ORIGINAL ARTICLE

Introductory Session to Direct Laryngoscopy and Endotracheal Intubation for Medical Interns: Is Video-laryngoscopy a Useful Teaching Aid?

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Abstract

Aim: Acquisition of basic and advanced airway skills on a mannequin is a well-accepted teaching methodology. To study the impact of video-laryngoscopy-aided identification of airway structures on basic skill acquisition by medical interns for endotracheal intubation (ETI) on a simulator was the aim.

Materials and methods: This observational study was conducted in a simulation laboratory. Medical interns were randomized into conventional direct laryngoscopy (DL) and video-laryngoscope aided (VL) groups; they were taught DL and ETI with or without an additional video-laryngoscopy-based session. Participants performed an average of five supervised intubations, subsequent practical exam, and assessed by a blinded observer followed by submission of a structured questionnaire.

Results: Eighty interns participated. The mean-time taken to intubate was 48.58 seconds and 48.65 seconds for the DL and VL groups, respectively. success in ETI in the first attempt was 90% (DL) and 87.5% (VL) ($p = 0.72$). Highest respect toward tissue in the DL group ($p = 0.0730$) was noted.

Conclusion: Addition of video-laryngoscope as a teaching aid in the simulation laboratory did not affect intubation success rate or time.

Clinical significance:

- Teaching medical and technical skills to students using mannequins is a well-accepted methodology for hands-on experience and attaining proficiency.
- Visualization of structures in video-laryngoscopy during endotracheal intubation is assumed to enhance success rate. However, success rate of intubation is independent of the technique used, that is, direct laryngoscopy and video-laryngoscopy.
- Tissue respect is superior with direct laryngoscopy.

Keywords: Airway management, Direct laryngoscopy, Endotracheal intubation, Simulation, Video-laryngoscopy.

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Introduction

Teaching advanced airway management to medical interns during clinical anesthesia rotation includes introductory practical session on a basic airway mannequin in a simulation laboratory. Interns are routinely taught conventional direct laryngoscopy (DL) and endotracheal intubation (ETI) followed by practical assessment. Acquisition of basic and advanced airway skills on a mannequin is a well-accepted teaching methodology.[1,2]

Introduction of video-laryngoscope in clinical practice has led to a paradigm shift with an increasing focus on improved ETI rates in multiple trials compared to DL.[3] ETI is still being taught conventionally using Macintosh blade as video-laryngoscopes are not yet widely available. The learning impact of exposure to both devices simultaneously is unexplored. Realtime magnified visualization and identification of key structures may impact the skill acquisition for DL and be a useful teaching aid, and will help the beginner in easy, quick insertion. We decided to use the video-laryngoscope for demonstration alone of vital airway structures in a stepwise manner prior to DL in the study group. The aim of this study was to compare video-laryngoscopy (VL)-aided teaching of DL teaching with DL alone for ETI to novice medical interns.

Materials and Methods

This prospective observational study was conducted by the department of anesthesia of a teaching hospital from January to March 2020 after obtaining approval from the institutional ethics committee. Written informed consent was obtained from the participants before inclusion in to the study. The objective of the study was to compare the impact of DL alone and DL with video-laryngoscope on ETI.

Medical interns were randomized into two groups using a computer-generated sequence; DL group that used direct laryngoscope and VL group that used video-laryngoscope for ETI. Participants in DL group were taught ETI using conventional Macintosh blade, and those in VL group were taught the same along with an additional teaching session using King Vision

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Video-laryngoscope, which has an angulated channeled blade and mounted screen, manufactured by King systems, King Corporation, USA.

Participants were divided into batches of eight and taught intubation skills in an intensive manner using Laerdal airway mannequin, model no 4708 (2010) to display the importance of alignment of oral, pharyngeal and laryngeal axes along with key points to consider for safe tracheal intubation. The interns randomized to VL-aided teaching had an extra session of approximately 15 minutes duration during which the investigator used the King video-laryngoscope as a teaching adjunct on mannequin and demonstrated the base of tongue, uvula, epiglottis, vallecula as well as glottic aperture in a step wise manner along with relevant explanations. Video-laryngoscope was not used to intubate trachea but to help in identification of key airway structures and reinforce the learning process among the participants. All interns performed DL and orotracheal intubation on a mannequin under the guidance of a senior anesthesiologist. Tips included proper head and neck positioning, care to avoid pressure on the upper teeth, which was detected by audible clicks on the airway trainer, smooth insertion of Macintosh blade from the right corner of the mouth along with lateral displacement of the tongue. The importance of direction of the lifting force on laryngoscope, visualization of epiglottis, positioning of the blade tip in the vallecula and finally, adequate exposure of the glottic aperture followed by insertion of endotracheal tube (ETT) under vision were emphasized. Interns were supervised closely and allowed to practice the maneuver till they felt satisfied with the learning experience in the same session. An average of five supervised intubations were performed by the participants during the teaching session. Subsequent assessment was conducted by a blinded observer; a certified lead paramedic and simulation coordinator, 5–7 days later in the simulation lab. Each intern was asked to perform orotracheal intubation on a airway mannequin with the observer recording time taken for successful intubation and other technical parameters. Stopwatch was switched on at insertion of the blade into the oral cavity and switched off after passage of the ETT into the glottis. The observer scored each intern using a 2-point scale (poor/good) to adjudge head and neck positioning, respect to tissue as adjudged by the absence of audible clicks on blade insertion, laryngoscope handling, smoothness of movement and overall performance. All interns were asked to complete a feedback form with questions pertaining to the training session. The feedback form consisted of three questions which had to be answered on a scale ranging from 1–10. The participants were asked to rate their individual training session (DL/VL), presession airway management knowledge and postsession knowledge acquisition.

