

Comparing the Effectiveness of Direct Laryngoscopy and Video Laryngoscopy (GlideScope®) Training on Medical Students' Performance: A Randomized Controlled Trial

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Abstract

Background

This study compared two methods of teaching endotracheal intubation to medical students with no prior training using a medical moulage: GlideScope® video laryngoscopy and direct laryngoscopy. Outcomes were student satisfaction and performance (intubation success).

Methods

In this randomized interventional study, 42 fifth-year medical students with no previous formal intubation training were randomly assigned to receive training with either a GlideScope® video laryngoscope (n = 21) or a conventional direct laryngoscope (n = 21). Participants performed five consecutive endotracheal intubation attempts on a simulator. The primary outcome was intubation success, while the secondary outcomes were intubation performance speed and student satisfaction.

Results

Both methods showed high overall success rates (GlideScope 95%, laryngoscope 90%; $p = 0.05$ by binomial test). The GlideScope group had more students achieving perfect 5/5 success (61.9% vs. 38.1%) and Excellent satisfaction (81% vs. 57.1%), but differences were not significant (success $p = 0.451$; satisfaction $p = 0.247$). Intubation speed improved progressively across five attempts in both groups, with no significant time-by-method interaction ($p = 0.841$). Subgroup analyses found no significant effects of gender ($p = 0.489$) or baseline knowledge ($p = 0.867$).

Conclusion

GlideScope and direct laryngoscopy were similarly effective for teaching endotracheal intubation, with comparable skill acquisition, success, and satisfaction. Although trends favored GlideScope for perfect success and higher satisfaction, these differences were not significant. Either device may be used based on resources and educational goals.

1. Introduction

Tracheal intubation is a fundamental skill in the medical sciences. Most airway intubations in the emergency department and ICU are performed by a direct laryngoscope (1) and with the outbreak of the COVID-19 pandemic, the use of video laryngoscopes has increased (2).

Among medical students and clinical trainees, two main reasons have made training this essential skill difficult and the success rate of beginners low. First, the opportunity for tracheal intubation is limited to

20 to 30 seconds, and it is not possible to extend this time for better and more training. Secondly, during direct intubation via the direct laryngoscopy method, only one person can observe the inside of the mouth and larynx, and it is not possible for the instructor and the trainee to be present at the same time. To compensate for these constraints, anatomical images, video demonstrations, and moulages are used in intubation training; however, the problem remains at the patient's bedside (3).

Two types of laryngoscopes are commonly utilized to perform endotracheal intubation: the direct laryngoscope (DL) and the video laryngoscope (VL). The direct laryngoscope consists of a handle, a blade, and a lamp. To employ the direct laryngoscope, the physician moves the patient's tongue and epiglottis by the blade, views the vocal cords through the mouth (direct laryngoscopy), and then passes the endotracheal tube through the vocal cords.

The video laryngoscope contains the same components as the direct laryngoscope, but it also has a camera on the distal half of the blade which transmits images to a screen. With the help of the video screen and indirect viewing of the vocal cords, the physician can guide the endotracheal tube into the trachea (4).

Video laryngoscopes, with GlideScope® being one of their types, are new devices that allow the visualization of the laryngeal structure on a monitor, whereby the images on the monitor can be viewed simultaneously by the instructor and the trainee, which can be useful in training tracheal intubation (5). Many experts believe that video laryngoscopes will replace direct laryngoscopes in the future thanks to the good view they provide of the laryngeal structure, as they have been very effective along the COVID-19 pandemic. One of the advantages of video laryngoscopes is protection of the physician, as they are less exposed to the patient's respiratory secretions(6). Meanwhile, clinical studies are examining their clinical superiority. Nevertheless, the high cost of this device is an obstacle to its daily use.

Given the COVID-19 pandemic and the increasing importance of implementing Airborne Precautions, the use of training methods that minimize close contact between the instructor and the learner has become more essential than ever. Simulator-Based Training not only fulfills this health-related need but also, by providing a safe, stress-free, and reproducible environment, enables the practice of complex skills such as tracheal intubation prior to facing real patients. Among these methods, video laryngoscopes inherently allow for maintaining physical distance and reducing the operator's direct exposure to patients' respiratory secretions due to their built-in screen. This feature, in addition to educational advantages such as simultaneous viewing of the operative field by both instructor and student, makes them an ideal choice for the post-COVID era as well as for high-risk situations such as patients with contagious diseases. Therefore, a scientific comparison of the effectiveness of this novel technology with the gold standard method (direct laryngoscopy) within the context of simulator-based training constitutes an essential step in revising and optimizing clinical curricula.

