นิพนธ์ต้นฉบับ **Original Article**

The success rates of direct endotracheal intubation comparing between trained by using direct versus video laryngoscopy in inexperienced medical students

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Abstract

Placement of an endotracheal tube is a fundamental procedure in airway management, but novice providers face an increased risk of failure and complications. While using a video laryngoscope (VL) has been shown to enhance success rates, limited evidence exists on whether training with a VL improves success when the procedure is performed with a direct laryngoscope (DL). **Objectives** This prospective randomized controlled trial aimed to compare the success rates of novice medical students in endotracheal intubation using a DL after training with either VL or traditional training with DL **Methods** One hundred and thirty novice medical students were randomly assigned to two groups: the VL group (n=65) and the DL group (n=65). After a single training session with their assigned equipment, all students performed one intubation attempt on a manikin using a DL. **Results** The study found no significant difference in the first-attempt success rate between the VL and DL groups (98.0% vs. 97.7%, p=1.000) However, the VL group demonstrated better full laryngeal visibility (Grade 1 view: 29.4% vs. 27.3%, p=0.030) and higher satisfaction levels (88.2% vs. 72.7%, p=0.039). There were no significant differences in intubation time or dental click events. **Conclusions** In conclusion, training with a VL provides a clearer visualization of laryngeal structures and enhances satisfaction among medical students when compared to traditional DL training.

Keywords: Laryngoscopes, Endotracheal intubations, Undergraduate

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(Received: November 6, 2025; Revised: November 13, 2025; Accepted: January 20, 2026)
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บทคัดย่อ: อัตราความสำเร็จในการใส่ท่อช่วยหายใจด้วยอุปกรณ์ส่องตรวจกล่องเสียงโดยตรง โดยเปรียบเทียบระหว่างการเรียนใส่ท่อช่วยหายใจด้วยอุปกรณ์ส่องตรวจกล่องเสียงโดยตรงและโดยกล้องวิดีโอในนักศึกษาแพทย์ที่ไม่มีประสบการณ์ในการใส่เครื่องช่วยหายใจ

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** ศูนย์แพทยศาสตรศึกษาชั้นคลินิก โรงพยาบาลมหาราชนครราชสีมา

การใส่ท่อช่วยหายใจ เป็นหัตถการพื้นฐานในการจัดการทางเดินหายใจ แต่นักศึกษาแพทย์ที่ไม่มีประสบการณ์มีความเสี่ยงสูงต่อความล้มเหลวและภาวะแทรกซ้อน แม้ว่ามีการแสดงให้เห็นว่าการใช้กล้องวิดีโอช่วยส่องกล่องเสียงช่วยเพิ่มอัตราความสำเร็จได้ แต่หลักฐานยังมีจำกัดว่าการฝึกฝนด้วย VL จะช่วยเพิ่มอัตราความสำเร็จในการทำหัตถการโดยใช้กล้องส่องกล่องเสียงชนิดตรง (Direct Laryngoscope, DL) ได้หรือไม่ **วัตถุประสงค์** การทดลองแบบสุ่มและมีกลุ่มควบคุมนี้ มีวัตถุประสงค์ เพื่อเปรียบเทียบอัตราความสำเร็จในการใส่ท่อช่วยหายใจด้วย DL ของนักศึกษาแพทย์ที่ไม่มีประสบการณ์ หลังจากที่ได้รับการฝึกฝนด้วย VL หรือการฝึกฝนแบบดั้งเดิมด้วย DL **วิธีการศึกษา** นักศึกษาแพทย์ที่ไม่มีประสบการณ์จำนวน 130 คน ถูกสุ่มแบ่งออกเป็นสองกลุ่ม: กลุ่ม VL (n=65) และกลุ่ม DL (n=65) หลังจากการฝึกฝนเพียงครั้งเดียวด้วยอุปกรณ์ที่ได้รับมอบหมาย นักศึกษาทุกคนได้ทำการใส่ท่อช่วยหายใจหนึ่งครั้งบนหุ่นฝึกโดยใช้ DL **ผลการศึกษา** การศึกษาไม่พบความแตกต่างอย่างมีนัยสำคัญในอัตราความสำเร็จในการใส่ครั้งแรกระหว่างกลุ่ม VL และ DL (98.0% เทียบกับ 97.7%, p=1.000) อย่างไรก็ตาม กลุ่ม VL แสดงให้เห็นการมองเห็นระดับกล่องเสียงที่เห็นชัดที่สุดดีกว่า (Grade 1 view: 29.4% เทียบกับ 27.3%, p=0.030) และมีระดับความพึงพอใจที่สูงกว่า (88.2% เทียบกับ 72.7%, p=0.039) ไม่พบความแตกต่างอย่างมีนัยสำคัญในเวลาที่ใช้ในการใส่ท่อช่วยหายใจหรือการบาดเจ็บของฟัน **สรุปผล** การฝึกฝนด้วย VL ช่วยให้มองเห็นโครงสร้างกล่องเสียงได้ชัดเจนยิ่งขึ้น และเพิ่มความพึงพอใจในหมู่นักศึกษาแพทย์เมื่อเทียบกับการฝึกฝนด้วย DL แบบดั้งเดิม

