The Egyptian Journal of Hospital Medicine (January 2025) Vol. 98, Page 1158- 1163

The Application Effect of Video Laryngoscopy in Tracheal Intubation in Critically Ill Patients

Asmaa B. Ebaed 1, Ahmed M Abd El-Hamid 1, Mahmoud Zakria Abd El-Hamid 1*, Elsayed M Abdelazeem 2
1 Critical Care Medicine, 2 Intensive Care Medicine Department,
Faculty of Medicine, Banha University, Banha, Egypt
*** Corresponding Author:** Mahmoud Zakria Abd El-hamid**, Email:** mahmoudzakria87@gmail.com, **Phone:** 01142858164

ABSTRACT

Background: Endotracheal intubation (TI) is a critical procedure in emergency airway management. While, direct laryngoscopy (DL) is widely used and video laryngoscopy (VL) enhances visualization and may improve intubation success and safety.

Objective: This study aimed to compare VL and DL in critically ill patients requiring emergency intubation, evaluating efficacy, success rates, and complications.

Patients and methods: A prospective observational study was conducted in the ICU at Benha University Hospital. Patients aged ≥18 years requiring emergency intubation were randomized into VL (n=55) or DL (n=55) groups. Primary outcomes included first-pass success, intubation time, glottic visualization (POGO score), and complication rates.

Results: VL significantly improved glottic visualization (POGO: 80.44% vs. 54.18%, p<0.001), first-pass success (83.64% vs. 63.64%, p=0.017), and reduced intubation time (36.02s vs. 40.91s, p<0.001). Fewer intubation attempts were required (p=0.032). VL was associated with a lower airway injury rate (3.64% vs. 16.36%, p=0.026) and overall complication rate (12.73% vs. 30.91%, p=0.021), with no significant differences in hemodynamic stability.

Conclusion: VL improves intubation efficiency, enhances first-pass success, and reduces complications compared to DL in critically ill patients. These findings support its integration into emergency airway management protocols.

Keywords: TI, VL, DL, Airway management, Glottic visualization.

INTRODUCTION

Endotracheal intubation (TI) is essential for maintaining airway patency and ventilation. While, direct laryngoscopy (DL) is a fundamental method, it has a high failure rate, with initial success reported between 51% and 65% [1]. Multiple intubation attempts increase morbidity and mortality risks, including hypoxemia, aspiration, and cardiac arrest, making the procedure stressful even for experienced clinicians. To enhance success rates, various devices have been developed [2].

Difficult intubation factors include limited mouth opening, cervical instability, airway secretions, and facial trauma with an incidence of 13.2%, complicating emergency airway management [3]. Failed or difficult intubation can lead to severe complications, including hypoxemia, aspiration, arrhythmias, cardiac arrest, and death. Poor visualization further increases trauma risk, contributing to anesthesia-related morbidity and mortality. To improve success, specialized blade designs such as the McCoy leverage and Dörges universal blade were introduced [4].

The rise of thoracoscopic procedures necessitates single-lung ventilation, often achieved using double-lumen endotracheal tubes (DLTs). While, DLTs are the gold standard, their large diameter and rotational insertion technique pose risks of prolonged intubation, failure, and airway trauma [5].

Video laryngoscopes (VLs) enhance anatomical visualization, facilitating intubation in both normal and difficult airways. These devices, available in flexible or rigid designs, transmit images from the distal laryngoscope to a monitor, aiding difficult intubations, while reducing failure, trauma and complications. VLs offer maneuverability and wide visibility, clearly displaying airway structures to improve outcomes [6].

This study aimed to compare VDL and conventional DL in endo TI for critically ill emergency patients to aid in establishing a rapid intubation protocol. It investigates whether a significant difference exists between the two methods, testing the hypothesis that VDL offers a distinct advantage. The null hypothesis states no significant difference between the techniques.

PATIENTS AND METHODS

Study design and participants: This was a prospective observational study conducted at the Critical Care Medicine Department of Benha University Hospital. Critically-ill patients who were admitted during the study period were considered for inclusion to evaluate the efficacy, safety, and procedural outcomes of VL compared to traditional DL in facilitating TI in critically ill patients within an intensive care unit (ICU).

