e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(1); 1719-1727

Original Research Article

Comparative Evaluation of Video Laryngoscope and Direct Laryngoscope for Tracheal Intubation in Adult Patients: A Prospective Randomized Study

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Received: 01-10-2025 Revised: 15-11-2025 / Accepted: 21-12-2025

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Conflict of interest: Nil

Abstract

Background: Video laryngoscopy has improved airway management by enhancing glottic visualization and facilitating tracheal intubation. However, its clinical advantages over conventional direct laryngoscopy remain under evaluation.

Aim: To compare the effectiveness of video laryngoscopy and direct laryngoscopy for tracheal intubation in adult patients undergoing elective surgery under general anesthesia.

Materials and Methods: This prospective randomized study included 150 adult patients (ASA I–II) undergoing elective surgery requiring endotracheal intubation. Patients were randomly allocated into two groups: Video Laryngoscope (VL, n=75) and Direct Laryngoscope (DL, n=75). Intubation time, first-pass success, Cormack–Lehane grade, Percentage of Glottic Opening (POGO) score, Intubation Difficulty Scale (IDS), hemodynamic parameters, and procedure-related complications were compared. Data were analyzed using the independent Student's t-test, Chi-square test, Pearson's correlation coefficient, and repeated-measures ANOVA.

Results: Baseline characteristics were comparable between the groups ($p>0.05$). The VL group demonstrated significantly shorter intubation time (24.8 ± 5.2 vs. 30.6 ± 6.8 seconds; $p<0.001$), higher Cormack–Lehane Grade I view (84.0% vs. 60.0%; $p<0.001$), higher POGO score ($92.6 \pm 9.8\%$ vs. $76.5 \pm 15.2\%$; $p<0.001$), and lower IDS score (1.2 ± 0.8 vs. 2.5 ± 1.3; $p<0.001$). External laryngeal manipulation, mucosal injury, postoperative sore throat, and post-intubation hemodynamic responses were significantly lower in the VL group ($p<0.05$).

Conclusion: Video laryngoscopy provided superior glottic visualization, easier tracheal intubation, improved hemodynamic stability, and fewer airway-related complications than direct laryngoscopy, supporting its routine use for elective adult airway management.

Keywords: Video Laryngoscope, Direct Laryngoscope, Tracheal Intubation, Airway Management, POGO Score, Cormack–Lehane Grade, Hemodynamic Response.

DOI: 10.25258/ijcpr.18.1.293

Introduction

Airway management is one of the most critical responsibilities of an anesthesiologist, and successful tracheal intubation is fundamental to the safe conduct of general anesthesia. Endotracheal intubation ensures adequate oxygenation, ventilation, and protection of the airway from pulmonary aspiration during surgical procedures.[1] Despite considerable advances in anesthetic techniques and monitoring, airway-related complications continue to be an important cause of perioperative morbidity and mortality. Difficult or failed tracheal intubation may result in hypoxemia, aspiration, airway trauma, hemodynamic instability, cardiac arrest, neurological injury, and even death.[2] The likelihood of these complications is influenced by several patient- and operator-related factors, including obesity, restricted cervical spine movement, difficult airway anatomy, emergency clinical settings, and the experience of the anesthesiologist.[3] For several decades, the Macintosh direct laryngoscope has remained the gold standard for tracheal intubation because of its simplicity, reliability, and widespread availability. However, successful direct laryngoscopy requires alignment of the oral, pharyngeal, and laryngeal axes to obtain a direct view of the glottis, which may be difficult in patients with anticipated or unanticipated difficult airways [4]. Multiple intubation attempts are associated with lower first-pass success and an increased risk of airway trauma, hypoxemia, aspiration, and exaggerated sympathetic cardiovascular responses, thereby adversely affecting patient outcomes. [4]

The introduction of video laryngoscopy has transformed airway management by providing an indirect, magnified view of the glottis through a miniature camera positioned at the distal end of the laryngoscope blade [5]. Unlike direct laryngoscopy, video laryngoscopes do not require complete alignment of the airway axes, thereby improving glottic visualization while minimizing airway manipulation. In addition, the shared monitor view facilitates supervision, teaching, and communication among the anesthesia team. Various video laryngoscopes, including Macintosh-style, hyper angulated, and channelled devices, are now routinely used in clinical practice.[6]

Numerous randomized controlled trials and systematic reviews have demonstrated that video laryngoscopy offers superior glottic visualization, improved Cormack–Lehane grading, higher first-pass intubation success, and lower failed intubation rates compared with conventional direct laryngoscopy, particularly in patients with difficult airways. [7] Nevertheless, despite improved visualization, evidence regarding intubation time, ease of endotracheal tube placement, hemodynamic responses, and airway-related complications remains inconsistent because of differences in device design, patient characteristics, clinical settings, and operator experience.[8–10]

