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Original Research Article

Comparison of VL vs DL for Endotracheal Intubation in Anticipated Difficult Airway

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Abstract

Background: Effective airway management is fundamental to safe anesthetic practice, particularly in patients with anticipated difficult airways. Although direct laryngoscopy has long been regarded as the standard technique for endotracheal intubation, video laryngoscopy has emerged as an alternative that may improve glottic visualization, increase first-pass success, and reduce intubation-related complications. The present study compared the clinical performance of video laryngoscopy and direct laryngoscopy for endotracheal intubation in patients with anticipated difficult airways.

Methods: Ninety-five adult patients with anticipated difficult airways undergoing elective surgery under general anesthesia were enrolled and randomly allocated into two groups: the video laryngoscopy (VL) group (n = 48) and the direct laryngoscopy (DL) group (n = 47). The primary outcome was first-pass intubation success. Secondary outcomes included overall intubation success, intubation time, number of intubation attempts, Cormack–Lehane grade, Percentage of Glottic Opening (POGO) score, requirement for external laryngeal manipulation and stylet/bougie use, hemodynamic responses, and intubation-related complications.

Results: Baseline demographic characteristics and preoperative airway assessment parameters were comparable between the two groups ($P > 0.05$). The first-pass intubation success rate was significantly higher in the VL group than in the DL group (93.8% vs. 76.6%; $P = 0.018$). Video laryngoscopy was associated with a significantly shorter intubation time (27.6 ± 7.1 vs. 35.9 ± 10.2 seconds; $P < 0.001$), fewer intubation attempts (1.08 ± 0.28 vs. 1.38 ± 0.61; $P = 0.002$), superior glottic visualization with higher POGO scores (89.5 ± 10.6% vs. 68.4 ± 16.8%; $P < 0.001$), and improved Cormack–Lehane grades ($P = 0.001$). The requirement for external laryngeal manipulation (14.6% vs. 44.7%; $P = 0.001$) and stylet/bougie use (18.8% vs. 46.8%; $P = 0.004$) was significantly lower in the VL group.

Conclusion: Video laryngoscopy demonstrated superior clinical performance compared with direct laryngoscopy for endotracheal intubation in patients with anticipated difficult airways. It significantly improved first-pass intubation success, enhanced glottic visualization, reduced intubation time and airway manipulation, attenuated the hemodynamic response to intubation, and decreased airway-related complications.

Keywords: Video laryngoscopy; Direct laryngoscopy; Anticipated difficult airway; Endotracheal intubation; First-pass success; Glottic visualization; Airway management; Hemodynamic response.

Introduction

Airway management remains one of the most critical responsibilities of the anesthesiologist, with successful endotracheal intubation being essential for maintaining oxygenation, ventilation, and patient safety during anesthesia and emergency care. Failure to secure the airway promptly can result in severe complications, including hypoxemia, aspiration, brain injury, cardiac arrest, and death. Although the majority of tracheal intubations are performed without difficulty, approximately 5–10% of patients present with features suggestive of a difficult airway, while failed intubation occurs in 0.05–0.35% of cases. Consequently, accurate prediction and effective management of anticipated difficult airways remain major priorities in modern anesthetic practice.[1,2]

A difficult airway is defined as a clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face-mask ventilation, tracheal intubation, or both. Anticipated difficult airway refers to patients in whom preoperative airway assessment suggests a high likelihood of difficult laryngoscopy or intubation based on predictors such as Mallampati classification, reduced mouth opening, limited neck mobility, obesity, short thyromental distance, previous history of difficult intubation, or craniofacial abnormalities.[2,3] Early identification of these patients allows appropriate planning, availability of advanced airway equipment, and selection of the most suitable intubation technique to improve patient safety.

For decades, direct laryngoscopy (DL) using the Macintosh laryngoscope has been considered the gold standard technique for tracheal intubation. Successful direct laryngoscopy requires alignment of the oral, pharyngeal, and laryngeal axes to obtain a direct line of sight to the glottis. However, this alignment may be difficult or impossible in patients with anatomical abnormalities, cervical spine pathology, obesity, or restricted neck movement, thereby reducing glottic visualization and increasing the likelihood of multiple intubation attempts.[4] Repeated attempts at direct laryngoscopy are associated with airway trauma, bleeding, dental injury, hypoxemia, aspiration, and increased morbidity.[5]

The introduction of video laryngoscopy (VL) has significantly changed airway management over the past two decades. Video laryngoscopes incorporate miniature cameras near the blade tip, providing an indirect, magnified view of the glottis on an external monitor without requiring complete alignment of the airway axes.[6] Improved visualization of the vocal cords theoretically increases first-pass intubation success while reducing airway trauma and complications. Numerous videolaryngoscopes, including GlideScope, C-MAC, McGrath, King Vision, and Airtraq devices, have become widely available and are increasingly incorporated into routine anesthetic practice.[7]

Several international airway management guidelines now recommend video laryngoscopy as an important option in the management of anticipated difficult airways. The Difficult Airway Society (DAS) guidelines emphasize limiting repeated intubation attempts and encourage early use of advanced airway devices when difficult intubation is expected.[8] Similarly, the American Society of Anesthesiologists (ASA) Difficult Airway Practice Guidelines recognize video laryngoscopy as an effective primary or rescue device for anticipated and unanticipated difficult airways, particularly when direct laryngoscopy is expected to be challenging.[2]

Despite these recommendations, the superiority of video laryngoscopy over conventional direct laryngoscopy remains a topic of ongoing investigation. Numerous randomized controlled trials and systematic reviews have demonstrated that video laryngoscopy provides superior glottic visualization, higher first-attempt success rates, fewer esophageal intubations, and reduced airway trauma in patients with difficult airways.[6,9] However, some studies have reported that although glottic visualization is significantly improved, total intubation time may be longer because of the need for stylet manipulation and advancement of the endotracheal tube under indirect vision.[10] Furthermore, the effectiveness of video laryngoscopy may vary depending on the operator's experience, the type of videolaryngoscope used, patient characteristics, and the clinical setting.