คำสำคัญ: กล้องส่องกล่องเสียงชนิดตรง, การใส่ท่อช่วยหายใจ, งานแพทยศาสตรศึกษา

Introduction

Endotracheal intubation is a critical procedure for managing patient airways, particularly in life-threatening situations such as acute respiratory failure or shock[1] Consequently, it is essential for medical students to receive rigorous training in this skill. Traditionally, students learn this procedure using direct laryngoscopes (DL) on manikins in a controlled skills laboratory environment. Jasper A O.[2] studied that training medical students in endotracheal intubation skills is more effective in a stress-free environment, such as a skills laboratory. Moreover, repeated attempts in this controlled setting significantly increases confidence levels and enhances the likelihood of successfully performing endotracheal intubation in real-life situations. While this practice can improve confidence and skills,

the success rate for novice medical students performing intubation can be unsatisfactory due to factors such as lack of experience, improper technique, and, most notably, difficulty in visualizing anatomical structures.[3-4]

The introduction of video laryngoscopes (VL) has aimed to overcome this challenge by providing enhanced anatomical visualization on a display screen. There are several studies[5-6] demonstrating that the use of video laryngoscopes in medical student training improved visualization and increased success rates in intubation maneuvers, particularly among inexperienced medical students. Additionally, this method offered superior glottic visualization compared to direct laryngoscopy.[7-8] This improvement was observed in the first attempt success rate, time to intubation, number of laryngoscopy attempts, and overall airway management ability. However, most of these studies evaluated performance using the same device for both training and assessment. A critical research gap remains: does training with a VL improve a student's performance when they are required to perform the intubation using a traditional DL?

This question is highly relevant because while VLs offer superior visualization and higher success rates, they may not be available in all clinical settings due to resource limitations. Furthermore, proficiency in using a DL is a fundamental requirement for medical doctors in many regions. Therefore, this study was designed to assess whether training with a VL provides a transferable skill benefit when students are evaluated using a DL.

Our primary objective was to determine if medical students trained with a VL would demonstrate a better success rate and a shorter intubation time when using a DL compared to students trained with a DL. The secondary objective was to evaluate the self-satisfaction of the medical students with their performance at the conclusion of their training. This assessment has significant implications for enhancing medical education and, ultimately, patient safety by reducing intubation failures and associated complications.

Methods

The study is a prospective randomized controlled trial conducted from July 27, 2023, to April 27, 2024 at one Medical Education Center hospital. After obtaining approval from the Instituted Ethic Committee (Number: 056/2023, Date of approval:18/05/2023), one-hundred and thirty medical students were randomly assigned by computer-generated randomization to either the direct laryngoscope (DL) group or the video laryngoscope (VL) group, with 65 participants in each group. The inclusion criteria are as follows: medical students with less than 1 year of intubation experience who have completed informed consent. The exclusion criteria are as follows: medical students with more than 1 year of intubation experience.

