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The role of video and direct laryngoscopy in medical student intubation training: a comparative study on success rates and learning curves

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Abstract

Background Direct laryngoscopy (DL) is widely recognized as the most commonly used method for tracheal intubation. However, growing evidence highlights the increasingly prominent role of video laryngoscopy (VL) in the management of difficult airways. This study aimed to determine the most effective medical education method to equip medical students with this critical skill. In addition to evaluating the contributions of an intubation training program utilizing direct laryngoscopy and video laryngoscopy to tracheal intubation success among inexperienced medical students, we also aimed to explore the potential benefits of combining these two techniques.

Methods This mannequin-based study included 130 medical students. Before the study began, participants attended a 30-minute theoretical training session. Participants were randomly assigned to start with one of two scenarios. In each scenario, participants were given three attempts to perform intubation using each laryngoscope. The maximum allowable time for each intubation was set at 3 min. Students who successfully intubated within 3 min were recorded as successful, while those who failed to do so were recorded as unsuccessful.

Results The study demonstrated that VL provided higher success rates and shorter intubation times, particularly during the first and second attempts. However, it is noteworthy that no significant difference in success rates was observed between VL and DL during the third attempt.

Conclusion This study highlights the necessity of integrating both VL and DL methods in intubation training programs. The combination of both approaches allows students to achieve quick initial results while progressively developing proficiency for more complex scenarios over time.

Clinical trial number Not applicable.

Keywords Endotracheal intubation, Medical education, Video laryngoscopy, Direct laryngoscopy

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Background

Endotracheal intubation is a frequently encountered and potentially life-saving procedure in both emergency and surgical settings [1, 2]. Direct laryngoscopy is widely recognized as the most frequently employed technique for tracheal intubation [3]. Evidence demonstrates that Macintosh and Miller direct laryngoscopes are employed by over 95% of experienced professionals [4, 5]. However, the first-attempt success rate for Emergency Endotracheal Intubation in critically ill patients ranges from 54 to 94%. This variation is influenced by factors such as the nature of the emergency, unforeseen complications, and the experience of the operator [6].

Endotracheal intubation is one of the most essential manual skills in anesthesiology and, like other technical skills, is subject to a learning curve [7, 8]. Regrettably, the first-pass success rates for emergency intubations tend to be variable and comparatively low [9]. Introduced in 2001, the GlideScope video laryngoscope is an advanced intubation device that has shown enhanced glottic visualization in intubations conducted in both operating rooms and emergency settings [3, 4]. Studies highlight that video laryngoscopy achieves higher overall success rates and significantly improves first-attempt success in airway management during emergency intubations, establishing itself as an effective alternative [10].

Previous research conducted with medical students found that intubation training using direct laryngoscopy (DL) resulted in shorter average intubation times compared to a group of medical students trained with video laryngoscopy (VL) [11]. A prior study by Lim et al. in 2004, which assessed intubation times among inexperienced medical students trained with indirect video laryngoscopy, demonstrated that intubation times were significantly shorter in cohorts utilizing VL during difficult intubations [12]. In contrast, a 2005 study by Lim et al. revealed that during simulated easy laryngoscopy, experienced anesthetists required more time with VL compared to DL. However, during simulated difficult laryngoscopy, anesthetists achieved shorter successful intubation times with VL, although there was no significant difference in success rates compared to DL [13].

Our study aims to identify the most effective medical education method to enable medical students to acquire this critical skill using a mannequin-based evaluation approach. Currently, there is no standardized training protocol for medical students. This study aims to evaluate the contributions of an intubation training program conducted using direct laryngoscopy (DL) and video laryngoscopy (VL) to tracheal intubation success among inexperienced medical students, and to demonstrate the potential benefits of combining these two methods.

Methods

This study was designed as a mannequin-based study and conducted with students from Ufuk University Faculty of Medicine. A total of 130 medical students who had not previously received endotracheal intubation training were included in the study during the 2024–2025 academic year. The participants consisted of 20 s-year, 20 third-year, 30 fourth-year, 30 fifth-year, and 30 sixth-year students. Prior to the commencement of the study, participants attended a 30-minute theoretical training session. This session covered the technical specifications of the laryngoscopes used and proper tracheal intubation techniques. Upon completion of the training, the instructor provided a demonstration of the proper intubation technique using both types of laryngoscopes. Subsequently, participants were given one hour to practice and become acquainted with the devices under normal airway conditions.