Recent international airway management guidelines recommend the availability of video laryngoscopes for both anticipated and unanticipated difficult airway management. However, direct laryngoscopy continues to be widely practiced owing to its lower cost, universal availability, and long-standing familiarity among anesthesiologists. Therefore, comparative evaluation of these two techniques remains clinically relevant to establish their relative effectiveness and safety in routine anesthetic practice.[11,12]

In view of the increasing adoption of video laryngoscopy and the continued role of conventional direct laryngoscopy, the present prospective randomized study was designed to compare video laryngoscopy and direct laryngoscopy for tracheal intubation in adult patients undergoing elective surgery under general anaesthesia.

Materials and Methods

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital after obtaining approval from the Institutional Ethics Committee. A total of 150 adult patients scheduled for elective surgical procedures under general anesthesia requiring endotracheal intubation were included in the study.

Sample Size: The sample size comprised 150 patients, who were randomly allocated into two equal groups of 75 patients each.

- Group VL (n = 75): Tracheal intubation performed using a video laryngoscope.
- Group DL (n = 75): Tracheal intubation performed using a conventional Macintosh direct laryngoscope.

Inclusion Criteria

- Adult patients aged 18–65 years.
- Either sex.
- American Society of Anesthesiologists (ASA) physical status I or II.
- Patients scheduled for elective surgery under general anesthesia requiring oral endotracheal intubation.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients with anticipated difficult airway requiring awake intubation.
- Mouth opening <2.5 cm.
- Mallampati grade IV.
- Restricted cervical spine movement.
- Patients with upper airway tumors, trauma, or infection.
- Emergency surgical procedures.
- Pregnancy.
- Patients with severe cardiovascular, respiratory, hepatic, or renal disease.
- Refusal to participate.

Randomisation and Allocation: Eligible patients were randomly assigned to either the video laryngoscope group or the direct laryngoscope group using a computer-generated randomisation sequence. Allocation concealment was achieved using sequentially numbered, opaque, sealed envelopes opened immediately before induction of anaesthesia.

Study Setting and Duration: The study was conducted at Gandhi Medical College, Bhopal, a tertiary care teaching hospital, for 7 months duration.

Preoperative Assessment: All patients underwent a detailed pre-anesthetic evaluation one day before surgery. Demographic characteristics including age, sex, body mass index (BMI), ASA physical status, and airway assessment were recorded. Airway evaluation included Mallampati classification, thyromental distance, inter-incisor distance, neck mobility, and upper lip bite test.

Patients were kept nil per oral according to standard fasting guidelines. Standard premedication was administered as per institutional protocol.

Anaesthetic Technique: Upon arrival in the operating room, standard monitoring including electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and capnography was instituted. Baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation were recorded. Intravenous access was established using an 18G cannula.

All patients received preoxygenation with 100% oxygen for 3 minutes. General anesthesia was induced with intravenous propofol (2–2.5 mg/kg) and fentanyl (2 µg/kg). Neuromuscular blockade was achieved using succinylcholine (1.5 mg/kg) or rocuronium (0.6 mg/kg), depending on institutional practice.

After adequate muscle relaxation, tracheal intubation was performed according to group allocation. In Group VL, intubation was performed using a video laryngoscope with an appropriately sized blade. In Group DL, intubation was performed using a Macintosh direct laryngoscope of appropriate blade size.

All intubations were performed by experienced anesthesiologists proficient in both techniques. Successful intubation was confirmed by bilateral chest auscultation and continuous end-tidal carbon dioxide ($EtCO_2$) monitoring.

Study Variables: The following parameters were recorded:

Primary Outcome: Time required for successful tracheal intubation (seconds).

Secondary Outcomes

- Cormack–Lehane grading.
- Percentage of Glottic Opening (POGO) score.
- First-attempt intubation success rate.
- Number of intubation attempts.
- Ease of intubation (Intubation Difficulty Scale).
- Requirement of external laryngeal manipulation.
- Requirement of stylet or bougie.
- Overall success rate of tracheal intubation.

Hemodynamic Parameters

Heart rate and mean arterial pressure were recorded at the following time points:

- Baseline
- After induction
- During laryngoscopy
- Immediately after intubation
- 1 minute after intubation
- 3 minutes after intubation
- 5 minutes after intubation

Complications

The following complications were documented:

- Dental trauma
- Oral or pharyngeal mucosal injury
- Blood staining on laryngoscope blade
- Esophageal intubation
- Oxygen desaturation (SpO_2 <90%)
- Postoperative sore throat
- Hoarseness of voice

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 27 (IBM Corp., Armonk, NY, USA).Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Shapiro–Wilk test. Continuous variables between the two groups were compared using the independent Student's t-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Repeated hemodynamic measurements were analyzed using repeated-measures ANOVA with Bonferroni post hoc correction. A p-value of <0.05 was considered statistically significant.

