RESEARCH PAPER

Video laryngoscopy versus direct laryngoscopy for first-pass success in predicted difficult airway: A comparative study

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ABSTRACT
Background and Objectives: Difficult airway management remains one of the most critical challenges in anaesthesiology and emergency medicine. Failed or multiple intubation attempts are associated with significant morbidity and mortality. This study aimed to compare the first-pass intubation success rate of video laryngoscopy (VL) versus direct laryngoscopy (DL) in adult patients with a predicted difficult airway. **Methods:** A prospective, randomised controlled comparative study was conducted at a tertiary care teaching hospital over 18 months. Two hundred and two adult patients (ASA I–IV) with predicted difficult airway features (Mallampati Class III/IV and at least one additional predictor) undergoing elective surgical procedures were randomised to VL (n = 101) or DL (n = 101). The primary outcome was first-pass intubation success. Secondary outcomes included Cormack-Lehane grade obtained, total intubation time, number of attempts, and peri-intubation complications. **Results:** First-pass success was achieved in 89 patients (88.1%) in the VL group compared to 68 patients (67.3%) in the DL group (OR 3.62, 95% CI 1.81–7.23; $p < 0.001$). Cormack-Lehane Grade I/II view was obtained in 93.1% of VL versus 60.4% of DL patients ($p < 0.001$). Mean intubation time was significantly shorter in the VL group (28.4 ± 7.2 s vs. 35.1 ± 9.8 s; $p < 0.001$). Complications including oropharyngeal trauma and oxygen desaturation were significantly lower in the VL group. **Conclusion:** Video laryngoscopy significantly improves first-pass success and laryngeal view while reducing intubation time and peri-intubation complications in patients with predicted difficult airway. VL should be considered the preferred primary technique in such high-risk patients.
Keywords: video laryngoscopy; direct laryngoscopy; difficult airway; first-pass success; airway management; Cormack-Lehane; Mallampati; Glide Scope
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INTRODUCTION

Airway management is a foundational skill in anaesthesiology, emergency medicine, and critical care. Securing the airway on the first attempt is paramount: each failed laryngoscopy attempt is associated with progressive mucosal oedema, haemorrhage, laryngospasm, and a significant increase in the risk of hypoxic cardiac arrest.1 The Fourth National Audit Project (NAP4) of the Royal College of Anaesthetists documented that complications arising from failure to anticipate or manage difficulty in tracheal intubation accounted for a substantial proportion of anaesthesia-related deaths.2

The incidence of difficult intubation in the general surgical population ranges from 1–8%, rising to 10–20% or higher in subgroups with anatomically unfavourable airways.3 Predictors of a difficult airway include restricted mouth opening, a short thyromental or sternomental distance, elevated Mallampati classification, limited neck extension, high body mass index (BMI), and a previous documented history of difficult intubation.4,5

Direct laryngoscopy (DL), introduced in the early twentieth century, has been the standard approach for orotracheal intubation for decades. Its reliance on an unobstructed line-of-sight from the operator's eye through the pharynx to the glottis renders it inherently vulnerable when airway anatomy is unfavourable. Even experienced laryngoscopists obtain a sub-optimal Cormack-Lehane Grade III or IV view in up to 30% of cases they identify as potentially difficult.6

Video laryngoscopy (VL) represents a paradigm shift in airway management technology. By mounting a miniaturised camera at the blade tip and displaying a magnified image on an external monitor, VL decouples the requirement for a direct line of sight, enabling operators to manoeuvre around anatomical obstacles that would preclude adequate DL views.7 Commercially available platforms include the GlideScope (Verathon), C-MAC (Karl Storz), McGrath MAC (Medtronic), and the Airtraq

(ProdolMeditec), each with distinct blade geometries and optical characteristics.8
Despite a growing body of evidence favouring VL in anticipated difficult airways, considerable practice variation persists. Several meta-analyses and systematic reviews have demonstrated improved glottic visualisation with VL, yet first-pass success—a clinically meaningful endpoint that incorporates both view and the ability to pass the tracheal tube—has been inconsistently reported.9,10 Furthermore, most available trials are dominated by patients with normal airways, limiting generalisability to the high-risk predicted difficult airway population.
The present study was therefore designed to compare VL versus DL specifically in adult patients with preoperatively identified predicted difficult airway features, using first-pass intubation success as the primary outcome. We hypothesised that VL would confer a clinically and statistically significant advantage over DL in this high-risk cohort.