2. Materials and methods

2.1. Study Design and Participants

This randomized interventional study was conducted among fifth-year medical students at Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Participants were recruited through convenience sampling. Students who had previously attended an intubation course or received formal intubation training were excluded from participation. Before practical training, all students received standardized theoretical instruction on airway management delivered by an emergency medicine specialist.

The sample size was calculated to compare two independent groups with respect to intubation speed and success. Assuming a two-sided significance level of 0.05, a statistical power of 80%, a standard deviation of 15 seconds, and an expected mean difference of 10 seconds, the required sample size was estimated to be 36 participants per group. Due to limitations in participant availability and eligibility, 42 students were ultimately enrolled and randomized, with 21 participants assigned to each study group.

2.2. Randomization

Following enrollment, participants were randomly assigned in a 1:1 ratio to either the GlideScope® video laryngoscopy group or the direct laryngoscopy (DL) group. Randomization was performed using a computer-generated random sequence, and allocation was concealed using sealed opaque envelopes until assignment. Owing to the nature of the intervention, blinding of participants and instructors was not feasible.

2.3. Baseline Knowledge Assessment

Prior to training, participants were asked to report their level of baseline knowledge regarding endotracheal intubation. Baseline knowledge was categorized into three levels. Students classified as having low knowledge reported only theoretical knowledge of the intubation procedure. Those classified as having moderate knowledge reported familiarity with airway anatomy and intubation equipment in addition to theoretical knowledge. Students classified as having high knowledge reported complete familiarity with the procedural steps of endotracheal intubation.

2.4. Training Procedure

All practical training sessions were conducted using a Laerdal Airway Management Trainer mannequin (Laerdal Medical, Norway). Participants allocated to the DL group were trained using a Macintosh size 3 laryngoscope blade (Heine, Germany), whereas participants in the GlideScope® group were trained using a GlideScope® GVL video laryngoscope (Verathon, USA). The same type and size of endotracheal tube was used for all participants.

Following completion of the training session, each participant performed five consecutive endotracheal intubation attempts on the simulator. For each attempt, the total procedure time and success or failure of the intubation were recorded. Intubation time was defined as the interval from insertion of the laryngoscope blade beyond the teeth until successful passage of the endotracheal tube cuff through the vocal cords. A maximum time limit of 60 seconds was allowed for each attempt. Attempts that were not

successfully completed within this period were recorded as failures, and a duration of 60 seconds was assigned.

2.5. Outcome Measures

The primary outcome was intubation success, defined as the number of successful intubation attempts achieved by each participant during five consecutive attempts. Scores ranged from 0 to 5, with higher scores indicating greater proficiency.

The secondary outcome was intubation performance speed, measured as the time required to complete each intubation attempt. Repeated measurements across five attempts were used to evaluate the learning curve associated with each training method.

Student satisfaction was assessed immediately after completion of the practical session. Participants were asked to rate their overall satisfaction with the assigned training method using a single-item 5-point scale ranging from 1 (very dissatisfied) to 5 (very satisfied).

2.6. Statistical Analysis

Data were analyzed using SPSS version 18 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean $\pm$ standard deviation and compared using independent-samples t-tests. Repeated measures analysis of variance (ANOVA) was used to evaluate changes in performance speed across the five intubation attempts. Categorical variables were analyzed using the chi-square test. A two-sided p-value less than 0.05 was considered statistically significant.

3. Results

Among the 69 students who entered the study, 42 were ultimately eligible for inclusion in the study and were randomly divided into two groups of 21.

The distribution of gender and baseline knowledge was similar across the GlideScope and Laryngoscope training groups, though students in the GlideScope group tended to report higher satisfaction and greater success rates on intubation attempts (Table 1).

Table 1
Demographic Characteristics of Students Stratified by Endotracheal
Intubation Training Method (GlideScope vs. Laryngoscope).

Gender	Laryngoscope (N = 21)	Glidoscope^R (N = 21)
Male	10 (47.6)	13 (61.9)
Female	11 (52.4)	8 (38.1)
Basic information		
Low	13 (61.9)	17 (80.9)
Medium	8 (38.1)	4 (19.0)
High	0 (0)	0 (0)
Satisfaction		
Low	0 (0)	0 (0)
Medium	2 (9.5)	1 (4.7)
Good	7 (33.3)	3 (14.3)
Very good	12 (57.1)	17 (81)
Successful attempts		
1 of 5	0 (0)	0 (0)
2 of 5	2 (9.5)	1 (4.7)
3 of 5	6 (28.6)	3 (14.3)
4 of 5	5 (23.8)	4 (19.0)
5 of 5	8 (38.1)	13 (61.9)

Evaluation of intubation success using a binomial test revealed that both the GlideScope (95% success, $p = 0.005$) and the Laryngoscope (90% success, $p = 0.005$) provided statistically significant training outcomes (Table 2).