Results

A total of 150 adult patients undergoing elective surgery under general anesthesia were enrolled and randomly allocated into two equal groups of 75 patients each. Group VL underwent tracheal intubation using a video laryngoscope, whereas Group DL underwent intubation using a conventional Macintosh direct laryngoscope. All patients completed the study and were included in the final analysis.

Baseline demographic and airway characteristics are presented in Table 1. Both groups were comparable regarding age, gender, BMI, ASA physical status, and Mallampati classification (p>0.05). The mean age was 42.8 ± 11.6 years in the VL group and 43.5 ± 10.9 years in the DL group (p=0.690). Male patients constituted 58.7% and 61.3% of the VL and DL groups, respectively (p=0.742). No significant differences were observed in BMI (25.3 ± 3.4 vs. 25.8 ± 3.6 kg/m²; p=0.412), ASA grade (p=0.621), or Mallampati classification (p=0.809), indicating comparable baseline characteristics (Table 1).Intubation characteristics are summarized in Table 2. The mean intubation time was significantly shorter in the VL group than in the DL group (24.8 ± 5.2 vs. 30.6 ± 6.8 seconds; p<0.001).

First-pass success was higher with video laryngoscopy (96.0% vs. 88.0%), although the difference was not statistically significant (p=0.082). Overall intubation success was comparable (100% vs. 98.7%; p=0.315). The need for external laryngeal manipulation was significantly lower in the VL group (10.7% vs. 30.7%; p=0.003), and the Intubation Difficulty Scale (IDS) score was significantly lower (1.2 ± 0.8 vs. 2.5 ± 1.3; p<0.001). Stylet use was less frequent in the VL group but did not differ significantly (24.0% vs. 37.3%; p=0.074) (Table 2).

Laryngoscopic findings are shown in Table 3. Video laryngoscopy provided significantly better glottic visualization than direct laryngoscopy. A Cormack–Lehane Grade I view was obtained in 84.0% of patients in the VL group compared with 60.0% in the DL group (p<0.001).

Likewise, the mean POGO score was significantly higher with video laryngoscopy (92.6 ± 9.8% vs. 76.5 ± 15.2%; p<0.001), indicating superior laryngeal visualization (Table 3).

Peri-intubation hemodynamic responses are presented in Table 4 and Figure 1. Baseline heart rate and mean arterial pressure (MAP) were similar in both groups (p>0.05). Immediately after intubation, the DL group demonstrated significantly greater increases in heart rate (99.6 ± 11.4 vs. 90.8 ± 10.2 beats/min; p<0.001) and MAP (107.3 ± 9.4 vs. 99.1 ± 8.7 mmHg; p<0.001). These differences remained significant at 1 minute and 3 minutes after intubation (p<0.001). At 5 minutes, heart rate (p=0.004) and MAP (p=0.036) remained significantly lower in the VL group.

Repeated-measures ANOVA demonstrated a significant group-by-time interaction for both heart rate and MAP (p<0.001), indicating better attenuation of the hemodynamic response with video laryngoscopy (Table 4; Figure 1).Procedure-related complications are summarized in Table 5 and Figure 2. Blood staining on the laryngoscope blade (4.0% vs. 13.3%; p=0.040), oral mucosal injury (2.7% vs. 10.7%; p=0.049), and postoperative sore throat (10.7% vs. 24.0%; p=0.031) were significantly less frequent in the VL group.

Although dental trauma, esophageal intubation, and oxygen desaturation were also lower with video laryngoscopy, these differences were not statistically significant (p>0.05) (Table 5; Figure 2).Correlation analysis is presented in Table 6 and Figures 3a and 3b.

Longer intubation time showed a significant positive correlation with peak heart rate and peak MAP in both groups, with stronger correlations observed in the DL group (r=0.536 and r=0.492, respectively; p<0.001). POGO score demonstrated a significant negative correlation with intubation time (VL: r=−0.582; DL: r=−0.641; p<0.001). Cormack–Lehane grade and Intubation Difficulty Scale also showed significant positive correlations with intubation time and peak hemodynamic responses.

The strongest correlation was observed between the number of intubation attempts and intubation time in the DL group (r=0.741; p<0.001), suggesting that greater intubation difficulty was associated with a more pronounced hemodynamic response (Table 6; Figures 3a and 3b).