Inclusion criteria: Ill patients aged 18 years or older who required endo TI for various medical indications. Eligibility criteria included respiratory failure (Hypoxemic, e.g., ARDS, pneumonia; or hypercapnic, e.g., COPD exacerbation and acute asthma), airway obstruction (Due to trauma, neoplastic masses and infections like epiglottitis), loss of airway protective reflexes (From stroke, trauma and overdose, or sedation), or signs of respiratory failure such as extreme respiratory rates (<8 or >35 breaths/min), oxygen

Received: 13/10/2024
Accepted: 13/12/2024

saturation < 80%, hemodynamic instability, or the need for emergency intubation.

Exclusion Criteria: Dental trauma risk, difficult intubation history, Mallampati III/IV, airway or respiratory deformities, pregnancy, severe coagulopathy, anatomical abnormalities, complete airway obstruction, and extreme hemodynamic instability.

Randomization and blinding:

The participants were randomly assigned into two groups: Visual group: 55 patients in this group underwent endo TI using a VDL. Direct Group: 55 patients in this group underwent endo TI using conventional DL.

Patient characteristics: Patient characteristics included demographics (age, sex, weight, height, and medical history), severity of illness assessed by APACHE II or SOFA scores, and baseline respiratory status, including ABG, SpO_2, and respiratory rate.

Equipment: The study used standard VLs (e.g., Glidescope and C-MAC) for real-time airway visualization and a Macintosh DL for comparison. Endotracheal tube size (7.0–8.0 mm) was chosen based on patient characteristics. Standard monitoring included NIBP, ECG, SpO_2, and capnography.

Intubation procedure: In the visual group (VDL Intubation): The VL was selected based on the patient's sex and size, checked for air leaks, and prepared with a guidewire in a "J" shape. Continuous monitoring of HR, MAP, and SpO_2 was maintained, with midazolam administered if needed for sedation. During intubation, the patient was positioned supine, the laryngoscope was inserted from the right corner of the mouth, and the glottis was visualized on the screen. The endotracheal tube was guided into the glottis, advanced, adjusted, and secured after laryngoscope removal.

In the direct group (Conventional DL intubation): The conventional laryngoscope was prepared based on patient characteristics. During intubation, the patient was positioned supine, and the laryngoscope was inserted from the right corner of the mouth, pushing the tongue leftward. The blade was positioned between the epiglottis and tongue root, lifting to expose the glottis. The endotracheal tube was inserted, advanced, adjusted, and secured after laryngoscope removal.

Outcomes and Assessments: Primary outcomes included time to successful intubation, first-pass success rate, number of attempts, incidence of oesophageal intubation, dental trauma, Cormack–Lehane grade, and complications such as airway trauma, vocal cord injury and hypoxia, or aspiration. Secondary outcomes assessed hemodynamic stability (BP, HR and SpO_2), oxygenation (SpO_2 and ABG), and post-intubation complications like difficult ventilation and reintubation, or aspiration.

Post-intubation care: Data collection included baseline characteristics (Age, sex, BMI, mouth opening, thyromental distance, and history of difficult intubation). Glottic exposure was assessed using the Cormack–Lehane grade and POGO score. Intubation success was measured by first-pass success rate, intubation time (< 60 sec target), and number of attempts. Hemodynamic parameters (HR, MAP and SpO_2) were recorded at five time points (T0–T4). Complications such as tooth loosening, bleeding, and airway injuries were documented up to 48 hours post-procedure.

Ethical considerations: The study adhered to the ethical principles outlined in the Declaration of Helsinki and was conducted with the highest standards of patient care and safety. Written informed consents were obtained from all patients or their legal representatives, ensuring that they understood the procedure and any risks involved. The study was approved by the Institutional Review Board (IRB) of Banha University ,ensuring that it met all ethical guidelines and standards. Confidentiality and patient privacy were safeguarded throughout the study, with data anonymized and securely stored.

Data Management:

All relevant data, including demographic characteristics, clinical parameters, and procedural outcomes, were collected and entered into a secure database. Statistical analysis was performed using descriptive statistics, including means and standard deviations for continuous variables, and proportions for categorical data. The comparison between VL and DL was performed using appropriate statistical tests such as t-tests for continuous variables and Chi-square tests for categorical variables. A p-value ≤ 0.05 was considered statistically significant. Subgroup analyses were conducted based on age, severity of illness, and intubation difficulty to explore potential modifiers of intubation outcomes.