Meta-analyses evaluating patients with known or predicted difficult airways have generally shown that video laryngoscopy improves first-pass success and reduces failed intubations compared with direct laryngoscopy while minimizing mucosal injury.[9] Recent evidence also suggests that video laryngoscopy may be particularly advantageous when used by less experienced operators or in patients with difficult anatomical airway characteristics, although experienced anesthesiologists continue to require proficiency in both techniques because direct laryngoscopy remains indispensable in situations involving excessive blood, secretions, equipment failure, or limited availability of video devices.[11]

The increasing adoption of video laryngoscopy has important implications for anesthesia education, airway algorithms, and patient safety. Nevertheless, direct laryngoscopy continues to serve as the foundation of airway management skills and remains an essential competency for anesthesiologists. Determining whether video laryngoscopy should replace direct laryngoscopy as the first-line technique in anticipated difficult airway management requires further evaluation of clinical outcomes such as first-attempt success, intubation time, glottic visualization, optimization maneuvers, hemodynamic responses, airway trauma, and postoperative complications.

Therefore, the present study aims to compare video laryngoscopy and direct laryngoscopy for endotracheal intubation in patients with anticipated difficult airways. The findings may contribute to evidence-based selection of the optimal intubation technique, improve first-pass success, reduce airway-related complications, and enhance patient safety during anesthetic management.

Materials and Methods

Study Design and Setting: This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at Hospital. Written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2013 revision) and adhered to the principles of Good Clinical Practice.

Study Population: A total of 95 adult patients scheduled for elective surgical procedures requiring endotracheal intubation under general anesthesia were included in the study. Patients presenting with features suggestive of an anticipated difficult airway during the pre-anesthetic evaluation were screened for eligibility.

Sample Size: The sample size was determined based on previous studies comparing the first-pass success rate of video laryngoscopy and direct laryngoscopy in anticipated difficult airway management. Assuming a statistically significant difference in first-attempt intubation success between the two groups, with a confidence level of 95%, study power of 80%, and allowing for a small dropout rate, the required sample size was calculated to be 95 patients**.**

Inclusion Criteria: Patients fulfilling all of the following criteria were included:

- Age between 18 and 65 years.
- Either sex.
- American Society of Anesthesiologists (ASA) physical status I–III.
- Scheduled for elective surgery under general anesthesia requiring oral endotracheal intubation.
- Presence of anticipated difficult airway based on one or more of the following:

1. Modified Mallampati Class III or IV.
2. Mouth opening less than 3 cm.
3. Thyromental distance less than 6 cm.
4. Sternomental distance less than 12.5 cm.
5. Limited cervical spine extension.
6. Previous history of difficult intubation.
7. Body mass index (BMI) ≥30 kg/m².

Exclusion Criteria

Patients were excluded if they had:

- Emergency surgery.
- Unanticipated difficult airway.
- Pregnancy.
- Upper airway tumors or trauma.
- Severe maxillofacial abnormalities.
- Requirement for awakefibreoptic intubation.
- Increased risk of aspiration.
- Patients refusing participation.
- Contraindications to general anesthesia.

Randomization and Allocation: Eligible participants were randomly allocated into two groups using a computer-generated randomization sequence. Allocation concealment was achieved using sequentially numbered, opaque, sealed envelopes prepared by an investigator not involved in patient recruitment or data collection.

- **Group VL (n = 48):** Endotracheal intubation was performed using a video laryngoscope.
- **Group DL (n = 47):** Endotracheal intubation was performed using a conventional Macintosh direct laryngoscope.

Blinding: Due to the nature of the intervention, the anesthesiologist performing the intubation could not be blinded. However, the investigator responsible for recording peri-intubation variables, postoperative outcomes, and statistical analysis remained blinded to group allocation to minimize observer bias.

Preoperative Airway Assessment: All patients underwent a standardized airway assessment during the pre-anesthetic evaluation. The following parameters were recorded:

- Modified Mallampati classification.
- Mouth opening (inter-incisor distance).
- Thyromental distance.
- Sternomental distance.
- Neck circumference.
- Cervical spine mobility.
- Presence of buck teeth.
- Body mass index.
- Previous history of difficult airway.

Baseline demographic characteristics, including age, sex, height, weight, BMI, ASA physical status, and indication for surgery, were also documented.

Anaesthetic Technique: All patients were kept fasting according to standard ASA fasting guidelines.

Upon arrival in the operating room, standard monitoring was instituted, including:

- Electrocardiography (ECG)
- Non-invasive blood pressure (NIBP)
- Pulse oximetry (SpO_2)
- End-tidal carbon dioxide ($EtCO_2$)

An 18-G intravenous cannula was secured, and Ringer's lactate solution was initiated.

All patients received standardized premedication consisting of:

- Glycopyrrolate 0.2 mg intravenously.
- Midazolam 0.02 mg/kg intravenously.
- Fentanyl 2 µg/kg intravenously.

General anesthesia was induced with intravenous propofol (2 mg/kg). Neuromuscular blockade was achieved using rocuronium (0.6 mg/kg). Following adequate muscle relaxation after approximately 90 seconds, endotracheal intubation was performed according to the allocated group.

Intubation Technique: In the Video Laryngoscope group, tracheal intubation was performed using the designated video laryngoscope according to the manufacturer's recommendations.

In the Direct Laryngoscope group, intubation was performed using a Macintosh laryngoscope with an appropriately sized blade.