Table 1: Baseline demographic and airway characteristics of study participants (n = 150)

Variable	Video Laryngoscope (n=75)	Direct Laryngoscope (n=75)	p-value
Age (years), Mean ± SD	42.8 ± 11.6	43.5 ± 10.9	0.690
Male, n (%)	44 (58.7)	46 (61.3)	0.742
Female, n (%)	31 (41.3)	29 (38.7)	
BMI (kg/m²), Mean ± SD	25.3 ± 3.4	25.8 ± 3.6	0.412
ASA I, n (%)	46 (61.3)	43 (57.3)	0.621
ASA II, n (%)	29 (38.7)	32 (42.7)	
Mallampati I/II, n (%)	65 (86.7)	64 (85.3)	0.809
Mallampati III, n (%)	10 (13.3)	11 (14.7)	

Statistical test: Independent Student's t-test, Chi-square test

Table 2: Comparison of intubation characteristics between the study groups (n = 150)

Variable	Video Laryngoscope	Direct Laryngoscope	p-value
Intubation time (seconds), Mean ± SD	24.8 ± 5.2	30.6 ± 6.8	<0.001
First-pass success, n (%)	72 (96.0)	66 (88.0)	0.082
Overall success, n (%)	75 (100)	74 (98.7)	0.315
External laryngeal manipulation, n (%)	8 (10.7)	23 (30.7)	0.003
Stylet use, n (%)	18 (24.0)	28 (37.3)	0.074
Intubation Difficulty Scale	1.2 ± 0.8	2.5 ± 1.3	<0.001

Statistical test: Independent Student's t-test; Chi-square test

Table 3: Comparison of laryngoscopic view between the study groups (n = 150)

Variable	Video Laryngoscope	Direct Laryngoscope	p-value
Cormack-Lehane Grade I	63 (84.0)	45 (60.0)	<0.001
Grade II	10 (13.3)	22 (29.3)	
Grade III	2 (2.7)	8 (10.7)	
Grade IV	0	0	
POGO score (%)	92.6 ± 9.8	76.5 ± 15.2	<0.001

Statistical test: Chi-square test; Independent Student's t-test

Table 4: Comparative analysis of hemodynamic parameters between the study groups (n = 150)

Time point	Heart Rate (beats/min), Mean ± SD			Mean Arterial Pressure (mmHg), Mean ± SD		
	Video Laryngoscope	Direct Laryngoscope	p-value	Video Laryngoscope	Direct Laryngoscope	p-value
Baseline	82.4 ± 9.5	81.9 ± 8.8	0.739	92.6 ± 8.4	93.1 ± 8.2	0.713
After induction	74.2 ± 8.3	75.6 ± 8.7	0.315	84.3 ± 7.6	85.2 ± 7.9	0.478
Immediately after intubation	90.8 ± 10.2	99.6 ± 11.4	<0.001	99.1 ± 8.7	107.3 ± 9.4	<0.001
1 minute	88.4 ± 9.7	97.5 ± 10.8	<0.001	96.8 ± 8.1	104.9 ± 8.9	<0.001
3 minutes	84.6 ± 8.9	91.3 ± 9.8	<0.001	93.7 ± 7.9	99.5 ± 8.4	<0.001
5 minutes	81.8 ± 8.3	85.9 ± 9.0	0.004	91.5 ± 7.5	94.2 ± 8.1	0.036