RESULTS

The results showed no significant differences between the two groups for any of these factors. Age (Mean 45.20 vs. 46.82), BMI (Mean 25.89 vs. 25.00), and sex distribution (34 males/21 females vs. 42 males/13 females) all have P-values > 0.05, indicating that age, BMI, and sex did not significantly impact the choice of laryngoscopy method. The comparison between VL and DL groups showed no significant differences in the prevalence of smoking, diabetes, hypertension, heart disease, kidney disease, liver failure, or malnutrition, with all P-values exceeding 0.05 (Table 1).

Table (1): Comparison of clinical parameters and comorbidities between VL and DL

Parameter	VL	DL	P-Value
Smoking			
Yes	32 (58.18%)	37 (67.27%)	0.324
No	23 (41.82%)	18 (32.73%)	
DM			
Yes	29 (52.73%)	30 (54.55%)	0.848
No	26 (47.27%)	25 (45.45%)	
Hypertension			
Yes	31 (56.36%)	25 (45.45%)	0.252
No	24 (43.64%)	30 (54.55%)	
Heart Diseases			
Yes	26 (47.27%)	25 (45.45%)	0.848
No	29 (52.73%)	30 (54.55%)	
Kidney Disease			
Yes	9 (16.36%)	8 (14.55%)	0.792
No	46 (83.64%)	47 (85.45%)	
Liver Failure			
Yes	9 (16.36%)	7 (12.73%)	0.589
No	46 (83.64%)	48 (87.27%)	
Malnutrition			
Yes	8 (14.55%)	8 (14.55%)	1.000
No	47 (85.45%)	47 (85.45%)	

DM: Diabetes Mellitus; VL: Video Laryngoscopy; DL: Direct Laryngoscopy.

Key intubation parameters showed no significant differences in tube size, mouth opening, and thyromental distance (P = 0.667, 0.471, 0.366). However, VL offers a significant advantage in visibility, with a higher POGO score (80.44% vs. 54.18%, P = 0.000), and faster intubation time (36.02s vs. 40.91s, P = 0.000). Additionally, time to reach various stages (T0–T4) is significantly shorter with VL (P = 0.016 to 0.009), indicating greater efficiency (Table 2).

Table (2): Comparison of key intubation parameters between VL and DL techniques

Parameter	VL (%)	DL (%)	P-Value
Size of Tube	7.464	7.445	0.667
Mouth Opening	3.73	3.67	0.471
Thyromental Distance	7.315	7.167	0.366
POGO (%)	80.44	54.18	<0.001*
IntubationTime (Seconds)	36.02	40.91	<0.001*
T0	91.44	90.42	0.422
T1	91.84	89.93	0.203
T2	94.02	90.60	0.016*
T3	94.22	88.96	<0.001*
T4	92.51	88.98	0.009*

VL: Video Laryngoscopy, DL: Direct Laryngoscopy, POGO: Percentage of Glottic Opening, T0: Baseline measurement (before intubation), T1: After anesthesia induction, T2: Immediately after intubation, T3: 1 minute after intubation, T4: 5 minutes after intubation value; SD: Standard deviation; IV: IV: Intra venous group; IT: Intrathecal group, *: significant p-value <0.05.

This comparison of difficult intubation and outcomes showed no significant difference in difficult intubation rates (38.18% vs. 45.45%, P = 0.439). However, VL had significantly better C/L grading (52.73% vs. 27.27%, P = 0.006), higher glottic exposure success (90.91% vs. 65.45%, P = 0.001), and a greater first-attempt success rate (83.64% vs. 63.64%, P = 0.017). Additionally, fewer intubation attempts were needed with VL, with 81.82% succeeding on the first attempt compared to 63.64% for DL (P = 0.032) (Table 3).