In the study, two laryngoscopes were utilized: the McGrath video laryngoscope equipped with a size 3 Macintosh blade and the Macintosh laryngoscope (MAC) with a size 3 blade, which is considered the "gold standard" due to its widespread use and serves as a reference point in comparisons with other laryngoscopes. A standard airway mannequin with a normal airway configuration (Ambu Airway Man, Ambu, Copenhagen, Denmark) was utilized for the study. Each participant performed endotracheal intubation with both the McGrath and MAC laryngoscopes across two distinct airway scenarios.

Participants were randomly assigned to begin with one of the two scenarios(starting with DL or starting with VL), and the devices for each case were further randomized. In each scenario, participants were allowed up to three attempts with each laryngoscope to achieve intubation. The maximum allowable time for each intubation was set at 3 min. Participants who successfully performed intubation within 3 min were recorded as successful, while those unable to do so within the given time were recorded as unsuccessful. Participants were permitted to make minor adjustments to the manikin's positioning during attempts. At each stage, data were collected on the time required for intubation, the number of successful attempts, and the number of unsuccessful attempts, and these metrics were compared between the groups.

Written informed consent was obtained from all students before participating in the study. Ufuk University Ethics Committee was obtained for this study (12024861-01,02.13.2025). The work was conducted in accordance with the World Medical Association Declaration of Helsinki.

All collected data were analyzed using the Chi-Square test and Fisher's exact test for qualitative data, and the t-test for quantitative data. Data that did not exhibit a normal distribution were analyzed using the

Table 1 Attempts success and time table

Method	Attempt	Successful Students Count	Success Rate (%)	Average İntubation Time(minute)
DL	1st Attempt	48	36.92	2.0
DL	2nd Attempt	88	67.69	1.89
DL	3rd Attempt	104	80.0	1.55
VL	1st Attempt	82	63.07	1.79
VL	2nd Attempt	111	85.38	1.55
VL	3rd Attempt	116	89.23	1.05

Mann-Whitney test. The Pearson correlation coefficient was employed to assess the relationship between success rates and duration. Data analysis was conducted using SPSS (29.0.2.0), and a p-value of < 0.05 was considered statistically significant.

Results

When analyzing the success rates of Direct Laryngoscopy (DL) and Video Laryngoscopy (VL) methods, the results indicate that 48 students (36.92%) achieved successful intubation on the first attempt using DL, 88 students (67.69%) on the second attempt, and 104 students (80%) on the third attempt. In contrast, with VL, 82 students (63.07%) were successful on the first attempt, 111 students (85.38%) on the second attempt, and 116 students (89.23%) on the third attempt.

Regarding the average intubation times for students who performed successful intubations, the times for DL were 2 min on the first attempt, 1.89 min on the second attempt, and 1.55 min on the third attempt. For VL, the average times were 1.79 min on the first attempt, 1.55 min on the second attempt, and 1.05 min on the third attempt (Table 1).

When examining the graph displaying success percentages across attempts, it is evident that the intubation success rates increase with the number of attempts for both Direct Laryngoscopy (DL) and Video Laryngoscopy (VL) methods (Fig. 1).

When examining the graph illustrating the average intubation times across attempts, it is observed that intubation times decrease as the number of attempts increases for both Direct Laryngoscopy (DL) and Video Laryngoscopy (VL) methods (Fig. 2).

The results of the Chi-Square test, conducted to evaluate the statistical significance of the success rates, revealed that the differences in the 1st and 2nd attempts were statistically significant ($p < 0.05$), while the difference in the 3rd attempt was not statistically significant ($p = 0.058$). The same data were also analyzed using Fisher's exact test, and Odds Ratios along with p-values were calculated for each attempt. The findings confirm that the differences in success rates were statistically significant for the 1st and 2nd attempts ($p < 0.05$). Consistent