MATERIALS AND METHODS

Study Design and Ethics

This was a single-centre, prospective, open-label, parallel-group randomised controlled trial conducted at a 1200-bed tertiary referral teaching hospital. The study was approved by the Institutional Ethics Committee Written informed consent was obtained from all participants prior to enrolment.

Participants

Adult patients (age 18–70 years, ASA physical status I–IV) scheduled for elective surgical procedures requiring general anaesthesia with orotracheal intubation were screened during the pre-anaesthetic evaluation. Predicted difficult airway was defined as Mallampati Class III or IV plus at least one of the following: mouth opening < 3 cm; thyromental distance < 6 cm; sternomental distance < 12 cm; neck circumference > 40 cm; limited neck extension (< 80°); or a documented previous history of difficult intubation.
Exclusion criteria were: age < 18 or > 70 years; emergency surgery; known or anticipated cervical spine instability; full dentition loss preventing mask ventilation; American Society of Anesthesiologists (ASA) Class V; pregnancy; requirement for rapid sequence induction (RSI); patient refusal; and prior participation in the trial.

Randomisation and Blinding

Patients were allocated in a 1:1 ratio to either the VL group or the DL group using computer-generated block randomisation (blocks of 4 and 6) with allocation concealment maintained via sequentially numbered opaque sealed envelopes prepared by an independent statistician not involved in patient care. Owing to the nature of the interventions, blinding of the operating anaesthetist was not possible; however, the outcome assessor recording time-based variables and complications was blinded to group allocation.

Anaesthetic Technique

All patients received a standardised pre-induction protocol: IV access established, standard monitoring applied (ECG, SpO_2, $EtCO_2$, NIBP), and pre-oxygenation with 100% O_2 via tight-fitting face mask for five minutes to target an end-tidal O_2 fraction ≥ 90%. Induction was achieved with fentanyl 2 µg/kg IV followed by propofol 2 mg/kg IV titrated to loss of verbal contact, and succinylcholine 1.5 mg/kg IV to facilitate intubation. All intubations were performed by two senior anaesthesiologists (>5 years post-qualification), each with documented experience of ≥ 200 VL and ≥ 500 DL procedures, ensuring comparability of operator proficiency.
In the VL group, intubation was performed using the GlideScope Ranger (Verathon Inc., Bothell, WA, USA) with a size 3 or 4 hyperangulated blade selected according to patient anatomy, using a preformed stylet at 60°. In the DL group, a Macintosh laryngoscope with size 3 or 4 blade was used. External laryngeal manipulation was permitted in both groups. A maximum of three intubation attempts per patient were allowed; failure after three attempts led to crossover to the alternative device per institutional protocol, and the outcome was recorded accordingly.

Outcome Measures

The primary outcome was first-pass intubation success, defined as correct tracheal tube placement confirmed by capnography (square-wave $EtCO_2$ waveform) and bilateral chest auscultation on the first laryngoscopy attempt without withdrawal of the laryngoscope blade.
Secondary outcomes included: (i) laryngeal view according to the modified Cormack-Lehane grading system as described by Yentis and Lee11; (ii) total intubation time measured from cessation of bag-mask ventilation to the first $EtCO_2$ waveform; (iii) total number of laryngoscopy attempts; (iv) overall intubation success within three attempts; (v) peri-intubation complications: oesophageal intubation (confirmed and subsequently corrected), oropharyngeal/dental soft-tissue trauma, oxygen desaturation (SpO_2 < 90%), and haemodynamic instability (>30% change in heart rate or blood pressure from baseline). Operators were asked to grade their perceived difficulty using a 10 cm Visual Analogue Scale (VAS) immediately after intubation.

Statistical Analysis

Sample size calculation was based on an anticipated first-pass success of 85% for VL and 65% for DL, derived from published literature.12,13 Using a two-sided α of 0.05 and β of 0.20 (80% power), a minimum of 91 patients per group was required; allowing for 10% attrition, 101 patients per group (202 total) were recruited.

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. Normally distributed continuous variables are expressed as mean ± standard deviation (SD) and compared using the independent samples t-test. Non-normally distributed continuous variables are expressed as median (interquartile range) and compared using the Mann-Whitney U test. Categorical variables are expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test as appropriate. Odds ratio (OR) with 95% confidence interval (CI) was calculated for the primary outcome. A p-value < 0.05 was considered statistically significant.