Table (3): Comparison of difficult intubation and outcomes between VL and DL

Parameter	VL (%)	DL (%)	P-Value
Difficult Intubation			0.439
Yes	21 (38.18%)	25 (45.45%)	
No	34 (61.82%)	30 (54.55%)	
C/L Grading			0.006*
Yes	29 (52.73%)	15 (27.27%)	
No	26 (47.27%)	40 (72.73%)	
Glottic Exposure Success			0.001*
Yes	50 (90.91%)	36 (65.45%)	
No	5 (9.09%)	19 (34.55%)	
Succes Rate at one Intubation			0.017*
1	46 (83.64%)	35 (63.64%)	
2	9 (16.36%)	20 (36.36%)	
Intubation Attempts			0.032*
Yes	45 (81.82%)	35 (63.64%)	
No	10 (18.18%)	20 (36.36%)	

VL: Video Laryngoscopy, DL: Direct Laryngoscopy, C/L Grading: Cormack-Lehane Grading (used to assess glottic visualization during intubation), *: significant p-value <0.05.

This comparison of complication rates between VL and DL revealed no significant differences in loose teeth (5.45% vs. 7.27%, P = 0.696) or hemorrhage (3.64% vs. 7.27%, P = 0.401). However, airway injury was significantly less frequent with VL (3.64%) than DL (16.36%), with a P-value of 0.026, indicating improved safety. Additionally, the overall complication rate was significantly lower for VL (12.73%) compared to DL (30.91%), with a P-value of 0.021, suggesting a lower risk of adverse events (Table 4).

Table (4): Comparison of complication rates between VL and DL

Parameter	VL	DL	P-Value
Loose Teeth			
Yes	3 (5.45%)	4 (7.27%)	0.696
No	52 (94.55%)	51 (92.73%)	
Hemorrhage			
Yes	2 (3.64%)	4 (7.27%)	0.401
No	53 (96.36%)	51 (92.73%)	
Airway Injury			
Yes	2 (3.64%)	9 (16.36%)	0.026*
No	53 (96.36%)	46 (83.64%)	
Total Complications Rate			
Yes	7 (12.73%)	17 (30.91%)	0.021*
No	48 (87.27%)	38 (69.09%)	

VL: Video Laryngoscopy DL: Direct Laryngoscopy, *: significant p-value <0.05.

DISCUSSION

TI is vital for managing critically ill patients, but multiple DL attempts are linked to poor outcomes, including airway complications and hemodynamic instability [7]. Initial intubation attempts fail in about 20% of cases in the emergency department (ED) and ICU. VL has emerged as a superior alternative, enhancing airway visualization, though approximately 80% of ED and ICU intubations still use DL despite its challenges, such as limited mouth aperture and cervical spine instability [8]. The efficacy and safety of VL in critically ill patients remain debated, with past meta-analyses showing no significant difference in first-attempt success. However, recent randomized controlled trials, including the large-scale DEVICE trial, have shown promising results [9]. This study aimed to evaluate and compare the effectiveness of VDL versus conventional DL in facilitating endo TI in critically ill emergency patients, assisting clinicians in establishing a rapid and effective intubation protocol.

Regarding our result, we found that the age and demographics of both groups were similar, with only minor differences that are unlikely to impact the results. Tube sizes were nearly identical across both groups, suggesting consistency in the equipment used. The visual group had slightly better anatomy for intubation, superior glottic visualization, and faster intubation times, while both techniques showed similar safety and performance outcomes. **Vlatten *et al.*** [10] found that while VL provides a superior glottic view, DL allows for quicker tube ventilation and intubation, highlighting a trade-off between visualization and speed. **Bektaş *et al.*** [11] found that VL shortened intubation time, improved glottic visualization, and reduced complications compared to Macintosh laryngoscopy, making it a more efficient and potentially safer option for intubation.

We also observed significant differences in POGO score and intubation time, while factors like age, tube size, and time-related variables showed no impact. No significant differences were found in comorbidities between the groups, minimizing their influence on outcomes. Although difficult intubation, loose teeth, haemorrhage, and malnutrition were similar, the visual group showed better Cormack-Lehane grading, glottic exposure, first-attempt success, and fewer airway injuries, indicating superior performance in key clinical aspects. **Araújo *et al.*** [12] conducted a meta-analysis of 14 randomized controlled trials, showing that VL significantly improved first-attempt intubation success compared to DL. Similarly, **Prekker *et al.*** [13] reported higher first-attempt intubation success with VL compared to DL, consistent with previous studies in emergency and ICU settings. However, a multicenter ICU trial with 371 patients found no significant difference between the two methods. Emergency intubation research links first-attempt success to reduced complications. **McDougall *et al.*** [14] found that VL improved first-pass success in critically ill patients.