During the process, medical students were taught methods and techniques for intubation using either the direct laryngoscope (DL) or video laryngoscope (VL) depending on their assigned group. The entire teaching process was conducted by a single anesthesiologist who has experience in instructing medical students in intubation. All intubation equipment used was standardized and included a Macintosh™ direct laryngoscope (model R8122) with a size-3 curved blade; C-MAC™ Video laryngoscope (HD series) with a size-3 curved blade of the same shape and curvature as the direct laryngoscope, a Laerdal™ airway management trainer (model 25000033), which was positioned in the sniffing position for both intubation methods and a PVC endotracheal tube with a 7.0-mm internal diameter (Covidien™). To prevent contamination, we separated the two groups on different days, and both groups learned both DL and VL techniques for intubation by the end. After learning the DL or VL techniques, medical students practiced one attempt for endotracheal intubation using the direct laryngoscope (DL). Following the training, the next phase involved evaluation and data collection. Each student performed one attempt of direct laryngoscope (DL) endotracheal intubation.

The time to intubation was measured from when the student opened the mouth until the Ambu™ bag was connected and chest movement was observed. Successful endotracheal intubation was achieved within 120 seconds from mouth opening to observe chest movement. An attempt was deemed unsuccessful if it took longer than 120 seconds or results in esophageal intubation. The number of times the equipment is impacted by the mannequin's teeth can be determined by counting the instances of sound produced when the equipment hits the mannequin's teeth. Researcher satisfaction with equipment is rated on a scale of 4 levels: (4 = Excellent, 3 = Good, 2 = Fair, 1 = Bad)

Respiratory tract anatomy is classified into 4 levels according to the Cormack and Lehane classification: (1 = Full view of the vocal cords and glottis, 2 = Partial view of the posterior aspect of the vocal cords, 3 = Only the epiglottis is visible, 4 = Neither vocal cords nor epiglottis are visible (As shown in Figure 1)

The sample size was calculated based on the study by Weerayutwattana R. [11], which used the first-attempt intubation success rate as the primary outcome when comparing direct laryngoscope (DL) and Video laryngoscope (VL). With a power of 0.80 and a two-sided alpha level of 0.05, 65 participants were required per group. Dropouts were not considered because all data were collected immediately after the intubation was completed.

Statistical analysis was performed using program Stata version 14. Quantitative data with a normal distribution will be presented as mean±SD and compared using an independent sample T-test. Quantitative data with a non-normal distribution will be presented as median (IQR) and compared using the Mann-Whitney U test. Qualitative or categorical data will be presented as

proportions and percentages, with comparisons assessed using Fisher's exact test to determine statistically significant differences at the 0.05 significance level.

Results

A total of 130 medical students were enrolled and completed the study. The characteristics of the participants, including sex and age, are presented in Table 1.

From the statistical analysis, it was found that the success rate was 97.7% in the Direct Laryngoscopy (DL) group, with intubation taking an average of 19.5 (16.0, 29.0) seconds. In comparison, the Video Laryngoscopy (VL) group had a success rate of 98%, with intubation taking an average of 23.0 (17.0, 30.0) seconds. There was no significant difference in both success rate (p=1.000) and time to intubation (p=0.261) between the VL and DL groups, as shown in Table 2.

However, the Cormack-Lahane laryngeal view grading and the satisfaction level observed in the VL group differed significantly from those in the DL group (p=0.030). Specifically, 29.4% of the VL group had a laryngeal view grade 1, compared to was 27.3% in the DL group. For laryngeal view grade 2, 52.9% of the VL group fell into this category, compared to 70.5% in the DL group. Regarding satisfaction, students in the VL group expressed significantly higher satisfaction with their performance compared to the DL group (p=0.039)

Regarding the incidence of dental click events, it was concluded that there was no significant difference between the DL and VL groups (p=0.094)

Discussion

This study investigated the effectiveness of training novice medical students with a video laryngoscope (VL) compared to a direct laryngoscope (DL) when their proficiency was assessed using a DL. The most significant findings were the improved laryngeal view and higher satisfaction levels among students in the VL training group, indicating a potential advantage of video laryngoscopes, which was according to previous study.[6-9]

The VL-trained group demonstrated a better laryngeal view (p=0.030) and expressed significantly higher satisfaction (p=0.039) with their performance than the DL-trained group. The improved visualization is a key advantage of VLs, which is an advantage of video laryngoscope over direct laryngoscope as mentioned in previous study.[7,9]

The high-definition display likely allowed students in the VL group to better visualize and understand the airway anatomy, enabling them to apply the laryngoscope blade more effectively during the subsequent DL assessment. This finding supports the use of VLs as an educational tool to enhance students' foundational understanding of airway anatomy. The higher satisfaction levels in the VL group

can be attributed to the clarity of the view, which may have increased their confidence during the procedure.