All intubations were performed by consultant anesthesiologists with experience of more than 100 successful intubations using both techniques, thereby minimizing operator-related variability. An appropriately sized cuffed endotracheal tube was inserted orally. Correct tube placement was confirmed by continuous capnography and bilateral chest auscultation.

A maximum of three intubation attempts was permitted. Failure after three attempts was managed according to the institutional difficult airway algorithm.
Outcome Measures

Primary Outcome

- First-attempt successful endotracheal intubation.

Secondary Outcomes

- Overall intubation success.
- Time required for successful intubation (from insertion of the laryngoscope until confirmation of end-tidal CO_2).
- Number of intubation attempts.
- Cormack-Lehanelaryngoscopic grading.
- Percentage of Glottic Opening (POGO) score.
- Requirement for external laryngeal manipulation.
- Use of stylet or bougie.
- Oxygen desaturation ($SpO_2 < 90\%$).
- Esophageal intubation.
- Airway trauma (blood staining, dental injury, lip injury).
- Hemodynamic responses (heart rate and mean arterial pressure) recorded at baseline, immediately after intubation, and at 1, 3, and 5 minutes.
- Postoperative sore throat assessed after 24 hours using a standardized grading scale.

Data Collection: All intraoperative observations were recorded using a structured case-record form by an independent observer not involved in airway management.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were assessed for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean ± standard deviation and compared using the independent Student's t-test. Non-normally distributed variables were expressed as median (interquartile range) and compared using the Mann–Whitney U test.

Categorical variables were presented as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test, as appropriate.

Repeated hemodynamic measurements were analyzed using repeated-measures analysis of variance (ANOVA). A two-sided P value <0.05 was considered statistically significant.

Results

A total of 95 patients with anticipated difficult airways were enrolled in the study. Forty-eight patients underwent tracheal intubation using video laryngoscopy (VL group) and forty-seven patients underwent intubation using direct laryngoscopy (DL group). Baseline demographic characteristics and airway assessment parameters were comparable between the groups. Video laryngoscopy demonstrated superior intubation performance with higher first-pass success, improved glottic visualization, fewer intubation attempts, and reduced need for external laryngeal manipulation. Hemodynamic responses were comparable between groups, while airway-related complications were less frequent in the VL group.

Table 1: Baseline Demographic Characteristics of the Study Population

Variable	Video Laryngoscopy (n=48)	Direct Laryngoscopy (n=47)	P-value
Age (years), mean ± SD	49.8 ± 11.7	50.6 ± 10.9	0.721
Male, n (%)	29 (60.4)	28 (59.6)	0.936
Female, n (%)	19 (39.6)	19 (40.4)	
Weight (kg), mean ± SD	69.4 ± 10.8	70.2 ± 11.3	0.714
Height (cm), mean ± SD	166.8 ± 7.9	167.5 ± 8.2	0.675
BMI (kg/m²), mean ± SD	24.9 ± 3.2	25.1 ± 3.4	0.801
ASA Grade I, n (%)	15 (31.3)	14 (29.8)	
ASA Grade II, n (%)	25 (52.1)	26 (55.3)	0.947
ASA Grade III, n (%)	8 (16.6)	7 (14.9)	

Table 1 presents the baseline demographic and clinical characteristics of the study participants. The mean age was comparable between the video laryngoscopy (49.8 ± 11.7 years) and direct laryngoscopy (50.6 ± 10.9 years) groups (P = 0.721). The distribution of sex was similar, with males accounting for 60.4% and 59.6% of the VL and DL groups, respectively (P = 0.936). No statistically significant differences were observed in body weight (69.4 ± 10.8 vs. 70.2 ± 11.3 kg; P = 0.714), height (166.8 ± 7.9 vs. 167.5 ± 8.2 cm; P = 0.675), or body mass index (24.9 ± 3.2 vs. 25.1 ± 3.4 kg/m²; P = 0.801). The distribution of ASA physical status was also comparable between the two groups (P = 0.947). Overall, both groups were well matched with respect to demographic and baseline clinical characteristics.

Table 2: Preoperative Airway Assessment Parameters

Airway Parameter	Video Laryngoscopy (n=48)	Direct Laryngoscopy (n=47)	P-value
Mallampati Grade III, n (%)	34 (70.8)	33 (70.2)	
Mallampati Grade IV, n (%)	14 (29.2)	14 (29.8)	0.944
Mouth opening (cm), mean ± SD	3.4 ± 0.5	3.3 ± 0.6	0.438
Thyromental distance (cm), mean ± SD	6.2 ± 0.7	6.1 ± 0.8	0.519
Sternomental distance (cm), mean ± SD	11.8 ± 1.2	11.6 ± 1.3	0.451
Neck circumference (cm), mean ± SD	39.4 ± 2.8	39.8 ± 3.1	0.523
Limited neck extension, n (%)	18 (37.5)	19 (40.4)	0.772
Previous difficult intubation, n (%)	9 (18.8)	8 (17.0)	0.821

Table 2 summarizes the preoperative airway assessment findings. The proportion of patients with Mallampati Grade III and Grade IV airways was similar in both groups (P = 0.944). Mean mouth opening (3.4 ± 0.5 vs. 3.3 ± 0.6 cm; P = 0.438), thyromental distance (6.2 ± 0.7 vs. 6.1 ± 0.8 cm; P = 0.519), sternomental distance (11.8 ± 1.2 vs. 11.6 ± 1.3 cm; P = 0.451), and neck circumference (39.4 ± 2.8 vs. 39.8 ± 3.1 cm; P = 0.523) did not differ significantly between the VL and DL groups. Similarly, the prevalence of limited neck extension (37.5% vs. 40.4%; P = 0.772) and previous history of difficult intubation (18.8% vs. 17.0%; P = 0.821) was comparable. These findings indicate that both groups had similar airway characteristics before induction of anesthesia.