RESULTS

Patient Demographics and Clinical Characteristics

A total of 247 patients were screened during the study period; 45 were excluded (11 did not meet inclusion criteria, 18 declined consent, 16 required emergency surgery). Two hundred and two patients were randomised: 101 to VL and 101 to DL. All 202 patients completed the study per protocol; there were no withdrawals or cross-overs attributable to operator preference. Baseline demographic and clinical characteristics were comparable between the two groups (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	VL Group (n=101)	DL Group (n=101)	p-value
Age (years), mean ± SD	44.3 ± 13.6	43.8 ± 14.1	0.78
Male sex, n (%)	62 (61.4%)	59 (58.4%)	0.65
BMI (kg/m²), mean ± SD	28.4 ± 5.1	28.9 ± 5.4	0.51
ASA Class I/II, n (%)	74 (73.3%)	72 (71.3%)	0.73
ASA Class III/IV, n (%)	27 (26.7%)	29 (28.7%)	0.73
Mallampati Class III/IV	101 (100%)	101 (100%)	—
Mouth opening < 3 cm	34 (33.7%)	32 (31.7%)	0.76
Thyromental distance < 6 cm	41 (40.6%)	43 (42.6%)	0.77
Sternomental distance < 12 cm	28 (27.7%)	31 (30.7%)	0.64
History of difficult intubation	18 (17.8%)	17 (16.8%)	0.86
Neck circumference > 40 cm	39 (38.6%)	41 (40.6%)	0.77

Values expressed as mean ± SD or n (%). BMI = Body Mass Index; ASA = American Society of Anesthesiologists. No significant between-group differences were observed (all p > 0.05).

Primary Outcome: First-Pass Success

First-pass intubation success was achieved in 89 of 101 patients (88.1%) in the VL group, compared to 68 of 101 patients (67.3%) in the DL group. This difference was statistically significant (OR 3.62, 95% CI 1.81–7.23; p < 0.001), representing a 20.8 percentage-point absolute risk difference and a number-needed-to-treat (NNT) of 4.8.

Secondary Outcomes

The VL group demonstrated significantly superior Cormack-Lehane Grade I/II views compared to DL (93.1% vs. 60.4%; p < 0.001). Correspondingly, Grade III/IV views were encountered in only 7 VL patients (6.9%) versus 40 DL patients (39.6%), confirming the expected mechanistic advantage of video-enhanced glottic visualisation in obstructed airways.

Mean intubation time was significantly shorter in the VL group (28.4 ± 7.2 seconds vs. 35.1 ± 9.8 seconds; p < 0.001). The mean number of laryngoscopy attempts was also lower in the VL group (1.14 ± 0.38 vs. 1.51 ± 0.66; p < 0.001). Overall intubation success within three attempts was achieved in all 101 VL patients (100%) versus 97 DL patients (96.0%), though this difference did not reach statistical significance (p = 0.12), likely reflecting adequate rescue strategies for DL failures.

With respect to complications, dental and soft-tissue oropharyngeal trauma was significantly more frequent in the DL group (8.9% vs. 2.0%; p = 0.03). Episodes of oxygen desaturation (SpO_2 < 90%) were similarly more common in DL patients (6.9% vs. 1.0%; p = 0.03). Three patients in the DL group experienced oesophageal intubation, promptly recognised and corrected; none occurred in the VL group (p = 0.08). Haemodynamic instability was comparable between groups (p = 0.76). Results are summarised in Table 2.

Table 2. Comparison of Primary and Secondary Outcomes Between the VL and DL Groups

Outcome	VL (n=101)	DL (n=101)	p-value
First-pass success rate	89 (88.1%)	68 (67.3%)	< 0.001
Mean intubation time (sec)	28.4 ± 7.2	35.1 ± 9.8	< 0.001
Cormack-Lehane Grade I/II (%)	94 (93.1%)	61 (60.4%)	< 0.001
Cormack-Lehane Grade III/IV (%)	7 (6.9%)	40 (39.6%)	< 0.001
Number of attempts, mean ± SD	1.14 ± 0.38	1.51 ± 0.66	< 0.001
Overall intubation success	101 (100%)	97 (96.0%)	0.12
Oesophageal intubation	0 (0%)	3 (3.0%)	0.08
Dental/soft tissue trauma	2 (2.0%)	9 (8.9%)	0.03
SpO_2 < 90% during attempt	1 (1.0%)	7 (6.9%)	0.03
Haemodynamic instability	5 (5.0%)	6 (5.9%)	0.76

OR = Odds Ratio; CI = Confidence Interval. Bold p-values indicate statistical significance (p < 0.05). SpO_2 = peripheral oxygen saturation.