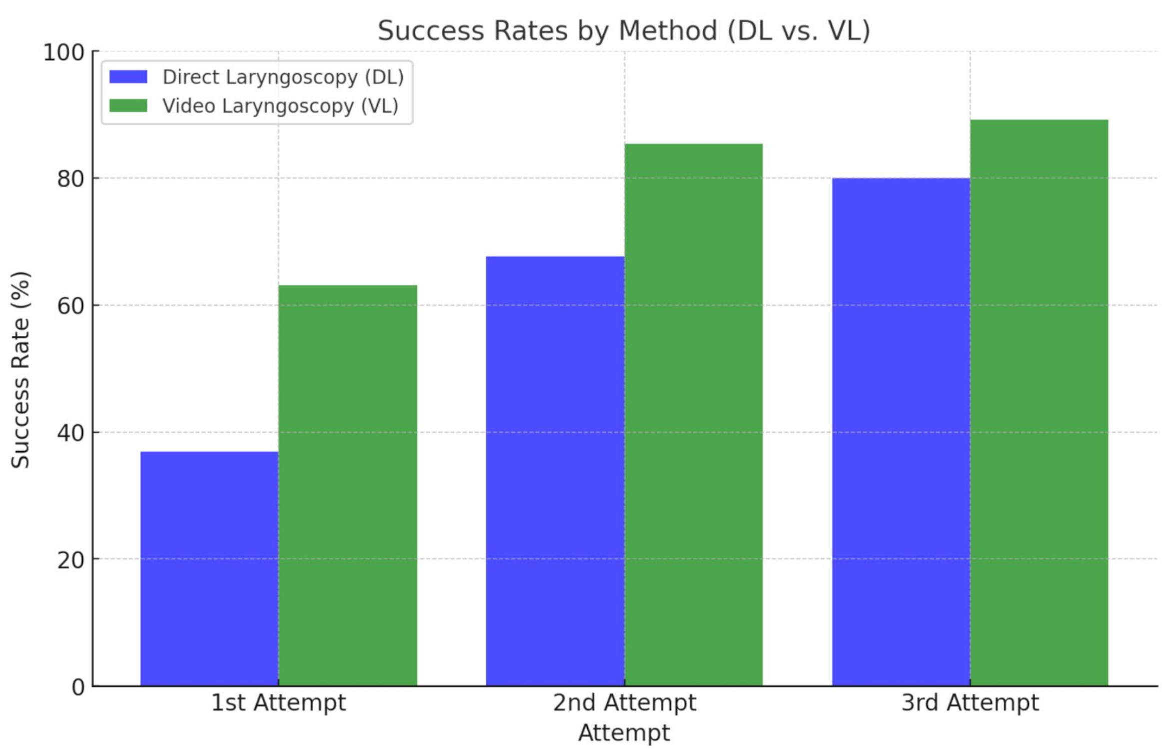

Fig. 1 Success rates by methods(DL vs.VL)