The superior glottic visualization provided by VL was well documented, especially in high-risk patients, such as those with aerosolized virus concerns like COVID-19, where rapid intubation is crucial. Randomized controlled studies consistently showed that VL enhances laryngeal visibility, increases intubation success, and improves first-attempt success compared to DL. Multiple studies have demonstrated the advantages of VL over the Macintosh laryngoscope in intubation. **Kaur *et al.***[15] found that McGrath MAC and TrueView VLs enabled faster intubation, fewer complications, and better glottic views. **Abdallah *et al.*** [16] reported that the Air traq VL facilitated easier intubation with reduced complications. **Reena *et al.***[17] showed that the King Vision VL improved intubation time and first-attempt success, while **Zhu *et al.*** [18] confirmed higher first-attempt success rates and superior glottic views with VL. **Cavus *et al.***[19] concluded that VL enhances intubation success in both normal and difficult airways due to its superior glottic view. **Hoshijima *et al.*** [20] found that the C-MAC VL required less external laryngeal manipulation and provided better visualization than the Macintosh laryngoscope. **Serocki *et al.***[21] and **Su *et al.***[22] confirmed VL advantage in improving glottic view and intubation success, particularly in difficult cases. **Liu *et al.***[23] reported a higher success rate in glottic exposure and first-attempt intubation with VL compared to DL.

The visual group demonstrated superior performance in several key clinical outcomes, including better glottic exposure and higher first-attempt intubation success, which is supported by the broader literature highlighting the advantages of VL over DL. The Visual group had a significantly lower complication rate than the direct group, with fewer individuals experiencing complications. The statistical analysis confirmed a significant difference between the groups, indicating a higher complication rate in the direct group. These findings align with previous studies [24-26], showing that VL reduces esophageal intubations and aspiration events compared to DL. While overall safety outcomes were similar between the two methods, VL demonstrated potential advantages in minimizing complications like esophageal intubation and dental injuries, with no significant impact on mortality.

Limitations: The study had some limitations like the single-center design, clinician skill variability, and patient heterogeneity that may limit the generalizability of the findings.

CONCLUSIONS

VDL demonstrated significant advantages over conventional DL in critically ill emergency patients, including improved glottic visualization, faster intubation times, and a lower complication rate. The Visual group showed better clinical outcomes, with fewer airway injuries and a higher first-attempt success rate. These findings support the use of VDL as a safer and more efficient alternative for endo TI in emergency settings.

Financial support and sponsorship: Nil.
Conflict of Interest: Nil.

REFERENCES

1. **McCullagh K, Shah R, Huang B (2022)**: Anatomy of the Larynx and Cervical Trachea. Neuroimaging Clin N Am., 32: 809-29.
2. **Langeron O, Birenbaum A, Amour J (2009)**: Airway management in trauma. Minerva Anestesiol., 75: 307-11.
3. **Piccione J, Hysinger E, Vicencio A (2021)**: Pediatric advanced diagnostic and interventional bronchoscopy. Semin Pediatr Surg., 30: 151065.
4. **Mehran R (2018)**: Fundamental and Practical Aspects of Airway Anatomy: From Glottis to Segmental Bronchus. Thorac Surg Clin., 28: 117-25.
5. **Brand-Saberi B, Schäfer T (2014)**: Trachea: anatomy and physiology. Thorac Surg Clin., 24:1-5.
6. **Yong S, Chaou C, Yu S *et al.* (2020)**: Video Assisted Laryngoscope Facilitates Intubation Skill Learning in the Emergency Department. J Acute Med., 10: 60-9.
7. **Nauka P, Moskowitz A, Fein D (2023)**: Appraising First-Pass Success: During Emergency Airway Management, What Does It Mean to Be Successful? Ann Am Thorac Soc., 20: 21-3.