Table 2
Assessment of Students' Intubation success in Endotracheal Intubation Training Using
GlideScope and Laryngoscope by Non-Parametric Binomial Test.

	Laryngoscope (N = 21)	P-value	Glidoscope^R (N = 21)	P-value
Successful	20 (95)	< 0.01	19 (90)	< 0.01
Unsuccessful	1 (5)		2 (10)	

Repeated measures analysis of intubation speed across five attempts demonstrated no significant time-by-method interaction ($F = 0.041$, $p = 0.841$), indicating comparable rates of improvement between the GlideScope and Laryngoscope training groups (Table 3)

Table 3
Repeated Measures Test for Comparing Students' Performance Speed Using GlideScope and Laryngoscope Methods.

Method	Attempt	Mean	Standard Deviation	F Statistic (Time × Teaching Method)	P-value
GlideScopeR	Attempt 1	34.06	22.56	0.041	0.841
	Attempt 2	29.08	19.61		
	Attempt 3	21.95	13.80		
	Attempt 4	16.35	9.11		
	Attempt 5	12.21	6.26		
Laryngoscope	Attempt 1	44.22	32.84	0.041	0.841
	Attempt 2	31.46	16.79		
	Attempt 3	26.01	13.78		
	Attempt 4	22.68	14.43		
	Attempt 5	16.04	7.43		

Comparison of satisfaction levels between the two educational methods revealed no statistically significant difference ($\chi^2 = 2.795$, $p = 0.247$), despite a trend toward higher 'Excellent' ratings in the GlideScope group (Table 4)

Table 4
Comparison of Participants' Satisfaction in Two Educational Methods: GlideScope
and Laryngoscope.

Satisfaction Level	GlideScope	Laryngoscope	Chi-Square (X²)	P-value
Low	0 (0%)	0 (0%)	2.795	0.247
Moderate	1 (4.8%)	2 (9.5%)		
Good	3 (14.2%)	7 (33.3%)		
Excellent	17 (81%)	12 (57.1%)		
Note: Data presented as number and percent (%).				

Repeated measures analysis of intubation speed revealed no significant three-way interaction between time, method, and gender ($F = 0.501$, $p = 0.489$), nor any significant time-by-gender interactions within either training method (GlideScope: $F = 1.111$, $p = 0.415$; Laryngoscope: $F = 2.013$, $p = 0.358$), indicating that performance improvement over time was not influenced by gender (Table 5).

Table 5
Repeated Measures Test for Comparing Students' Performance Speed Between Females and Males in Two Educational Methods.

Method	Attempt	Females (Mean $\pm$ SD)	Males (Mean $\pm$ SD)	F (Time $\times$ Gender)	P-Value	F (Time $\times$ Method $\times$ Gender)	P-Value
GlideScope	Attempt 1	40.2 $\pm$ 17.42	31.0 $\pm$ 25.01	1.111	0.415	0.501	0.489
	Attempt 2	35.71 $\pm$ 22.26	24.86 $\pm$ 17.49				
	Attempt 3	27.71 $\pm$ 17.11	18.84 $\pm$ 11.20				
	Attempt 4	20.14 $\pm$ 7.75	14.30 $\pm$ 9.41				
	Attempt 5	16.28 $\pm$ 7.01	9.83 $\pm$ 4.54				
Laryngoscope	Attempt 1	28.5 $\pm$ 13.77	56.8 $\pm$ 39.63	2.013	0.358		
	Attempt 2	34.0 $\pm$ 21.20	29.3 $\pm$ 13.33				
	Attempt 3	28.64 $\pm$ 15.62	23.08 $\pm$ 11.60				
	Attempt 4	21.65 $\pm$ 10.73	23.93 $\pm$ 18.63				
	Attempt 5	16.18 $\pm$ 6.95	15.90 $\pm$ 8.30				

to assess proficiency, each student's **intubation success** was determined by recording the number of successful intubations they achieved out of five consecutive attempts. Scores ranged from 1 to 5, with a score of 5/5 indicating successful intubation on all attempts (Very High Success) and 1/5 indicating success on only one attempt (Very Low Success). Stratified analysis by gender revealed no significant differences in intubation success between the GlideScope and Laryngoscope training methods for either female ($p = 0.715$) or male ($p = 0.427$) students. The overall comparison between the two methods was also non-significant ($\chi^2 = 2.635$, $p = 0.451$), as shown in Table 6.