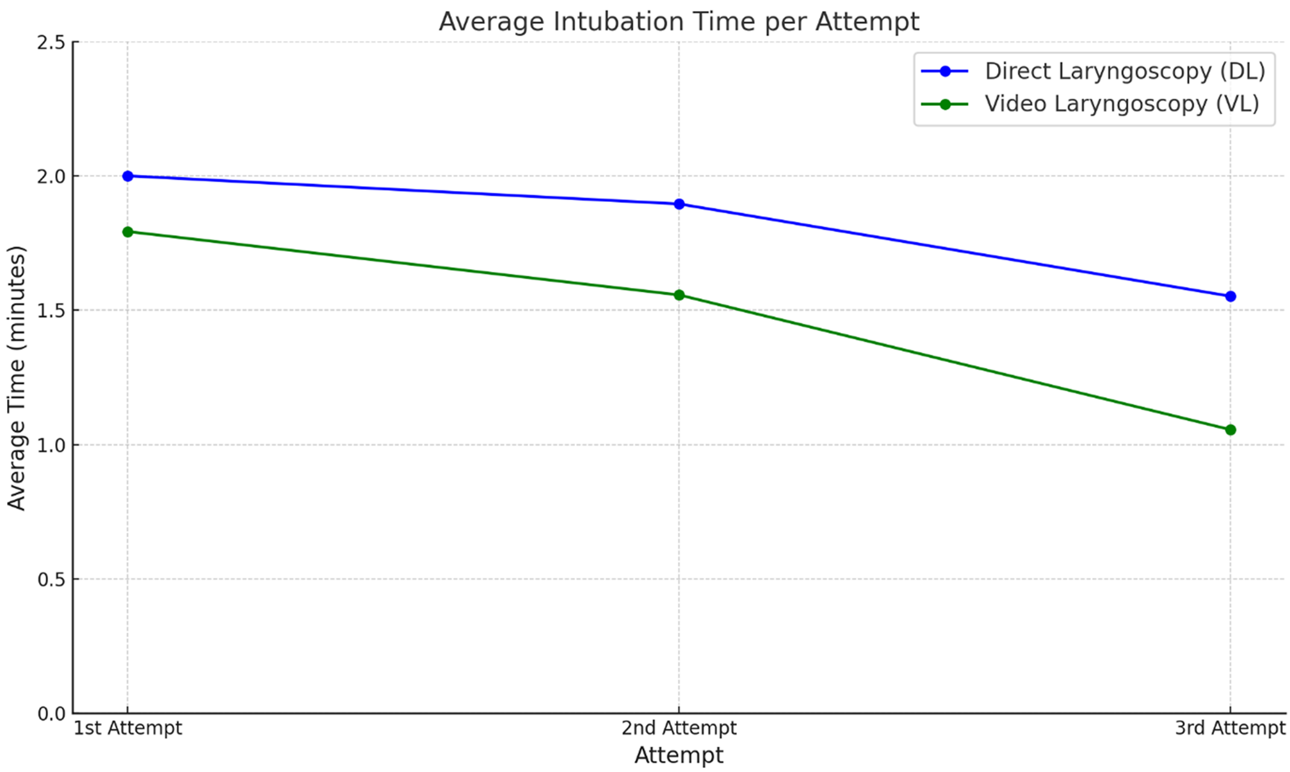

Fig. 2 Average intubation time per attempt

Table 2 Statistical test results

Attempt	Chi-Square *P*-Value	Fisher *P*-Value	T-Test *P*-Value	Mann-Whitney *P* Value
1st Attempt	0.00004	0.000039	0.139	0.128
2nd Attempt	0.00128	0.00117	0.001	0.001
3rd Attempt	0.0586	0.05767	0.00000004	0.000000156

with the Chi-Square test results, the difference in the 3rd attempt was not statistically significant ($p = 0.057$) (Table 2).

The results of the T-Test, conducted to assess whether the differences in average intubation times were statistically significant, indicated that the differences in the 2nd and 3rd attempts were statistically significant ($p < 0.05$), whereas the difference in the 1st attempt was not statistically significant ($p = 0.13$). Similarly, when the time data were analyzed using the Mann-Whitney U test, the results showed that the differences in intubation times for the 2nd and 3rd attempts were statistically significant ($p < 0.05$), while the difference in the 1st attempt ($p = 0.128$) was not statistically significant (Table 2).

When analyzing the regression results that demonstrate how success rates change with the number of attempts, the following trends were identified:

DL Trend: The slope is steeper (slope = 0.215), indicating that the success rate increases more rapidly with the number of attempts.

VL Trend: The initial success rate is higher (intercept = 0.531), but the rate of increase is slower (slope = 0.131).

These findings suggest that VL has an initial advantage; however, DL closes the gap as the number of attempts increases (Fig. 3).

When analyzing the regression results depicting how intubation time changes with the number of attempts, the following trends emerge:

VL: VL achieves shorter intubation times from the outset compared to DL.

DL: Intubation times with DL decrease more significantly as the number of attempts increase.

VL Trend: The reduction in intubation time with VL is relatively less pronounced, as the method already provides a faster initial performance.

These findings indicate that while VL maintains an initial advantage in speed, DL demonstrates greater improvement over successive attempts (Fig. 4).

The relationship between the success rate and intubation time was assessed using the Pearson correlation coefficient:

DL: The correlation coefficient is -0.86, indicating a strong negative relationship. This suggests that as the success rate increases, intubation time decreases significantly. These results demonstrate that users become both more successful and faster with DL as the number of attempts increases.