Table 3: Intubation Characteristics

Variable	Video Laryngoscopy (n=48)	Direct Laryngoscopy (n=47)	P-value
First-pass success, n (%)	45 (93.8)	36 (76.6)	0.018
Overall intubation success, n (%)	48 (100.0)	45 (95.7)	0.118
Intubation time (seconds), mean ± SD	27.6 ± 7.1	35.9 ± 10.2	<0.001
Number of attempts, mean ± SD	1.08 ± 0.28	1.38 ± 0.61	0.002
Cormack–Lehane Grade I, n (%)	36 (75.0)	19 (40.4)	
Grade II, n (%)	10 (20.8)	18 (38.3)	
Grade III, n (%)	2 (4.2)	9 (19.1)	
Grade IV, n (%)	0 (0.0)	1 (2.1)	0.001
POGO score (%), mean ± SD	89.5 ± 10.6	68.4 ± 16.8	<0.001
External laryngeal manipulation required, n (%)	7 (14.6)	21 (44.7)	0.001
Stylet/Bougie used, n (%)	9 (18.8)	22 (46.8)	0.004

Table 3 compares the intubation characteristics between the two study groups. The first-pass intubation success rate was significantly higher in the video laryngoscopy group than in the direct laryngoscopy group (93.8% vs. 76.6%; P = 0.018). Although the overall intubation success rate was marginally higher in the VL group (100% vs. 95.7%), the difference was not statistically significant (P = 0.118). The mean intubation time was significantly shorter with video laryngoscopy (27.6 ± 7.1 seconds) than with direct laryngoscopy (35.9 ± 10.2 seconds; P < 0.001). Patients in the VL group also required fewer intubation attempts (1.08 ± 0.28 vs. 1.38 ± 0.61; P = 0.002). Video laryngoscopy provided significantly better glottic visualization, with a greater proportion of Cormack–Lehane Grade I views and higher POGO scores (89.5 ± 10.6% vs. 68.4 ± 16.8%; P < 0.001). Furthermore, the need for external laryngeal manipulation (14.6% vs. 44.7%; P = 0.001) and the use of adjuncts such as stylets or bougies (18.8% vs. 46.8%; P = 0.004) was significantly lower in the VL group.

Table 4: Hemodynamic Changes During Intubation

Time Point	Heart Rate (beats/min) VL	Heart Rate DL	P-value	Mean Arterial Pressure (mmHg) VL	Mean Arterial Pressure DL	P-value
Baseline	79.8 ± 9.1	80.3 ± 8.9	0.785	92.4 ± 8.6	91.8 ± 9.1	0.744
Immediately after intubation	90.8 ± 10.7	97.5 ± 12.1	0.005	101.6 ± 9.2	108.4 ± 10.8	0.002
1 minute	88.1 ± 9.8	94.6 ± 11.2	0.004	98.5 ± 8.7	104.7 ± 9.5	0.003
3 minutes	84.2 ± 8.9	87.9 ± 9.8	0.056	95.6 ± 8.1	97.9 ± 8.8	0.188
5 minutes	81.6 ± 8.4	82.8 ± 8.9	0.507	93.4 ± 7.9	94.1 ± 8.2	0.671

Table 4 shows the hemodynamic responses during and after tracheal intubation. Baseline heart rate and mean arterial pressure were similar between the two groups ($P > 0.05$). Immediately after intubation, the direct laryngoscopy group exhibited a significantly greater increase in heart rate (97.5 ± 12.1 vs. 90.8 ± 10.7 beats/min; $P = 0.005$) and mean arterial pressure (108.4 ± 10.8 vs. 101.6 ± 9.2 mmHg; $P = 0.002$) compared with the video laryngoscopy group. Similar significant differences persisted at one minute following intubation ($P < 0.01$). However, by three and five minutes after intubation, heart rate and mean arterial pressure had gradually returned toward baseline levels in both groups, and the differences were no longer statistically significant ($P > 0.05$). These findings suggest that video laryngoscopy was associated with a less pronounced hemodynamic response during intubation.

Table 5: Intubation-Related Complications

Complication	Video Laryngoscopy (n=48)	Direct Laryngoscopy (n=47)	P-value
Airway trauma, n (%)	2 (4.2)	8 (17.0)	0.045
Blood on laryngoscope, n (%)	3 (6.3)	9 (19.1)	0.058
Dental injury, n (%)	0 (0.0)	2 (4.3)	0.149
Lip injury, n (%)	1 (2.1)	5 (10.6)	0.091
Esophageal intubation, n (%)	0 (0.0)	3 (6.4)	0.078
Oxygen desaturation (SpO_2 <90%), n (%)	1 (2.1)	5 (10.6)	0.091
Postoperative sore throat (24 h), n (%)	5 (10.4)	14 (29.8)	0.020

Table 5 presents the incidence of intubation-related complications. Airway trauma occurred significantly less frequently in the video laryngoscopy group than in the direct laryngoscopy group (4.2% vs. 17.0%; $P = 0.045$). Similarly, postoperative sore throat at 24 hours was significantly less common in patients intubated using video laryngoscopy (10.4% vs. 29.8%; $P = 0.020$). Although blood on the laryngoscope, lip injury, esophageal intubation, oxygen desaturation, and dental injury were observed more frequently in the direct laryngoscopy group, these differences did not reach statistical significance ($P > 0.05$). Overall, the findings indicate that video laryngoscopy was associated with fewer airway-related complications.