Table 6

Comparison of students' intubation success in the two training methods between males and females.

Gender	Relative Success	GlideScope	Laryngoscope	Comparison by Gender	Overall Comparison
				Cramer's V	P-Value
Female	1/5	0 (0%)	0 (0%)	0.268	0.715
	2/5	1 (12.5%)	1 (9.1%)		
	3/5	1 (12.5%)	4 (36.4%)		
	4/5	2 (25%)	2 (18.2%)		
	5/5	4 (50%)	4 (36.4%)		
Male	1/5	0 (0%)	0 (0%)	0.427	0.427
	2/5	0 (0%)	1 (10%)		
	3/5	2 (15.4%)	2 (20%)		
	4/5	2 (15.4%)	3 (30%)		
	5/5	9 (69.2%)	4 (40%)		

Repeated measures analysis of intubation speed revealed no significant three-way interaction between time, method, and baseline knowledge ($F = 0.029$, $p = 0.867$), nor any significant time-by-knowledge interactions within either training method (GlideScope: $F = 1.304$, $p = 0.346$; Laryngoscope: $F = 1.455$, $p = 0.446$), indicating that performance improvement over time was not influenced by students' baseline knowledge level (Table 7)

Table 7

Repeated Measures Test for Comparing Students' Performance Speed in Two Educational Methods Based on Level of Baseline Knowledge.

Method	Attempt	Low (Mean ± SD)	Moderate (Mean ± SD)	F1	P- Value	F2	P- Value
GlideScope	Attempt 1	32.90 ± 21.48	37.25 ± 28.64	1.304	0.346	0.029	0.867
	Attempt 2	30.60 ± 20.81	23.75 ± 15.90				
	Attempt 3	22.06 ± 13.70	21.50 ± 16.36				
	Attempt 4	16.18 ± 8.30	17.00 ± 13.44				
	Attempt 5	12.50 ± 6.68	10.66 ± 3.78				
Laryngoscope	Attempt 1	25.00 ± 6.55	53.83 ± 37.10	1.455	0.446		
	Attempt 2	35.22 ± 23.07	29.12 ± 12.77				
	Attempt 3	31.99 ± 14.81	17.78 ± 6.46				
	Attempt 4	28.05 ± 16.23	14.62 ± 5.23				
	Attempt 5	18.40 ± 8.47	12.22 ± 2.81				
F1: (Time × Baseline Knowledge), F2: (Time × Method × Baseline Knowledge)							

4. Discussion

This study compared the effectiveness of GlideScope versus Laryngoscope training for endotracheal intubation among students, assessing intubation success, performance speed, and satisfaction. The main findings revealed that both devices were effective training tools, with no statistically significant differences between the two methods in terms of relative success (overall $p = 0.451$) or satisfaction ($p = 0.247$). However, descriptive trends suggested that the GlideScope group achieved higher rates of perfect success (5/5 attempts) and reported higher satisfaction compared to the Laryngoscope group.

Both groups demonstrated high success rates (GlideScope 95%, Laryngoscope 90%; Table 2), confirming that both methods are viable for training.

Although the GlideScope group showed a higher proportion of students achieving "5/5" successful attempts (61.9% vs. 38.1%; Table 1) and males in the GlideScope group had a 69.2% "5/5" rate compared to 40% in the Laryngoscope group (Table 6), these differences did not reach statistical significance.

The lack of statistical significance may be attributed to the sample size or the inherent effectiveness of both devices in achieving basic competency. The clinical relevance of the observed trends, however, suggests that the GlideScope may offer advantages for achieving mastery-level proficiency.

Both groups demonstrated progressive improvement in intubation speed across five attempts (Table 3), indicating a positive learning curve with both devices.

The repeated measures analysis revealed no significant interaction between time and teaching method ($p = 0.841$; Table 3), suggesting that the rate of improvement was similar regardless of the device used.

This finding implies that both devices are equally effective in facilitating skill acquisition over time. The steeper decline in mean time for the Laryngoscope group (from 44.22 to 16.04 seconds) compared to the GlideScope group (from 34.06 to 12.21 seconds) may reflect a greater initial learning challenge with the Laryngoscope, which students overcame with practice.

Analysis of gender differences revealed no significant interactions for either performance speed (Table 5) or relative success (Table 6).

The three-way interaction (time $\times$ method $\times$ gender) was not significant ($p = 0.489$; Table 5), indicating that male and female students improved at similar rates regardless of the device used.

These findings suggest that both training methods are equally suitable for male and female learners, and that gender does not influence the ability to acquire intubation skills with either device. This supports the equitable application of both training methods across diverse student populations.

