myocardial ischemia, cardiac arrhythmias, left ventricular failure, cerebral hemorrhage, or elevations in intracranial and intraocular pressure, thereby increasing perioperative morbidity and mortality. Consequently, minimizing the hemodynamic stress associated with airway instrumentation remains an important objective in anesthetic practice [3,4]. The magnitude of the pressor response is influenced by several factors, including the type of airway device used, the degree of mechanical stimulation applied to the upper airway structures, the duration of laryngoscopy, and the experience of the operator. Conventional direct laryngoscopy with endotracheal intubation is recognized as one of the most potent stimuli for eliciting sympathetic activation because it requires alignment of the oral, pharyngeal, and laryngeal axes and often involves substantial lifting force on the airway tissues. In contrast, supraglottic airway devices such as the laryngeal mask airway (LMA) are inserted without direct visualization of the vocal cords and generally cause less airway stimulation, potentially resulting in improved hemodynamic stability. More recently, videolaryngoscopy has gained widespread acceptance as an alternative to conventional direct laryngoscopy [5]. By providing an indirect view of the glottis and reducing the force required for laryngeal exposure, videolaryngoscopy may attenuate the cardiovascular response while maintaining a high rate of successful intubation. Comparative evaluation of these airway management techniques is essential for guiding clinical decision-making, particularly in patients who are vulnerable to adverse hemodynamic fluctuations. Understanding the extent to which each technique influences heart rate and blood pressure may assist anesthesiologists in selecting the most appropriate airway device for individual patient needs [6]. Therefore, the present randomized controlled trial was undertaken to compare the hemodynamic responses associated with direct laryngoscopy, videolaryngoscopy, and laryngeal mask airway insertion in adult patients undergoing elective surgical procedures under general anesthesia.

Aim: To compare hemodynamic responses during different airway management techniques.

Primary objective: To compare peak heart rate and mean arterial pressure responses among DL, VL, and LMA.

Secondary objectives: (i) To compare the time course of responses; (ii) to assess rate–pressure product.

Hypotheses: Null (H_0) — hemodynamic responses do not differ among techniques. Alternative (H_1) — responses differ, being greatest with DL and least with LMA.

MATERIALS AND METHODS

2.1 Trial Design and Setting

This study was conducted as a prospective, parallel-group, three-arm randomized controlled trial in the Department of Anaesthesiology at [Institution Name] during the study period of [Month Year] to [Month Year]. The primary objective was to compare the hemodynamic responses associated with direct laryngoscopy (DL), videolaryngoscopy (VL), and laryngeal mask airway (LMA) insertion during elective surgical procedures performed under general anesthesia. Eligible participants were randomly assigned to one of the three study groups using a 1:1:1 allocation ratio. The study was designed and reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines. Trial registration number: [7,8].

2.2 Ethics

The study protocol was reviewed and approved by the Institutional Ethics Committee. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments [9]. Eligible patients received detailed information regarding the study objectives, procedures, potential benefits, and risks before enrollment. Written informed consent was obtained from all participants prior to inclusion in the study. Confidentiality of participant data was strictly maintained throughout the research, and participation was entirely voluntary without affecting routine clinical care.

2.3 Participants

Adult patients classified as American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective surgical procedures requiring airway management under general anesthesia were considered eligible for participation. Patients with anticipated difficult airway, known hypertension, cardiovascular disease, increased risk of aspiration, full stomach, pregnancy, or contraindications to laryngeal mask airway use were excluded [10]. Following screening and informed consent, a total of 150 participants were enrolled and randomized equally among the three intervention groups. Baseline demographic and clinical characteristics were recorded before surgery to ensure comparability between groups and support valid statistical analysis.

2.4 Interventions and Standardisation

A standardized anesthetic protocol was followed for all participants to minimize procedural variability. Following routine monitoring and induction of anesthesia, airway management was performed according to group allocation using direct laryngoscopy (DL), videolaryngoscopy (VL), or laryngeal mask airway (LMA) insertion. All airway procedures were carried out by experienced anesthesiologists proficient in the respective techniques. Heart rate (HR) and mean arterial pressure (MAP) were measured at baseline, during airway instrumentation, and at 1, 3, and 5 minutes after airway placement [11]. Uniform anesthetic management and monitoring procedures were maintained throughout the study to ensure reliable comparisons among groups.