Table 6: Overall Comparison of Primary and Secondary Outcomes

Outcome	Video Laryngoscopy	Direct Laryngoscopy	P-value
First-pass success (%)	93.8	76.6	0.018
Overall success (%)	100.0	95.7	0.118
Mean intubation time (seconds)	27.6 ± 7.1	35.9 ± 10.2	<0.001
Mean number of attempts	1.08 ± 0.28	1.38 ± 0.61	0.002
Mean POGO score (%)	89.5 ± 10.6	68.4 ± 16.8	<0.001
External manipulation required (%)	14.6	44.7	0.001
Airway trauma (%)	4.2	17.0	0.045
Postoperative sore throat (%)	10.4	29.8	0.020

Table 6 summarizes the primary and secondary outcome measures. Video laryngoscopy demonstrated a significantly higher first-pass success rate (93.8% vs. 76.6%; $P = 0.018$), shorter mean intubation time (27.6 ± 7.1 vs. 35.9 ± 10.2 seconds; $P < 0.001$), fewer intubation attempts (1.08 ± 0.28 vs. 1.38 ± 0.61; $P = 0.002$), and substantially better glottic visualization as reflected by higher POGO scores (89.5 ± 10.6% vs. 68.4 ± 16.8%; $P < 0.001$). The requirement for external laryngeal manipulation was also significantly reduced (14.6% vs. 44.7%; P = 0.001). Furthermore, airway trauma (4.2% vs. 17.0%; P = 0.045) and postoperative sore throat (10.4% vs. 29.8%; P = 0.020) occurred less frequently in the video laryngoscopy group. Although the overall intubation success rate was slightly higher with video laryngoscopy (100% vs. 95.7%), this difference was not statistically significant (P = 0.118). Collectively, these results demonstrate that video laryngoscopy offers superior intubation performance and improved safety compared with direct laryngoscopy in patients with anticipated difficult airways.

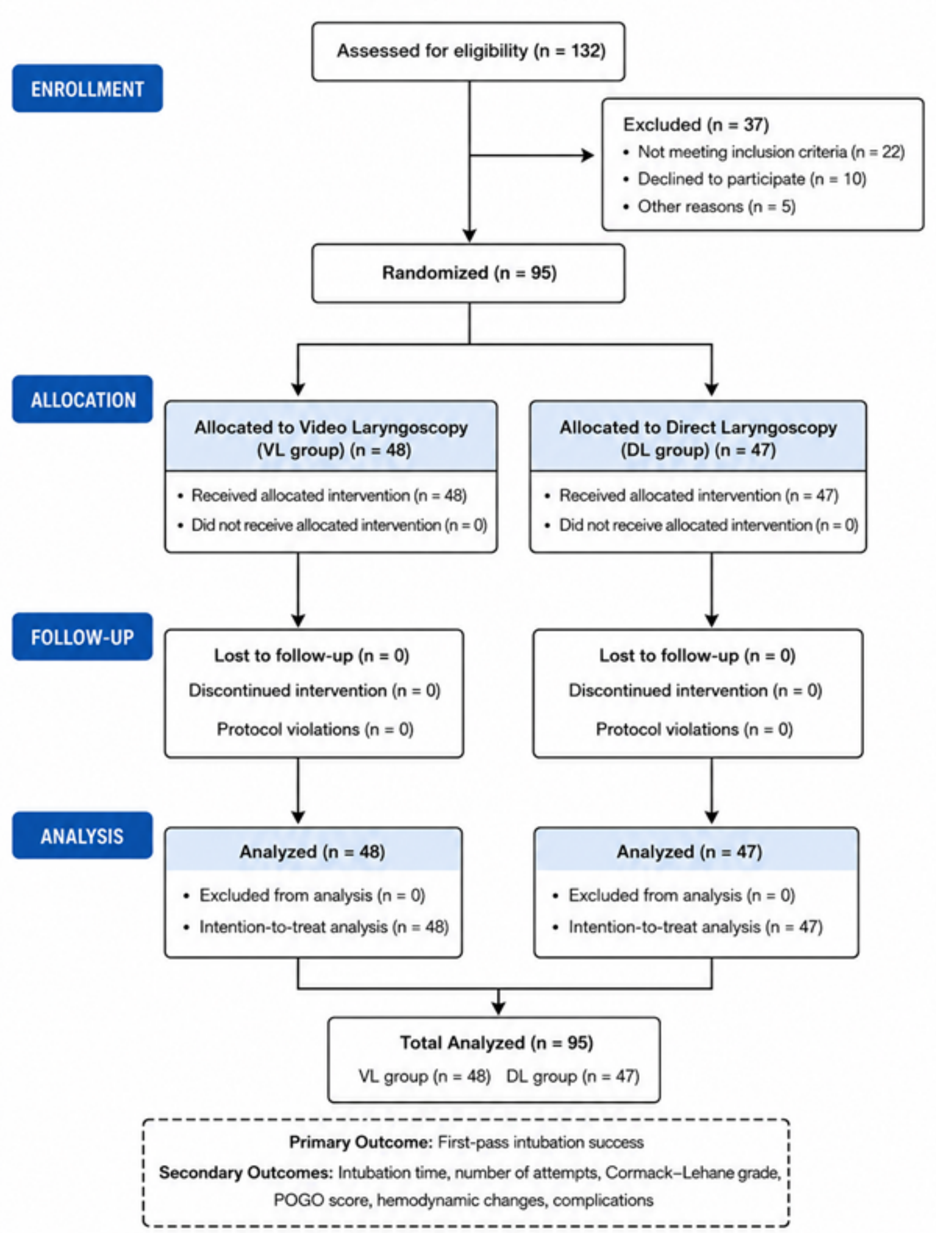

Figure 1: CONSORT flow diagram showing patient recruitment, randomization, allocation, follow-up, and analysis

Figure 1 illustrates the CONSORT (Consolidated Standards of Reporting Trials) flow diagram depicting the progression of participants through the various phases of the study.

A total of 132 patients were initially assessed for eligibility. Of these, 37 patients were excluded, including 22 who did not meet the inclusion criteria, 10 who declined to participate, and 5 who were excluded for other reasons.