Interestingly, there was no significant difference in the first-attempt success rates between the two groups. The overall success rates were very high in both groups (98.0% and 97.7%), which is common in simulation-based studies with manikins and may have obscured any potential differences. While the median intubation time was slightly longer in the VL group (23.0 seconds vs. 19.5 seconds), this difference was not statistically significant (p=0.261). The finding that VL training did not lead to a significant difference in time or dental click events is important, as it suggests that VL-assisted learning does not negatively impact these critical aspects of the procedure.

A potential limitation of this study is that the final assessment was conducted with a DL, which may have conferred a slight advantage to the DL training group due to their greater familiarity with the equipment. However, this study design was intentional and reflects real-world constraint: DL proficiency is a minimal requirement for medical doctors in many healthcare systems, and VLs are not universally available. Therefore, this study provides valuable evidence for how VLs can be integrated into existing curricula to improve foundational skills that are transferable to traditional methods.

A second limitation is that this was a simulation-based study in which the manikin was pre-positioned in the sniffing position. This differs from real-world intubation, where learners must independently assess and position the patient to achieve optimal conditions for intubation.

In conclusion, incorporating VLs into the intubation learning process is a beneficial tool for medical students. It facilitates a clearer understanding of airway anatomy and leads to greater student satisfaction. While DL training remains an essential skill, VLs can serve as a powerful educational aid to improve the quality of a student's laryngeal view during a DL procedure.

Conclusion

Training with a video laryngoscope helps medical students achieve better laryngeal views and results in higher satisfaction levels compared to training with a direct laryngoscope. This study suggests that incorporating video laryngoscopes into the medical curriculum can be a valuable educational tool, as it enhances students' understanding of airway anatomy, a benefit that is transferable to procedures performed with a traditional direct laryngoscope.

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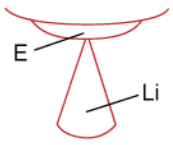
Original Cormack and Lehane system	I	II		III	IV
	Full view of the glottis	Partial view of the glottis or arytenoids		Only epiglottis visible	Neither glottis nor epiglottis visible
View at laryngoscopy					
Modified system	**I** As for original Cormack and Lehane above	**IIa** Partial view of the glottis	**IIb** Arytenoids or posterior part of the vocal cords only just visible	**III** As for original Cormack and Lehane above	**IV** As for original Cormack and Lehane above

Figure 1: Cormack and Lehane classification[10]

Table 1. Characteristics of the medical students between direct laryngoscope (DL) and Video laryngoscope (VL)

Characteristics	DL group N = 65	VL group N = 65
Sex, n (%)		
Male	18 (27.7)	21 (32.3)
Female	47 (72.3)	44 (67.7)
Age (years), mean ± SD	22.1 ± 1.44	23.1 ± 1.11

Table 2. The comparison of first attempt successful, time to intubation, number of dental click events and satisfaction between direct laryngoscope (DL) and Video laryngoscope (VL)

Variables	DL group N = 65	VL group N = 65	P-value
Successful, n (%)	63 (97.7)	63 (98.0)	1.000
Time to intubation, median (IQR)	19.5 (16.0, 29.0)	23.0 (17.0, 30.0)	0.261
Laryngeal view, n (%)			0.030*
Grade 1	18 (27.3)	19 (29.4)	
Grade 2	46 (70.5)	34 (52.9)	
Grade 3	1 (2.3)	12 (17.7)	
Grade 4	0 (0.0)	0 (0.0)	
Number of dental click events, median (IQR)	0 (0.0, 1.0)	0 (0.0, 1.0)	0.094
Satisfaction, n (%)			0.039*
0	0 (0.0)	1 (2.0)	
1	5 (6.8)	0 (0.0)	
2	13 (20.5)	6 (9.8)	
3	47 (72.7)	58 (88.2)	