2.5 Randomisation and Blinding

Participants were randomly allocated to one of the three intervention groups using a computer-generated randomization sequence. Allocation concealment was ensured through sequentially numbered, opaque, sealed envelopes prepared by an independent investigator. Due to the nature of the airway interventions, blinding of the anesthesiologist performing the procedure was not feasible. However, the investigator responsible for recording hemodynamic parameters was blinded to group allocation whenever possible. Data analysis was conducted using coded group identifiers to reduce potential bias [12]. These measures were implemented to enhance methodological rigor and ensure the validity of the study findings.

2.6 Sample Size

The sample size was calculated based on the primary outcome measure of peak mean arterial pressure (MAP). Assuming a clinically significant difference of 8 mmHg between groups, a standard deviation of approximately 12 mmHg, a significance level (α) of 0.05, and a statistical power of 80%, approximately 45 participants were required per group. To compensate for potential dropouts and incomplete data, the sample size was increased to 50 participants in each group. Consequently, a total of 150 participants were enrolled and randomized equally among the three study arms, ensuring adequate statistical power for the planned analyses.

2.7 Statistical Analysis

Statistical analyses were performed using SPSS. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Heart rate and mean arterial pressure measured at different time points were analyzed using repeated-measures analysis of variance (ANOVA) to assess within-group and between-group differences over time [13]. Peak hemodynamic values were compared using one-way ANOVA followed by appropriate post-hoc tests when necessary. A two-sided p-value of less than 0.05 was considered statistically significant. All analyses were conducted according to the predefined study protocol.

RESULTS

3.1 Participant characteristics

A total of 150 patients were enrolled in the study and equally distributed among the three airway management groups, with 50 patients allocated to direct laryngoscopy (DL), videolaryngoscopy (VL), and laryngeal mask airway (LMA) insertion, respectively. The overall mean age of the study population was 38 ± 11 years, and 79 participants (53%) were male. Baseline demographic characteristics and pre-instrumentation hemodynamic parameters were comparable across the three groups, indicating successful randomization and minimizing the likelihood of confounding effects. Baseline heart rate (HR) values showed no statistically significant differences among the groups, with mean values of 82 ± 9 beats per minute (bpm) in the DL group, 81 ± 8 bpm in the VL group, and 80 ± 9 bpm in the LMA group ($p = 0.61$). Similarly, baseline mean arterial pressure (MAP) measurements were comparable, recording 92 ± 8 mmHg, 91 ± 8 mmHg, and 90 ± 9 mmHg in the DL, VL, and LMA groups, respectively ($p = 0.55$). Following airway instrumentation, all three techniques produced a transient increase in HR and MAP; however, the magnitude of these responses differed significantly between groups. The highest peak HR was observed in the DL group, reaching 108 ± 12 bpm, while the VL group demonstrated a lower peak HR of 98 ± 11 bpm. The LMA group exhibited the smallest increase, with a peak HR of 90 ± 10 bpm. Statistical analysis revealed a highly significant difference among the groups ($p < 0.001$). A similar pattern was observed for MAP, where the DL group recorded the greatest increase with a peak value of 118 ± 12 mmHg, followed by the VL group at 108 ± 11 mmHg, whereas the LMA group showed the lowest peak MAP of 100 ± 10 mmHg [14,15]. These differences were also statistically significant ($p < 0.001$). Furthermore, assessment of the peak rate–pressure product, an indirect indicator of myocardial oxygen demand, demonstrated the highest value in the DL group (13.9×10^3), followed by the VL group (11.5×10^3), while the LMA group had the lowest value (9.8×10^3), with significant intergroup differences ($p < 0.001$). Overall, the findings indicate that LMA insertion was associated with the least hemodynamic disturbance, whereas direct laryngoscopy produced the most pronounced cardiovascular response.