Statistical test: Independent Student's t-test

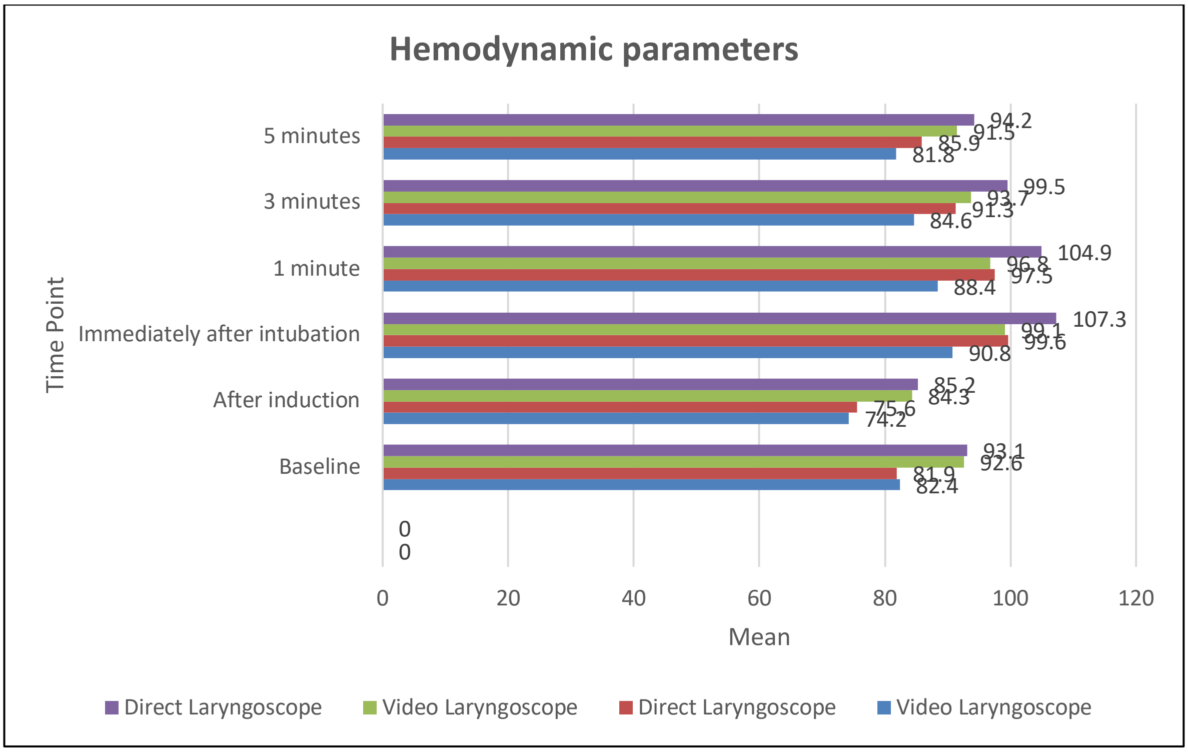

Figure 1: Comparative analysis of hemodynamic parameters between the study groups (n = 150)

Table 5: Comparison of procedure-related complications between the study groups (n = 150)

Complication	Video Laryngoscope n (%)	Direct Laryngoscope n (%)	p-value
Blood staining on blade	3 (4.0)	10 (13.3)	0.040
Oral mucosal injury	2 (2.7)	8 (10.7)	0.049
Dental trauma	0	1 (1.3)	0.315
Esophageal intubation	0	2 (2.7)	0.154
Oxygen desaturation (SpO_2 <90%)	1 (1.3)	4 (5.3)	0.173
Postoperative sore throat	8 (10.7)	18 (24.0)	0.031

Statistical test: Chi-square test

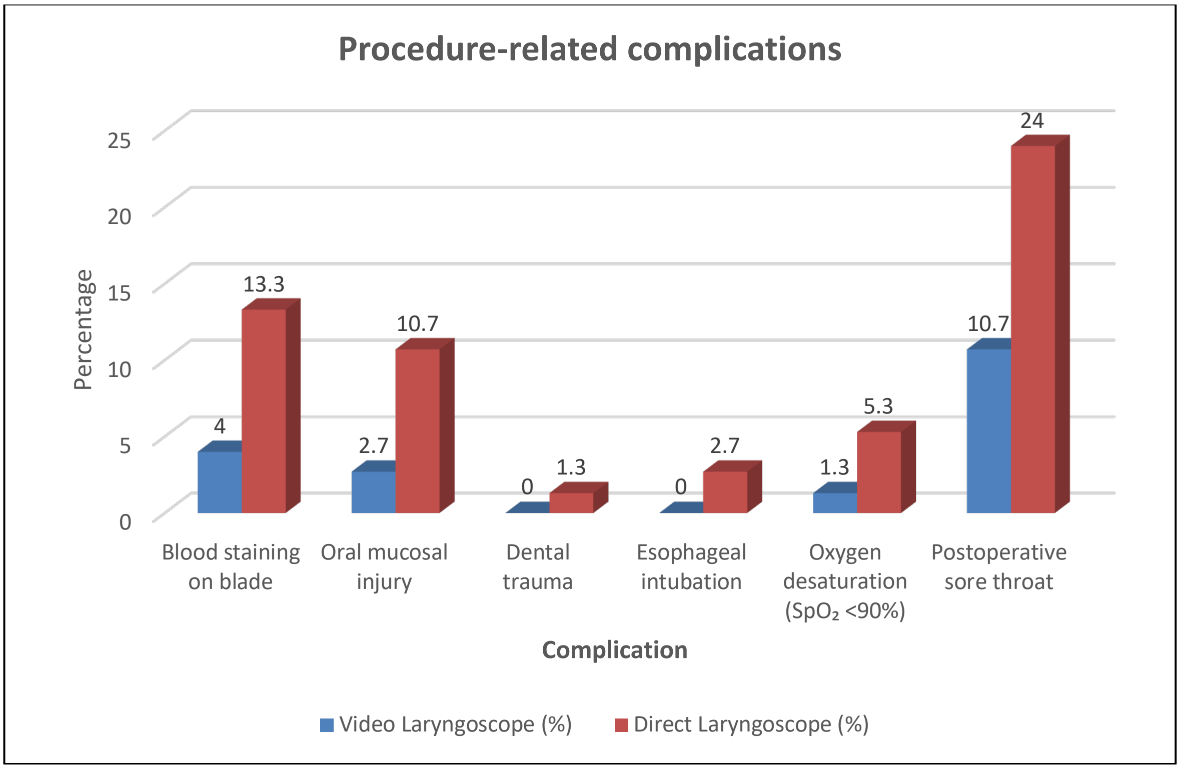

Figure 2: Comparison of procedure-related complications between the study groups (n = 150)