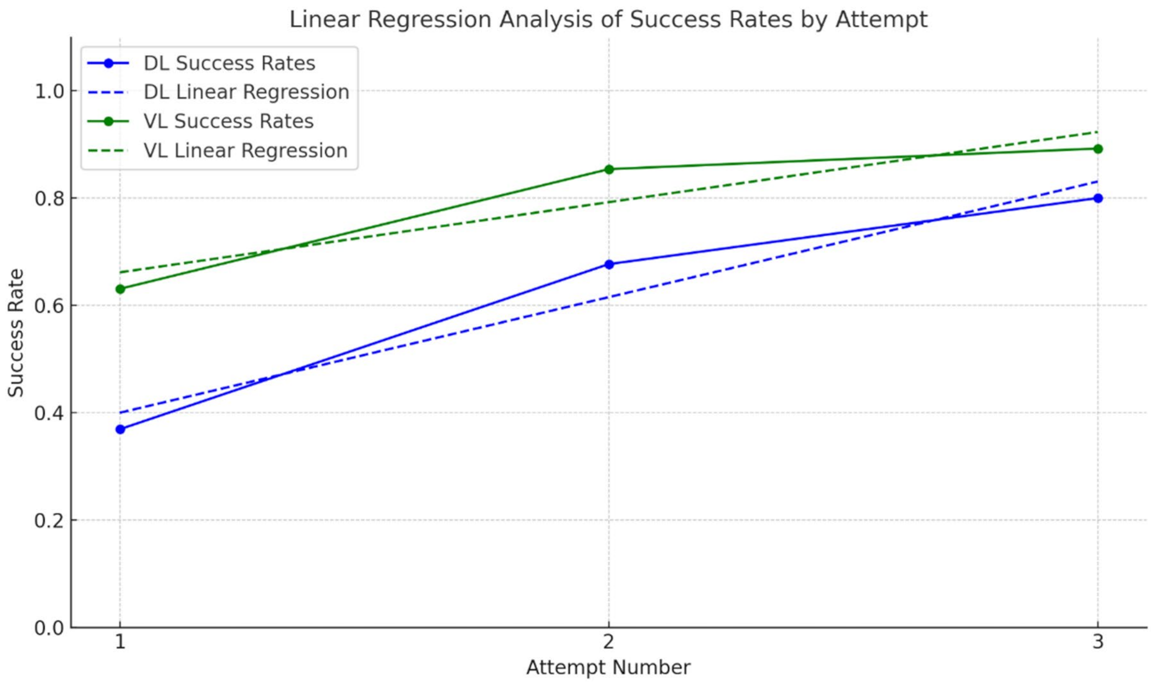

Fig. 3 Linear regression analysis of success rates by attemp

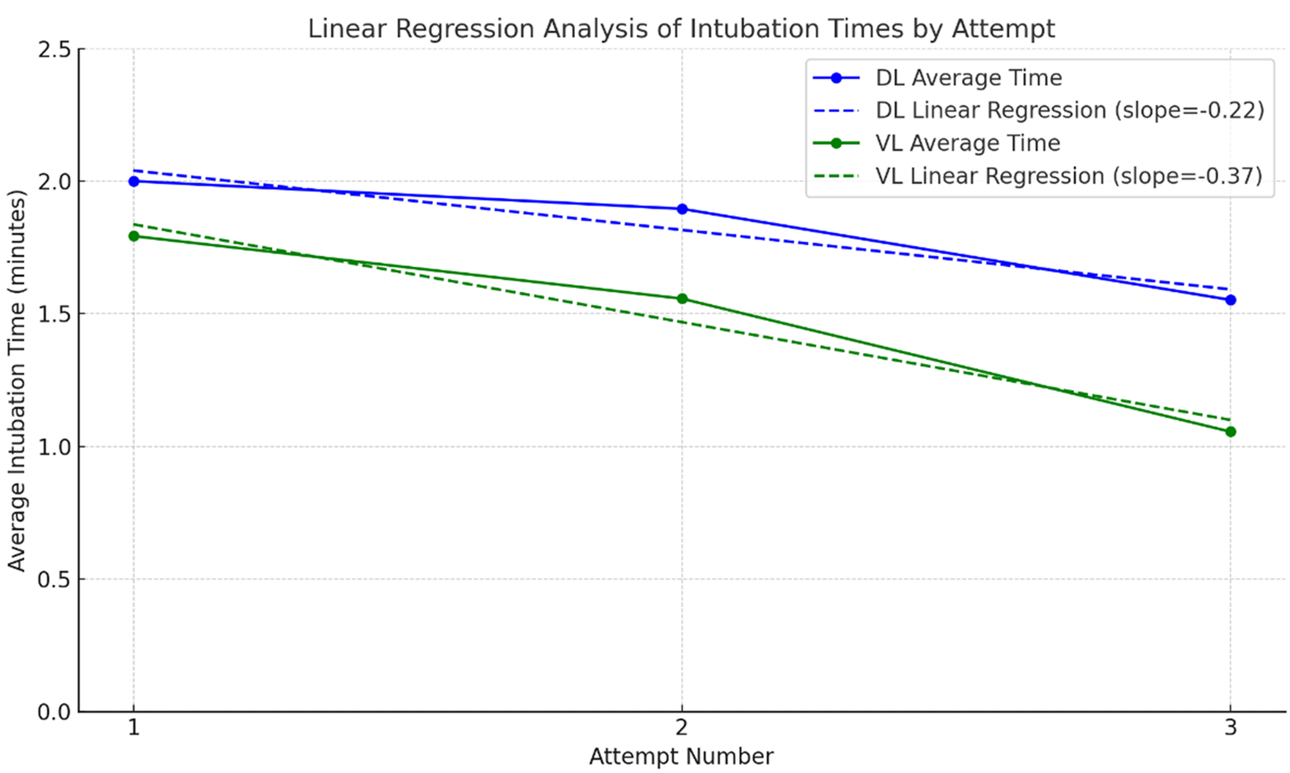

Fig. 4 Linear regression analysis of intubation times by attempt

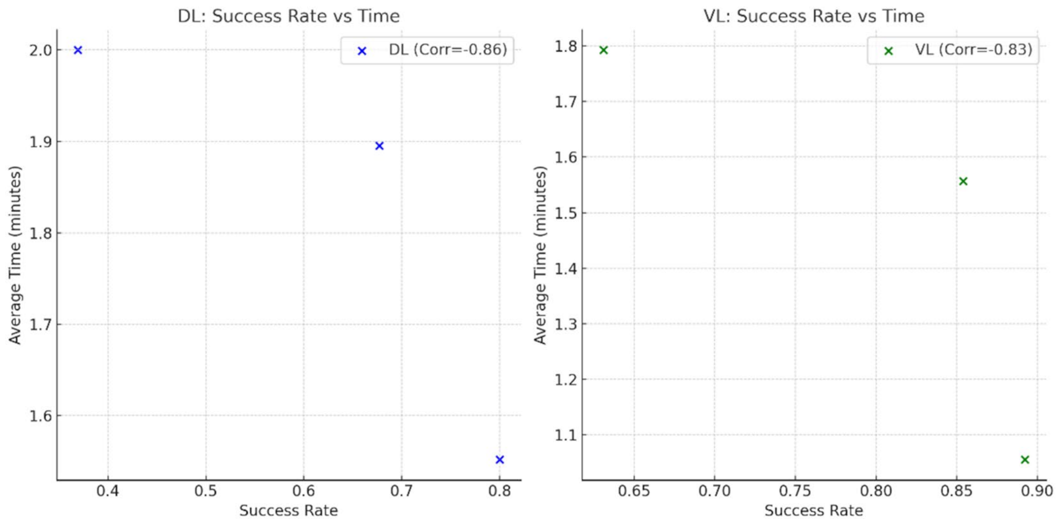

Fig. 5 The relationship between the success rate and intubation

VL: The correlation coefficient is -0.83, also indicating a strong negative relationship, though slightly weaker than that of DL. Since VL users are initially faster, the reduction in intubation time is less pronounced compared to DL.

The stronger negative correlation for DL suggests that this method has a greater potential for improvement during the learning process. With continued practice, DL users may achieve performance levels comparable to those of VL users (Fig. 5).