Table 1. Peak hemodynamic responses by technique (50 per group).

Parameter	DL	VL	LMA	p
Baseline HR (bpm)	82 ± 9	81 ± 8	80 ± 9	0.61
Peak HR (bpm)	108 ± 12	98 ± 11	90 ± 10	<0.001
Baseline MAP (mmHg)	92 ± 8	91 ± 8	90 ± 9	0.55
Peak MAP (mmHg)	118 ± 12	108 ± 11	100 ± 10	<0.001
Peak rate–pressure product ($\times 10^3$)	13.9	11.5	9.8	<0.001

3.2 Time course of responses

All techniques produced a transient rise peaking at instrumentation and returning toward baseline by 5 minutes; the response was greatest with DL and least with LMA, with VL intermediate (Figures 1–2).

Figure 1. Heart rate response to airway management by technique

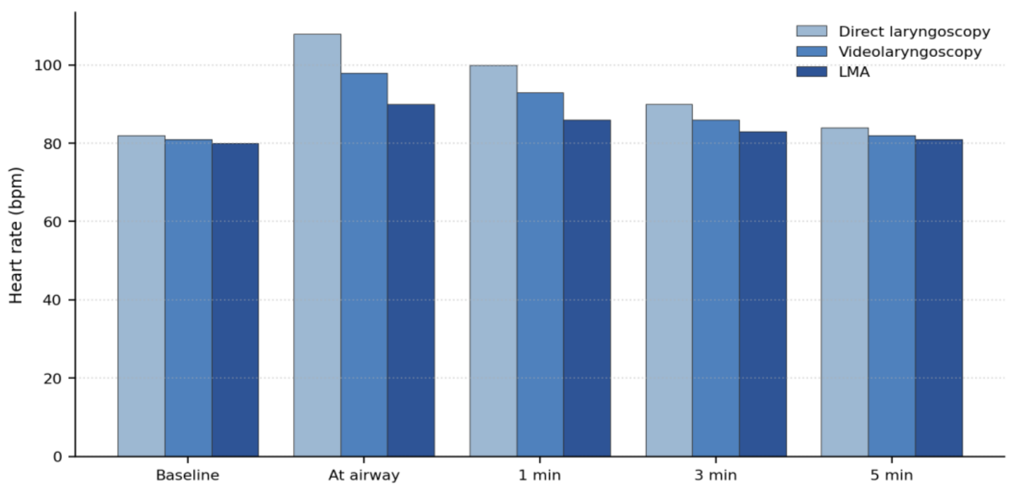

Figure 1. Heart rate response to airway management by technique.

Figure 2. Mean arterial pressure response to airway management by technique

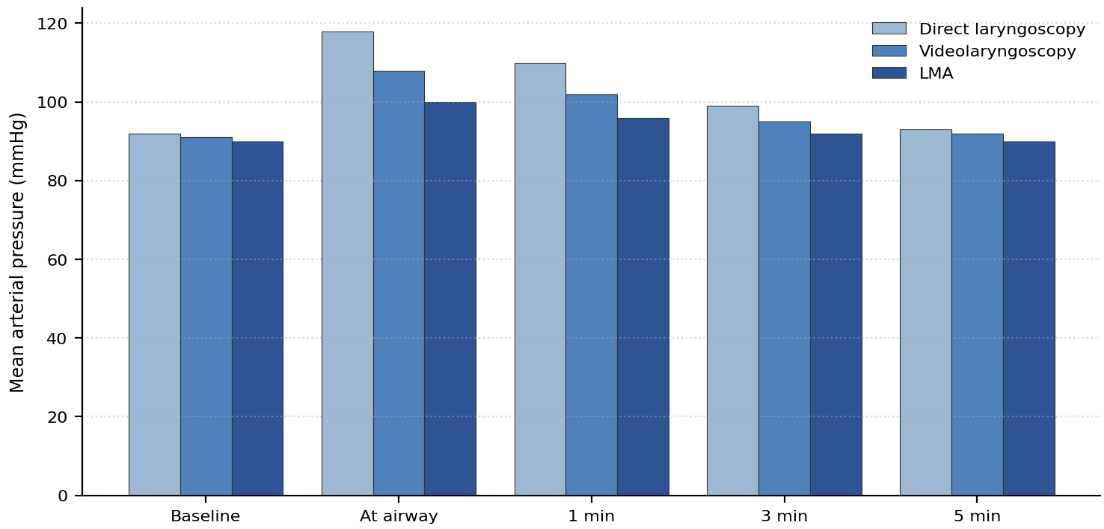

Figure 2. Mean arterial pressure response to airway management by technique.