Table 6: Comparative correlation between intubation characteristics and hemodynamic response in the two study groups

Variables	Video Laryngoscope Pearson's r	p-value	Direct Laryngoscope Pearson's r	p-value
Intubation time vs Peak Heart Rate	0.284	0.014	0.536	<0.001
Intubation time vs Peak Mean Arterial Pressure	0.241	0.037	0.492	<0.001
Intubation time vs Intubation Difficulty Scale	0.462	<0.001	0.694	<0.001
POGO Score vs Intubation Time	−0.582	<0.001	−0.641	<0.001
POGO Score vs Peak Heart Rate	−0.236	0.041	−0.425	<0.001
POGO Score vs Peak Mean Arterial Pressure	−0.218	0.061	−0.398	<0.001
Cormack–Lehane Grade vs Intubation Time	0.472	<0.001	0.633	<0.001
Cormack–Lehane Grade vs Peak Heart Rate	0.328	0.004	0.518	<0.001
Cormack–Lehane Grade vs Peak Mean Arterial Pressure	0.291	0.011	0.473	<0.001
Intubation Difficulty Scale vs Peak Heart Rate	0.351	0.002	0.594	<0.001
Intubation Difficulty Scale vs Peak Mean Arterial Pressure	0.314	0.006	0.556	<0.001
Number of Intubation Attempts vs Intubation Time	0.612	<0.001	0.741	<0.001

Statistical test: Pearson's correlation coefficient.