Students with low and moderate baseline knowledge showed comparable rates of improvement across both devices, with no significant interactions involving baseline knowledge (Table 7).

The three-way interaction (time $\times$ method $\times$ baseline knowledge) was not significant ($p = 0.867$), indicating that prior knowledge did not differentially affect learning outcomes between the two devices.

This suggests that both the GlideScope and Laryngoscope are effective for learners at different knowledge levels. The GlideScope's video-assisted technology may help compensate for lower baseline knowledge, while the Laryngoscope's direct view may reinforce fundamental anatomical understanding.

The trend toward higher satisfaction with the GlideScope may be attributed to its video-assisted features, which provide a shared view for instructors and students, potentially enhancing the learning experience. However, the lack of statistical significance suggests that both devices are generally well-received by learners.

The findings of this study align with previous research demonstrating that both video laryngoscopes and direct laryngoscopes are effective for teaching intubation skills to novice learners. O'Shea et al compared the success rate of intubation using two methods, video laryngoscopy (VL) and direct laryngoscopy (DL) on the success rate of intubation in 206 infants. There was a significant difference in the success rate in the VL versus DL groups. The success rate was reported to be 66%, 104.69 in the VL group and 102.42 in the DL group ($P < .001$, OR 2.81, 95% CI 1.54 to 5.17). In this study, researchers did not allow one group of learners to view the video monitor while performing VL so that they could develop their skills in DL (i.e., VL acted as a DL). They found that intubation success rates in inexperienced trainees improved significantly when using a video laryngoscope (7).

In a study by Pourfakhr et al. at the University of Tehran, which was similar to the present study, 72% of students in the GlideScope® group successfully performed tracheal intubation within 40 seconds on their first attempt, but only 44% of students in the Macintosh group performed tracheal intubation within 40 seconds ($P = 0.00$). Furthermore, the evaluator scores and student satisfaction were higher in the GlideScope® group than in their laryngoscope counterpart. Note that, in the above study, training was first performed on a moulage and then the test was carried out on a real patient (8).

The trend toward higher success rates with the GlideScope is consistent with studies suggesting that video-assisted technology may accelerate mastery by improving visualization and instructor feedback (9–11).

Another advantage of this method is that images from the video laryngoscope can be transferred to the teacher's computer using Bluetooth, thus allowing for recording the resulting video as well as providing better review and feedback (12). These factors will lead to better training and greater consolidation of the training in the students' minds (13).

The discrepancy between our findings and some previous studies reporting the superiority of GlideScope® in novice performance (13) can be attributed to several key methodological differences. Most notably, in the present study, a standardized theoretical module on airway anatomy and management principles was mandatorily completed by all participants before any hands-on training. This foundational knowledge likely created a robust cognitive framework, equipping students to better understand and execute the mechanical steps of intubation, regardless of the viewing technology. In contrast, studies where video laryngoscopy demonstrated a clear advantage often involved participants with minimal or no prior structured theoretical instruction. In such settings, the visual guidance and shared view provided by the GlideScope® screen may offer a more significant compensatory benefit, effectively bridging the anatomical knowledge gap for the untrained operator. The relatively small sample size may have limited the statistical power to detect significant differences between groups, particularly for subgroup analyses by gender and baseline knowledge.

The study was conducted at a single institution, which may limit the generalizability of findings to other settings with different student populations or training protocols. Outcomes were measured immediately following training, and long-term retention of skills was not assessed. The absence of students with

"High" baseline knowledge (Table 1) limited the ability to examine the full spectrum of knowledge levels. Factors such as prior clinical experience, hand dominance, or anxiety levels were not controlled for and may have influenced performance.

5. Conclusion

Both the GlideScope and Laryngoscope are effective tools for teaching endotracheal intubation to students, with comparable rates of improvement in performance speed and no significant differences in overall success or satisfaction. While trends favored the GlideScope for achieving perfect success rates and higher satisfaction, particularly among male students, these differences were not statistically significant. Gender and baseline knowledge did not influence learning outcomes with either device. Future research with larger sample sizes and long-term follow-up is warranted to confirm these findings and further elucidate the potential advantages of video-assisted laryngoscopy in medical education.

Declarations

6. Acknowledgments

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (Approval code: IR.SSU.MEDICINE.REC1400.06). Written informed consent was obtained from all participants prior to enrollment. All procedures were conducted in accordance with relevant guidelines and regulations, including the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FZ contributed to study design, data collection, data analysis, and manuscript drafting.

MAJN contributed to study supervision, methodology, and critical revision of the manuscript.

ARE contributed to statistical analysis and interpretation of data.

AR contributed to literature review and manuscript editing.

All authors read and approved the final manuscript.

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