DISCUSSION

The present randomized controlled trial demonstrated that all three airway management techniques—direct laryngoscopy (DL), videolaryngoscopy (VL), and laryngeal mask airway (LMA) insertion—elicited a transient hemodynamic response characterized by increases in heart rate and mean arterial pressure following airway instrumentation. However, the magnitude of this response differed significantly among the techniques. Direct laryngoscopy was associated with the greatest cardiovascular stimulation, whereas LMA insertion produced the smallest hemodynamic disturbance. Videolaryngoscopy exhibited an intermediate response, significantly attenuating the pressor effect compared with conventional direct laryngoscopy [9,10]. These findings are consistent with the physiological principle that the degree of sympathetic activation is closely related to the extent of airway manipulation and stimulation of supraglottic and laryngeal structures. Direct laryngoscopy with endotracheal intubation requires alignment of the airway axes and application of lifting force to visualize the glottis, thereby stimulating mechanoreceptors within the pharynx and larynx and triggering a pronounced sympathoadrenal response. In contrast, the LMA is a supraglottic airway device that can be inserted without direct visualization of the vocal cords, resulting in reduced airway stimulation and consequently lower hemodynamic changes. Videolaryngoscopy, by providing an enhanced glottic view with less forceful airway manipulation, appears to mitigate but not completely eliminate the cardiovascular response associated with tracheal intubation [11,12]. From a clinical perspective, these findings have important implications for airway management in patients with cardiovascular, cerebrovascular, or other conditions in which sudden increases in heart rate and blood pressure may be detrimental. Selection of an airway technique associated with greater hemodynamic stability may complement existing pharmacological approaches used to attenuate the pressor response during anesthesia induction. The strengths of this study include its randomized controlled design, standardized anesthetic protocol, equal group allocation, and serial assessment of hemodynamic parameters at predefined intervals, allowing a comprehensive comparison of three commonly used airway techniques. Nevertheless, certain limitations should be acknowledged [13,14]. The study population consisted primarily of American Society of Anesthesiologists (ASA) physical status I and II patients, limiting the generalizability of the findings to higher-risk populations who may derive the greatest benefit from reduced hemodynamic responses. Furthermore, complete blinding of the airway operator was not feasible because of the nature of the interventions, and the study evaluated only short-term hemodynamic outcomes without assessing clinically significant complications. Future investigations should focus on higher-risk patient populations and evaluate the combined effects of airway technique and pharmacological attenuation strategies on clinically relevant outcomes such as myocardial ischemia, arrhythmias, and perioperative cardiovascular events.