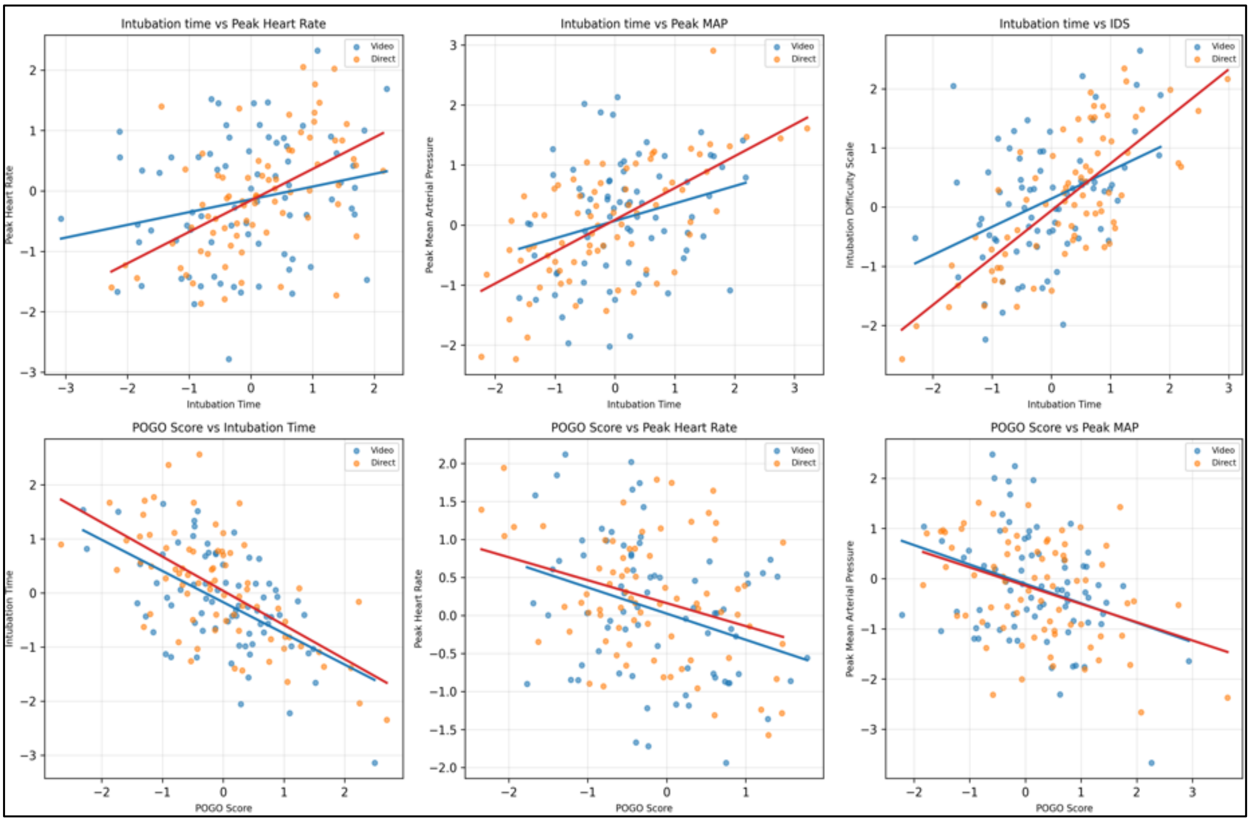

Figure 3a: Comparative correlation between intubation characteristics and hemodynamic response in the two study groups

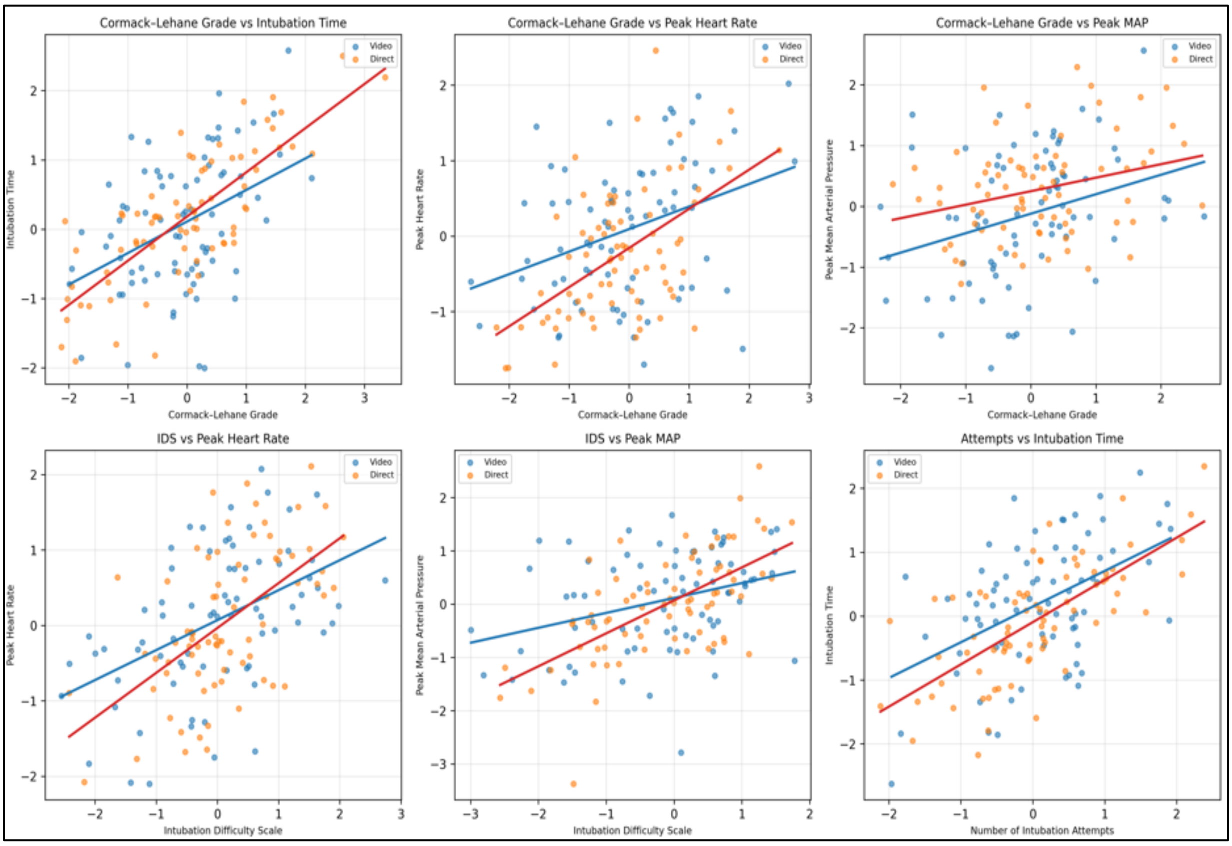

Figure 3b: Comparative correlation between intubation characteristics and hemodynamic response in the two study groups

Discussion

The present study demonstrated comparable baseline demographic and airway characteristics between the video laryngoscope (VL) and direct laryngoscope (DL) groups with respect to age, gender, BMI, ASA physical status, and Mallampati classification ($p>0.05$). This indicates successful randomization and minimizes the influence of confounding variables on study outcomes. Similar baseline comparability has been reported by Trimmel et al. [13], who observed no significant differences in demographic characteristics between the GlideScope and direct laryngoscopy groups before evaluating intubation outcomes.In the present study, video laryngoscopy significantly reduced the mean intubation time compared with direct laryngoscopy (24.8 ± 5.2 vs. 30.6 ± 6.8 seconds; $p<0.001$).