The remaining 95 eligible patients were randomly allocated into two study groups: 48 patients were assigned to the Video Laryngoscopy (VL) group and 47 patients to the Direct Laryngoscopy (DL) group.

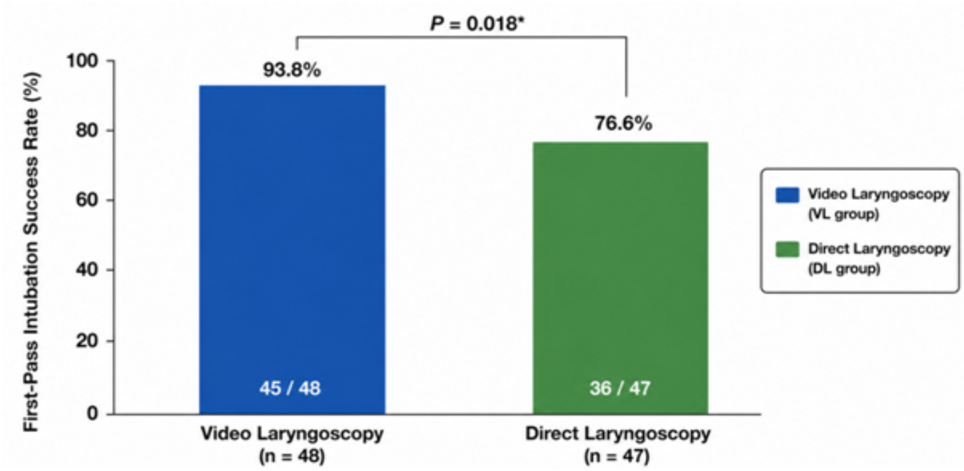

Figure 2: Comparison of first-pass intubation success rates between the video laryngoscopy and direct laryngoscopy groups

Figure 2 compares the first-pass intubation success rates between the video laryngoscopy (VL) and direct laryngoscopy (DL) groups.

The video laryngoscopy group achieved a significantly higher first-pass success rate of 93.8% (45/48 patients) compared with 76.6% (36/47 patients) in the direct laryngoscopy group (P = 0.018).

The difference was statistically significant, indicating that patients intubated using video laryngoscopy were more likely to be successfully intubated on the first attempt.

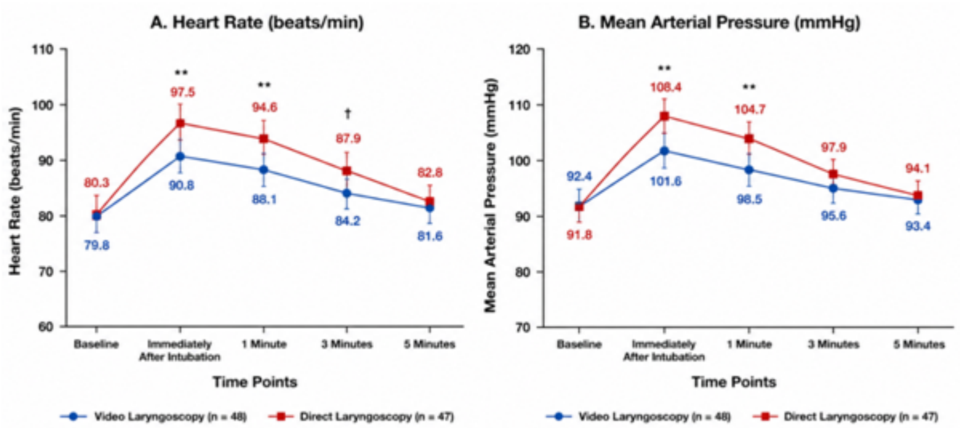

Figure 3: Changes in heart rate and mean arterial pressure at baseline, immediately after intubation, and at 1, 3, and 5 minutes

Figure 3 illustrates the hemodynamic responses, including heart rate (Panel A) and mean arterial pressure (Panel B), following tracheal intubation in the video laryngoscopy (VL) and direct laryngoscopy (DL) groups. Baseline heart rate and mean arterial pressure were comparable between the two groups (P > 0.05). Immediately after intubation, both parameters increased in both groups; however, the increase was significantly greater in the DL group. The mean heart rate immediately after intubation was 97.5 ± 12.1 beats/min in the DL group compared with 90.8 ± 10.7 beats/min in the VL group (P = 0.005). Similarly, mean arterial pressure increased to 108.4 ± 10.8 mmHg in the DL group versus 101.6 ± 9.2 mmHg in the VL group (P = 0.002).

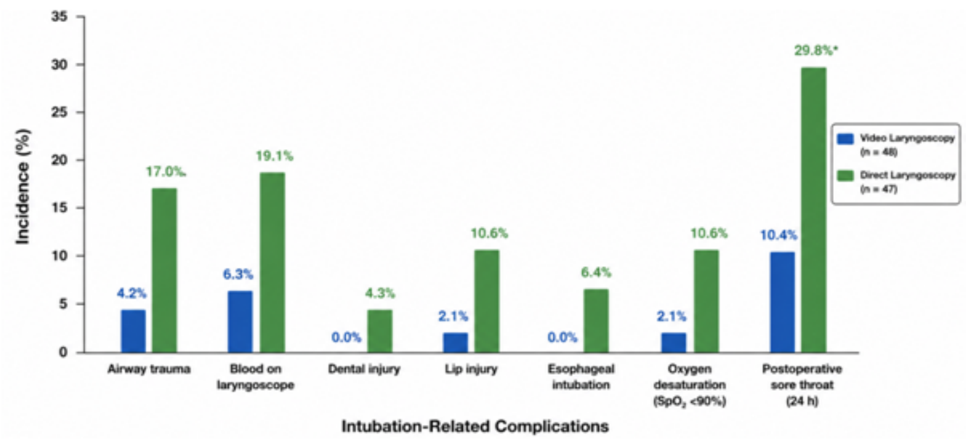

Figure 4: Comparison of the incidence of intubation-related complications between the two groups

Figure 4 compares the incidence of intubation-related complications between the video laryngoscopy (VL) and direct laryngoscopy (DL) groups. Overall, complications occurred less frequently in the video laryngoscopy group. The incidence of airway trauma was significantly lower in the VL group (4.2%) compared with the DL group (17.0%;P = 0.045). Likewise, the incidence of postoperative sore throat at 24 hours was significantly reduced in patients intubated using video laryngoscopy (10.4% vs. 29.8%; P = 0.020).