DISCUSSION

The principal finding of this randomised controlled trial is that video laryngoscopy confers a significantly higher first-pass intubation success rate than direct laryngoscopy in adult patients with predicted difficult airways (88.1% vs. 67.3%; OR 3.62), with additional benefits in laryngeal view quality, intubation time, number of attempts, and peri-intubation complications. These findings are consistent with, and extend, the existing literature.

The landmark Cochrane systematic review by Lewis et al. (2017), encompassing 64 randomised trials and over 7,000 patients, demonstrated that VL was associated with fewer failed intubations compared to DL, with the benefit being most pronounced in patients with difficult or simulated difficult airways (RR 0.41, 95% CI 0.16–1.07).10 A meta-analysis by Griesdale et al. specifically evaluating GlideScope performance found improved glottic views in patients with Cormack-Lehane Grade III/IV, corroborating our findings.13 The magnitude of the first-pass success advantage observed in the present trial (20.8 percentage points) exceeds some earlier estimates, likely reflecting our exclusive enrolment of predicted difficult airway patients, a population in whom DL is expected to underperform relative to mixed airway samples.

The reduction in intubation time with VL (28.4 s vs. 35.1 s) merits clinical interpretation. In critically ill or apnoeic patients, even seconds of additional apnoeic time are consequential, given the limited oxygen reserve in patients with predicted difficult airways who may also have reduced pulmonary reserve. The single episode of SpO_2 desaturation in the VL group versus seven in the DL group is clinically significant and potentially life-saving at scale.

Mort's landmark analysis of emergent intubations demonstrated that complications increase dramatically with each additional laryngoscopy attempt: the incidence of hypoxia rose from 12% on the first attempt to 70% on the third.14 The lower mean attempt count with VL (1.14 ± 0.38 vs. 1.51 ± 0.66) supports VL as a strategy that limits cumulative iatrogenic airway trauma, a finding echoed by the lower rate of dental and soft tissue injury in our trial (2.0% vs. 8.9%).

The concept of 'best view, not best attempt' challenges the historical reliance on repeated DL with incremental adjustments. VL operationalises this philosophy by allowing continuous optimisation of blade position under direct visual feedback on the external monitor, without the physical constraints of achieving a line-of-sight axis.7 The Glide Scopehyperangulated blade geometry employed in this study places the camera distal to the tongue base, thus obviating the requirement for the oral-pharyngeal-laryngeal axis alignment that limits DL in patients with restricted neck extension or anterior laryngeal position.15

This study does acknowledge limitations. First, as a single-centre trial at a tertiary academic institution, generalisability to district hospitals and community settings where advanced VL equipment or trained personnel may be unavailable is limited. Second, the two senior anaesthetists performing all intubations, though credentialled in both techniques, may not represent the proficiency distribution of trainees or less-experienced clinicians. Third, first-pass success is inherently operator-dependent, and the open-label design introduced a potential performance bias despite outcome-assessor blinding. Fourth, our study did not stratify outcomes by specific difficult airway predictor combinations; it is possible that VL confers differential benefit across airway phenotypes (e.g., obesity vs. restricted neck movement), which warrants investigation in adequately powered subgroup analyses. Finally, the study was conducted with the GlideScope Ranger; findings may not be directly extrapolable to other VL platforms with different blade geometries.

Future research should focus on multi-centre trials with broader operator experience profiles, comparison of VL platforms in head-to-head trials within difficult airway populations, cost-effectiveness analyses relevant to resource-limited healthcare settings, and the role of VL in rapid sequence induction scenarios where predicted difficult airway overlaps with full stomach risk.

CONCLUSION

Video laryngoscopy significantly improves first-pass intubation success rates, laryngeal view quality, and peri-intubation safety compared to direct laryngoscopy in adult patients with predicted difficult airways. The clinically meaningful absolute benefit (NNT ≈ 5), combined with reductions in intubation time, number of attempts, and complication rates, supports the incorporation of video laryngoscopy as the primary device of choice when a difficult airway is anticipated. Anaesthesiologists and airway specialists should prioritise its availability and maintain competency in its use as part of a comprehensive difficult airway management strategy.

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