The requirement for external laryngeal manipulation was also significantly lower (10.7% vs. 30.7%; $p=0.003$), and the Intubation Difficulty Scale (IDS) score was significantly reduced (1.2 ± 0.8 vs. 2.5 ± 1.3; $p<0.001$), indicating easier tracheal intubation. Although first-pass success was higher in the VL group (96.0% vs. 88.0%), the difference was not statistically significant. These findings are consistent with Cortellazzi et al. [14], who reported that Glide Scope videolaryngoscopy was associated with improved intubation performance and that optimal intubation was strongly predicted by a single laryngoscope insertion and a Cormack–Lehane Grade I view ($p<0.001$). Similarly, Trimmel et al. [13] demonstrated higher intubation success and easier airway management with Glide Scope videolaryngoscopy in emergency airway management. Superior glottic visualization was a major finding of the present study. Cormack–Lehane Grade I view was achieved in 84.0% of patients in the VL group compared with 60.0% in the DL group, while the mean POGO score was significantly higher with video laryngoscopy (92.6 ± 9.8% vs. 76.5 ± 15.2%; $p<0.001$). These findings indicate that video laryngoscopy provides better visualization of the laryngeal inlet, facilitating easier endotracheal intubation. Levitan et al. [15] validated the Percentage of Glottic Opening (POGO) score as a reliable quantitative measure of glottic visualization. Cortellazzi et al. [14] further demonstrated that achieving a Grade I laryngoscopic view significantly improved successful videolaryngoscopic intubation. Both study groups exhibited transient increases in heart rate and mean arterial pressure following laryngoscopy and tracheal intubation. However, these increases were significantly attenuated in the VL group immediately after intubation and persisted up to five minutes ($p<0.05$). The reduced hemodynamic response observed with video laryngoscopy is likely attributable to less lifting force and reduced airway manipulation. Semler et al. [9] reported that although overall intubation success was comparable between video and direct laryngoscopy, videolaryngoscopy provided improved visualization and may reduce airway manipulation in selected patients. Likewise, Lewis et al. [12] and Hansel et al. [7] concluded in their systematic reviews that video laryngoscopy improves laryngeal visualization and reduces failed intubation, although its effect on hemodynamic responses varies among studies. The present study demonstrated significantly fewer airway-related complications in the VL group. Blood staining on the laryngoscope blade (4.0% vs. 13.3%; $p=0.040$), oral mucosal injury (2.7% vs. 10.7%; $p=0.049$), and postoperative sore throat (10.7% vs. 24.0%; $p=0.031$) were significantly lower with video laryngoscopy. Although dental trauma, esophageal intubation, and oxygen desaturation were also less frequent in the VL group, these differences were not statistically significant. Trimmel et al. [13] similarly reported fewer airway-related complications and improved intubation success with Glide Scope videolaryngoscopy during emergency airway management. Cortellazzi et al. [14] also observed a very low complication rate during videolaryngoscopic intubation, with only isolated cases of mucosal bleeding, oxygen desaturation, and esophageal intubation despite 890 intubations. Correlation analysis demonstrated that longer intubation time was significantly associated with higher peak heart rate, higher peak mean arterial pressure, and greater intubation difficulty in both groups, while POGO score showed a significant negative correlation with intubation time. Correlation coefficients were consistently stronger in the DL group, suggesting that poorer glottic visualization was associated with greater intubation difficulty and a more pronounced hemodynamic response. Adnet et al. [16] proposed the Intubation Difficulty Scale as a comprehensive measure of intubation complexity, demonstrating that higher IDS scores are associated with increasingly difficult airway management. Similarly, Levitan et al. [15] showed that higher POGO scores reflect improved glottic visualization and facilitate easier tracheal intubation, findings that support the correlations observed in the present study.

Conclusion

Video laryngoscopy provided superior glottic visualization, shorter intubation time, lower intubation difficulty, and better attenuation of hemodynamic responses compared with conventional direct laryngoscopy. It was also associated with fewer airway-related complications while maintaining a high first-pass and overall intubation success rate. These findings support the routine use of video laryngoscopy as an effective and safe alternative to direct laryngoscopy for tracheal intubation in adult patients undergoing elective surgery.

Limitations: This was a single-center study conducted in patients with predominantly normal airways, which may limit the generalizability of the findings to difficult airway scenarios. In addition, operator experience with video laryngoscopy may have influenced intubation performance and study outcomes.

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