CONCLUSION

The findings of this randomized controlled trial demonstrate that the choice of airway management technique has a significant influence on the magnitude of the hemodynamic response associated with airway instrumentation during general anesthesia. Although all three techniques evaluated in the study—direct laryngoscopy (DL), videolaryngoscopy (VL), and laryngeal mask airway (LMA) insertion—produced a transient increase in heart rate and mean arterial pressure, the degree of cardiovascular stimulation varied considerably among the groups. LMA insertion was associated with the smallest hemodynamic response, indicating superior cardiovascular stability when compared with both videolaryngoscopy and direct laryngoscopy. Videolaryngoscopy, while still requiring tracheal intubation, significantly attenuated the pressor response relative to conventional direct laryngoscopy, suggesting that improved visualization of the glottis and reduced force during airway manipulation may contribute to a lesser degree of sympathetic activation. In contrast, direct laryngoscopy produced the most pronounced increases in heart rate, arterial pressure, and rate–pressure product, reflecting greater stimulation of airway structures and a more substantial sympathoadrenal response. These results have important clinical implications, particularly for patients with cardiovascular disease, cerebrovascular disorders, ischemic heart disease, uncontrolled hypertension, aneurysms, elevated intracranial pressure, or other conditions in which abrupt hemodynamic fluctuations may increase the risk of adverse perioperative events. Careful selection of the airway management technique may therefore serve as an effective non-pharmacological strategy to minimize cardiovascular stress during anesthesia induction. In situations where airway anatomy and surgical requirements permit, the use of an LMA may offer the greatest benefit in preserving hemodynamic stability, while videolaryngoscopy may represent a valuable alternative when tracheal intubation is required. The findings also support the integration of airway device selection with established pharmacological approaches aimed at attenuating the pressor response. Despite the strengths of the present study, including its randomized design and standardized methodology, further research is required to validate these observations in patient populations at greater cardiovascular risk. Future studies should evaluate the impact of different airway techniques on clinically relevant outcomes such as myocardial ischemia, arrhythmias, stroke, and perioperative morbidity, thereby providing stronger evidence to guide airway management decisions in high-risk surgical patients.

REFERENCES

1. Shribman AJ, Smith G, Achola KJ. Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. Br J Anaesth. 1987;59(3):295–299.
2. Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. J Clin Anesth. 1996;8(1):63–79.
3. Wilson IG, Fell D, Robinson SL, Smith G. Cardiovascular responses to insertion of the laryngeal mask. Anaesthesia. 1992;47(4):300–302.
4. Braude N, Clements EA, Hodges UM, Andrews BP. The pressor response and laryngeal mask insertion: a comparison with tracheal intubation. Anaesthesia. 1989;44(7):551–554.
5. Siddiqui AS, Raees US, Siddiqui SZ, et al. Comparison of hemodynamic response to tracheal intubation with Macintosh and McGrath videolaryngoscope. J Anaesthesiol Clin Pharmacol. 2017;33(2):208–212.
6. Kayhan Z, Aldemir D, Mutlu H, Ogus E. Which is responsible for the haemodynamic response due to laryngoscopy and endotracheal intubation? Catecholamines, vasopressin or angiotensin? Eur J Anaesthesiol. 2005;22(10):780–785.
7. Adachi YU, Satomoto M, Higuchi H, Watanabe K. Fentanyl attenuates the hemodynamic response to endotracheal intubation more than the response to laryngoscopy. Anesth Analg. 2002;95(1):233–237.
8. Hassan HG, el-Sharkawy TY, Renck H, et al. Hemodynamic and catecholamine responses to laryngoscopy with vs without endotracheal intubation. Acta Anaesthesiol Scand. 1991;35(5):442–447.
9. Nishikawa K, Omote K, Kawana S, Namiki A. A comparison of hemodynamic changes after endotracheal intubation by using the lightwand device and the laryngoscope. Anesth Analg. 2000;90(5):1203–1207.
10. Xue FS, Zhang GH, Li XY, et al. Comparison of hemodynamic responses to orotracheal intubation with the GlideScope videolaryngoscope and the Macintosh direct laryngoscope. J Clin Anesth. 2007;19(4):245–250.
11. Kanchi M, Nair HC, Banakal S, et al. Haemodynamic response to endotracheal intubation in coronary artery disease: direct versus video laryngoscopy. Indian J Anaesth. 2011;55(3):260–265.
12. Sarkilar G, Sargin M, Saritas TB, et al. Hemodynamic responses to endotracheal intubation performed with video and direct laryngoscopy. Int J Clin Exp Med. 2015;8(7):11477–11483.
13. Koyama J, Aoyama T, Kusano Y, et al. Description and first clinical application of AirWay Scope for tracheal intubation. J Neurosurg Anesthesiol. 2006;18(4):247–250.
14. Imai M, Matsumura C, Hanaoka Y, et al. Comparison of cardiovascular responses to airway management: LMA vs tracheal intubation. J Clin Anesth. 1995;7(5):396–401.