Discussion

The present prospective comparative study evaluated the effectiveness of video laryngoscopy (VL) versus direct laryngoscopy (DL) for endotracheal intubation in patients with anticipated difficult airways. The principal findings demonstrated that video laryngoscopy significantly improved first-pass intubation success, reduced intubation time and the number of intubation attempts, provided superior glottic visualization, and decreased the requirement for external laryngeal manipulation and intubation adjuncts. Although the overall intubation success rate was comparable between the two groups, video laryngoscopy was associated with superior procedural performance and a more favorable airway management profile. These findings are consistent with the growing body of evidence supporting videolaryngoscopy as the preferred primary intubation technique in anticipated difficult airways [12–14].

An important strength of the present study is the comparability of baseline demographic characteristics between the two groups. There were no statistically significant differences in age, sex, body weight, height, body mass index, or ASA physical status. Such homogeneity minimizes confounding factors and ensures that differences in intubation outcomes are attributable to the airway device rather than patient characteristics. Similar baseline comparability has been reported in previous randomized controlled trials comparing video and direct laryngoscopy [12,10].

Similarly, preoperative airway assessment parameters, including Mallampati grade, mouth opening, thyromental distance, sternomental distance, neck circumference, limited neck extension, and previous history of difficult intubation, were comparable between groups. Equal distribution of these predictors of difficult airway enhances the internal validity of the present study and reduces selection bias. Comparable airway characteristics have also been reported in previous randomized studies evaluating videolaryngoscopy in predicted difficult airways [12,9].

One of the most clinically important findings of this study was the significantly higher first-pass intubation success with video laryngoscopy (93.8%) compared with direct laryngoscopy (76.6%). First-pass success is widely regarded as one of the most important indicators of airway management quality because repeated attempts substantially increase the risks of hypoxemia, aspiration, airway trauma, and cardiovascular complications. The present findings closely resemble those reported by Aziz et al., who demonstrated a first-attempt success rate of 93% with the C-MAC videolaryngoscope compared with 84% using direct laryngoscopy in patients with predicted difficult airways [12]. These observations are further supported by systematic reviews and meta-analyses showing that videolaryngoscopy significantly improves first-pass success, particularly in anticipated difficult airways [9,11,13].

Although the overall intubation success rate was marginally higher in the VL group (100% versus 95.7%), the difference was not statistically significant. This finding is consistent with previous investigations demonstrating that when experienced anesthesiologists follow established difficult airway algorithms, overall success rates remain high regardless of the device used. Nevertheless, videolaryngoscopy provides the major advantage of achieving successful intubation on the initial attempt while minimizing rescue interventions [9,12,14].

The present study also demonstrated a significantly shorter intubation time in the video laryngoscopy group (27.6 ± 7.1 seconds) compared with the direct laryngoscopy group (35.9 ± 10.2 seconds). Earlier generations of videolaryngoscopes were occasionally associated with prolonged intubation because of difficulties in tube advancement despite excellent glottic visualization. However, improvements in blade design and increasing operator experience have substantially reduced this limitation. Several recent clinical studies have similarly reported either comparable or shorter intubation times with modern videolaryngoscopes in patients with predicted difficult airways [12,14].

Patients intubated with video laryngoscopy also required significantly fewer intubation attempts than those undergoing direct laryngoscopy. Every additional attempt at laryngoscopy increases the risk of airway edema, bleeding, hypoxemia, and failed airway management. Therefore, minimizing the number of attempts represents an important patient safety benefit. Previous meta-analyses have consistently demonstrated that videolaryngoscopy reduces repeated intubation attempts and facilitates earlier successful tracheal intubation in difficult airway scenarios [9,10,12].

Superior glottic visualization represented another major advantage of video laryngoscopy in the present study. Seventy-five percent of patients in the VL group achieved a Cormack–Lehane Grade I view compared with only 40.4% in the DL group, while the mean POGO score was significantly higher (89.5% versus 68.4%). These findings reflect the ability of videolaryngoscopes to provide an indirect, magnified view of the laryngeal inlet without requiring complete alignment of the oral, pharyngeal, and laryngeal axes. Similar improvements in Cormack–Lehane grading and POGO scores have been consistently reported in randomized trials and systematic reviews evaluating videolaryngoscopy in patients with anticipated difficult airways [9,10,12,16].

Another clinically significant observation in the present study was the reduced requirement for external laryngeal manipulation and adjunctive devices such as stylets or bougies. External manipulation was required in only 14.6% of VL cases compared with 44.7% of DL cases, while adjunct use was reduced from 46.8% to 18.8%. These findings indicate that videolaryngoscopy provides a more favorable laryngeal view, thereby simplifying tube placement and reducing dependence on optimization maneuvers. Aziz et al. similarly reported significantly lower requirements for external laryngeal manipulation and bougie use during C-MAC videolaryngoscopy, findings that have subsequently been confirmed by systematic reviews [12,14].