Discussion

This study evaluates the process by which medical students develop intubation skills using direct laryngoscopy (DL) and video laryngoscopy (VL), as well as the impact of these methods on success rates and intubation times. The findings indicate that VL is a more user-friendly and rapidly learnable method, particularly for novice learners. During initial attempts, VL demonstrated both higher success rates and shorter intubation times compared to DL. This outcome is likely attributed to the superior glottic visualization provided by VL devices, such as the GlideScope, which enable novice users to more easily identify anatomical structures and perform tracheal intubation more efficiently.

In comparable studies, Silverberg reported a statistically significant finding: the success rate in VL group was 15% higher than that in the DL group [3]. Similarly, Mosier demonstrated that VL could improve first-pass success rates and enhance overall intubation efficiency [14]. In the present study, VL showed higher success rates and shorter intubation times during the first and second attempts, indicating its effectiveness in time-sensitive scenarios such as emergencies. However, it is noteworthy that during the third attempt, the success rates between VL and DL showed no significant difference. This suggests that while VL offers an initial advantage, the learning curve for DL is steeper and longer, allowing users to achieve significant improvements with practice.

The regression analysis supports this observation, showing a stronger upward trend for DL compared to VL, indicating a greater potential for skill improvement over time. With continued practice, DL users may eventually achieve performance levels comparable to those of VL users.

Herbstreit et al. demonstrated the superiority of VL over DL in terms of intubation success and intubation time [15]. Similarly, Yi et al. highlighted the advantages of VL in reducing intubation time [16]. In this study, VL demonstrated faster results during the first attempt compared to DL; however, as the number of attempts increased, this difference diminished. This finding highlights the potential of DL to improve over time, achieving performance levels closer to VL in the long term.

Numerous studies have shown that VL provides a faster learning curve compared to DL, offers better glottic visualization, and ensures higher intubation efficiency, particularly in challenging scenarios such as difficult airways or limited access [6, 10, 17]. Our study's T-test and Mann-Whitney U test results also demonstrated that VL was significantly faster during the first attempt. However, by the third attempt, this difference was no longer statistically significant, emphasizing the potential for DL to improve intubation times with practice.

The findings of this study suggest that both VL and DL should be integrated into intubation training programs. VL can enhance motivation by providing novice learners with rapid learning and higher initial success rates. On the other hand, DL supports long-term skill development, and training programs should allocate significant focus to this method as well. Combining both approaches ensures that learners achieve quick results initially while gradually developing the competency required to handle more complex cases. VL offers an effective starting point for users requiring rapid learning, especially in emergencies, while mastering DL's learning curve helps prepare clinicians for a broader range of clinical challenges.

Strengths and limitations of the study

The strengths of this study include the participation of a large and diverse cohort of medical students and the evaluation of both methods across various airway scenarios. Furthermore, the use of statistical analyses provided detailed evaluations and enhanced the reliability of the findings.

However, there are limitations. Simulated airway scenarios may not fully replicate real clinical conditions. Factors such as anatomical variations, secretions, or trauma in real-world scenarios could influence success rates and intubation times. Additionally, this study was limited to a specific group of medical students, highlighting the need for broader studies involving more diverse populations. Future research could evaluate the performance of clinicians with varying levels of experience and include comparisons conducted in actual clinical settings.

Conclusions

In conclusion, this study demonstrates that DL and VL play complementary roles in intubation training. VL provides rapid learning and higher initial success rates, making it particularly effective for novice learners. However, DL supports long-term skill development, and training programs should allocate sufficient focus to this method. The combination of these two approaches allows learners to achieve quick results early in their training while developing the expertise required to manage more complex scenarios over time.

For scenarios requiring rapid skill acquisition, such as emergencies, VL offers an excellent starting point. Meanwhile, mastering DL's learning curve ensures that clinicians are adequately prepared for diverse clinical challenges, contributing to their readiness for real-world practice.

Abbreviations

DL Direct laryngoscopy
VL Video laryngoscopy

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Not applicable.

Author contributions

This manuscript was written by a single author.

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Data availability

All data supporting the findings of this study are available from the authors upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Ufuk University (approval number: 12024861-01,02.13.2025). The work was conducted in accordance with the World Medical Association Declaration of Helsinki. Written informed consent was obtained from all participants involved in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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