8. **Mihai R, Blair E, Kay H *et al.* (2008)**: A quantitative review and meta-analysis of performance of non-standard laryngoscopes and rigid fibreoptic intubation aids. Anaesthesia, 63: 745-60.
9. **Griesdale D, Chau A, Isac G *et al.* (2012)**: Video-laryngoscopy versus direct laryngoscopy in critically ill patients: a pilot randomized trial. Can J Anaesth., 59: 1032-9.
10. **Vlatten A, Aucoin S, Litz S *et al.* (2009)**: A comparison of the STORZ video laryngoscope and standard direct laryngoscopy for intubation in the Pediatric airway--a randomized clinical trial. Paediatr Anaesth., 19: 1102-7.
11. **Bektaş H, Göksu S, Şen E (2022)**: A Comparison of the Effectiveness of Videolaryngoscopy and Macintosh Laryngoscopy in Intubation Attempts on Adult Patients. Turk J Anaesthesiol Reanim., 50: 352-7.
12. **Araújo B, Rivera A, Martins S *et al.* (2024)**: Video versus direct laryngoscopy in critically ill patients: an updated systematic review and meta-analysis of randomized controlled trials. Crit Care, 28: 1.
13. **Prekker M, Driver B, Trent S *et al.* (2023)**: Video versus Direct Laryngoscopy for Tracheal Intubation of Critically Ill Adults. N Engl J Med., 389: 418-29.
14. **McDougall G, Flindall H, Forestell B *et al.* (2024)**: Direct Laryngoscopy Versus Video Laryngoscopy for Intubation in Critically Ill Patients: A Systematic Review, Meta-Analysis, and Trial Sequential Analysis of Randomized Trials. Crit Care Med., 52: 1674-85.
15. **Kaur G, Gupta S, Mehta N *et al.* (2020)**: Comparative Evaluation of McGrath MAC, Truview Video Laryngoscopes and Macintosh Laryngoscope for Endotracheal Intubation in Patients Undergoing Surgery under General Anaesthesia. Anesth Essays Res., 14: 20-4.
16. **Abdallah S, Gaballah K (2019)**: Endotracheal Intubation Criteria and Stress Response: Airtraq versus Macintosh Laryngoscopes - A Prospective Randomized Controlled Trial. Anesth Essays Res., 13: 430-6.
17. **Reena (2019)**: Comparison of King Vision video laryngoscope (channeled blade) with Macintosh laryngoscope for tracheal intubation using armored endotracheal tubes. J Anaesthesiol Clin Pharmacol., 35: 359-62.
18. **Zhu H, Liu J, Suo L *et al.* (2019)**: A randomized controlled comparison of non-channeled king vision, McGrath MAC video laryngoscope and Macintosh direct laryngoscope for nasotracheal intubation in patients with predicted difficult intubations. BMC Anesthesiol., 19: 166.
19. **Cavus E, Neumann T, Doerges V *et al.* (2011)**: First clinical evaluation of the C-MAC D-Blade videolaryngoscope during routine and difficult intubation. Anesth Analg., 112: 382-5.
20. **Hoshijima H, Mihara T, Maruyama K *et al.* (2018)**: C-MAC videolaryngoscope versus Macintosh laryngoscope for tracheal intubation: A systematic review and meta-analysis with trial sequential analysis. J Clin Anesth., 49: 53-62.
21. **Serocki G, Neumann T, Scharf E *et al.* (2013)**: Indirect videolaryngoscopy with C-MAC D-Blade and GlideScope: a randomized, controlled comparison in patients with suspected difficult airways. Minerva Anestesiol., 79: 121-9.
22. **Su Y, Chen C, Lee Y *et al.* (2011)**: Comparison of video laryngoscopes with direct laryngoscopy for tracheal intubation: a meta-analysis of randomised trials. Eur J Anaesthesiol., 28: 788-95.
23. **Liu D-X, Ye Y, Zhu Y-H *et al.* (2019)**: Intubation of non-difficult airways using video laryngoscope versus direct laryngoscope: a randomized, parallel-group study. BMC Anesthesiology, 19: 75.
24. **Silverberg M, Li N, Acquah S *et al.* (2015)**: Comparison of video laryngoscopy versus direct laryngoscopy during urgent endotracheal intubation: a randomized controlled trial. Crit Care Med., 43: 636-41.
25. **Aziz M, Dillman D, Fu R *et al.* (2012)**: Comparative effectiveness of the C-MAC video laryngoscope versus direct laryngoscopy in the setting of the predicted difficult airway. Anesthesiology, 116: 629-36.
26. **Orser B (2020)**: Recommendations for Endotracheal Intubation of COVID-19 Patients. Anesth Analg., 130: 1109-10.