The hemodynamic response to laryngoscopy and endotracheal intubation is primarily mediated by sympathetic stimulation resulting from mechanical manipulation of the upper airway. Excessive increases in heart rate and arterial blood pressure may be clinically important, particularly in patients with cardiovascular or cerebrovascular disease. In the present study, baseline heart rate and mean arterial pressure were comparable between the two groups, confirming similar pre-induction physiological status. However, immediately after intubation and at one minute, patients in the direct laryngoscopy group demonstrated significantly greater increases in both heart rate and mean arterial pressure than those undergoing video laryngoscopy. These findings suggest that video laryngoscopy produces less mechanical force during laryngoscopy, thereby attenuating the sympathetic response associated with tracheal intubation. By three and five minutes following intubation, the hemodynamic variables had returned toward baseline in both groups, indicating that the pressor response was transient. Similar findings have been reported by previous investigators, who observed significantly lower cardiovascular stimulation with videolaryngoscopy owing to reduced lifting force and improved visualization of the glottis [15,6]. Furthermore, systematic reviews have concluded that although videolaryngoscopy consistently improves laryngeal visualization and intubation performance, its effect on hemodynamic responses may vary depending on patient characteristics, device design, anesthetic technique, and operator experience. Nevertheless, most studies involving anticipated difficult airways have demonstrated either comparable or reduced cardiovascular responses with videolaryngoscopy compared with conventional direct laryngoscopy.

Another important finding of the present study was the lower incidence of airway-related complications associated with video laryngoscopy. Airway trauma occurred in only 4.2% of patients in the VL group compared with 17.0% in the DL group, while postoperative sore throat was also significantly less frequent following videolaryngoscopy. Although blood staining on the laryngoscope, lip injury, oxygen desaturation, dental injury, and esophageal intubation occurred more frequently in the direct laryngoscopy group, these differences did not reach statistical significance, possibly because of the relatively modest sample size. The reduced incidence of airway trauma observed with videolaryngoscopy may be explained by improved visualization of the laryngeal inlet, fewer intubation attempts, and reduced need for excessive lifting force or repeated manipulation during tube placement. These findings are consistent with those reported by Pieters et al., who demonstrated significantly lower mucosal trauma among patients managed with videolaryngoscopy, as well as by the Cochrane systematic review, which found that videolaryngoscopy reduced failed intubation and airway trauma while improving glottic visualization [6,9]. Recent meta-analyses have similarly shown reductions in upper airway injury, esophageal intubation, and dental trauma when videolaryngoscopy is used as the primary intubation technique, particularly in patients with anticipated difficult airways.

The significantly lower requirement for external laryngeal manipulation and intubation adjuncts observed in the present study further highlights the technical advantages of videolaryngoscopy. External manipulation was required in only 14.6% of patients in the VL group compared with 44.7% in the DL group, while stylets or bougies were required less frequently. These findings indicate that videolaryngoscopy facilitates a more direct approach to glottic visualization and tracheal tube placement, thereby simplifying airway management even in anatomically difficult patients. Similar reductions in optimization maneuvers have been consistently reported in randomized controlled trials and systematic reviews evaluating modern videolaryngoscopes[6,9,16].

The overall findings of the present study therefore support current international difficult airway guidelines, which increasingly recommend videolaryngoscopy as an appropriate first-line device in patients with anticipated difficult airways. The updated American Society of Anesthesiologists Difficult Airway Guidelines emphasize early use of videolaryngoscopy because of its ability to improve first-pass success and reduce failed intubation. Similarly, the Difficult Airway Society recommends limiting repeated direct laryngoscopy attempts and considering videolaryngoscopy early in difficult airway management algorithms. Our findings provide additional evidence supporting these recommendations and reinforce the role of videolaryngoscopy as an effective tool for improving patient safety during airway management [2,8,13].

The present study has several strengths. First, it employed a prospective comparative design with well-balanced baseline demographic and airway characteristics, thereby minimizing selection bias. Second, all intubations were performed using standardized anesthetic techniques by experienced anesthesiologists, reducing operator-related variability. Third, multiple clinically relevant outcome measures, including first-pass success, intubation time, glottic visualization, hemodynamic responses, and airway-related complications, were comprehensively evaluated. These factors enhance the reliability and clinical applicability of the study findings.

Nevertheless, certain limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively modest sample size, which may limit the generalizability of the findings. The anesthesiologist performing the intubation could not be blinded because of the obvious differences between the devices, introducing the possibility of performance bias. Furthermore, only one type of videolaryngoscope was evaluated; therefore, the findings may not be directly applicable to other videolaryngoscope designs. Finally, long-term postoperative airway outcomes beyond the first 24 hours were not assessed. Future multicenter randomized trials involving larger patient populations, different videolaryngoscope models, and longer follow-up periods are required to further establish the comparative effectiveness and cost-effectiveness of videolaryngoscopy across diverse clinical settings [17]. Overall, the findings of the present study demonstrate that video laryngoscopy provides significant clinical advantages over conventional direct laryngoscopy in patients with anticipated difficult airways. Improved first-pass success, superior glottic visualization, shorter intubation time, fewer optimization maneuvers, reduced hemodynamic stress during intubation, and a lower incidence of airway trauma collectively support the routine incorporation of videolaryngoscopy into difficult airway management strategies. Although direct laryngoscopy remains an essential skill for anesthesiologists, videolaryngoscopy appears to offer greater procedural efficiency and patient safety when managing Anticipated Difficult Airways.

Conclusion

The present study demonstrated that video laryngoscopy is superior to conventional direct laryngoscopy for endotracheal intubation in patients with anticipated difficult airways. Video laryngoscopy achieved a significantly higher first-pass intubation success rate, reduced intubation time, required fewer intubation attempts, and provided superior glottic visualization, as evidenced by improved cormack–lehane grades and higher percentage of glottic opening (pogo) scores. Furthermore, the need for external laryngeal manipulation and adjunctive airway devices was significantly lower with video laryngoscopy, indicating greater procedural ease and efficiency.

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