Statistical Analysis

After consulting the available literature, a difference of 10 seconds to secure the airway was considered to be clinically significant. We accepted an OE-error of 0.05 and a ß-error of 0.2 to detect a 22% difference in intubation success. Sample size calculation predicted a required enrolment of 75 students. Our null hypotheses stated that there is no difference in the success rates or time taken for ETI between interns taught conventional vs VL-aided DL. Chi-square test for associations, unpaired "*t*" test or Mann–Whitney *U* test were used for comparison of means as appropriate, with a *p* value ≦0.05 considered significant. IBM SPSS version 24.0 was used for statistical analysis.

Results

We included 80 interns, 40 in each group. The results are summarized in Tables 1 and 2. The null hypothesis could not be rejected in our study. Successful intubation at first laryngoscopy was similar for both groups, 36 (90%) and 35 (87.5%) in the DL and VL group, respectively ($p = 0.72$). There was no statistically significant difference in the time taken to intubate between the two groups. The mean time taken to intubate the mannequin in test conditions was 44.83 ± 17.14 seconds (Mean ± SD) for DL group vs 50.12 ± 17.26 seconds (Mean ± SD) for the VL group ($p = 0.55$). Esophageal intubation in the first attempt was noted by six (15%) in the DL and four (10%) in the VL group

Table 1: Summary of results (original)

Parameter	*DL*	*VL*	*p-value*
Single attempt	36 (90%)	35 (87.5%)	0.72
Esophageal intubation	06 (15%)	04 (10%)	0.49
Time to intubate (in seconds)	44.83 (±17.14)	50.12 (±17.26)	0.55
Correct position	15 (37.5%)	17 (42.5%)	0.64
Respect to tissue	23 (57.5%)	15 (37.5%)	0.07*
Efficient handling of laryngoscope	12 (30%)	12 (30%)	1.00
Good procedural flow	22 (55%)	15 (37.5%)	0.11
Satisfactory performance	13 (32.5%)	17 (42.5%)	0.35
Session feedback (10/10)	33 (91.7%)	23 (69.7%)	0.06*

DL, direct laryngoscopy; VL, video laryngoscopy assisted; *trend noted

Table 2: Knowledge score (original)

Knowledge score	*DL Mean (95% CI)*	*VL Mean (95% CI)*	*p-value*
Knowledge score (presession)	2.79 (2.13–3.46)	2.83 (2.16–3.49)	0.948
Knowledge score (postsession)	8.73 (8.54–9.05)	8.55 (8.19–8.91)	0.271

Values are mean and 95% confidence interval, no mean differences were observed across DL and VL in both sessions but a significant improvement in acquisition of airway management knowledge post-training session in DL and VL (*p*-value = 0.001); DL, direct laryngoscopy; VL, video laryngoscopy assisted

($p = 0.49$). We noted a trend toward superior "respect to tissue" in the DL group adjudged by the absence of audible clicks secondary to inappropriate hinging on the upper teeth as demonstrated in 57.5 and 37.5% of interns ($p = 0.073$).

Analysis of the feedback forms revealed a clinically significant difference in the rating of the teaching session as isolated conventional laryngoscopy teaching session was scored a perfect 10 by 33 (91.7%) interns as compared to only 23 (69.7%) interns for the VL aided session ($p = 0.065$). Intragroup analysis showed both the groups had benefited with a significant improvement in acquisition of airway management knowledge post-training session (p value = 0.001) (Table 2).

Discussion

Simulation of DL and oral intubation in a basic or advanced high-fidelity airway mannequin is widely accepted for teaching airway management to novice learners in a controlled environment.[1,2] In our institution all interns undergo an airway management session in simulation lab as part of anesthesia rotation followed by an assessment. We decided to incorporate an additional session with the available video-laryngoscope for 40 interns to assess its potential role as a teaching aid.

The advantages of video-laryngoscopy are multiple and it has led to a paradigm shift in modern airway management strategy.[3] A section of investigators strongly recommend replacing DL with video-laryngoscopy for conventional use in routine and difficult airway management.[4,5] There are multiple trials to compare the teaching effects of DL vs VL in various clinical scenarios.[6–8] Studies have shown a significant decrease in time, tissue injury and hemodynamic stress response coupled with an improved ease of intubation during indirect laryngoscopy in novice as well as experienced anesthetists. The ability to "look around the corner" contributes to improved glottic exposure and ability to demonstrate the appropriate placement of ETT with the cuff distal to the vocal cords. Investigators have demonstrated improved pharyngeal and laryngeal visualization *via* the video-laryngoscope, yet this may not translate into improved time to intubate. Improved Cormack-Lehane grading of the glottic aperture may not result in quicker intubation due to angulated blade, need for stylet and a different set of psychomotor skills including superior hand-eye coordination.[9,10] Even with a strong case for use of video-laryngoscope in routine airway management, we need to continue teaching DL as the video-laryngoscope is not available in most setups and it will take considerable time for widespread acceptance.

While investigators have focused on teaching orotracheal intubation using conventional or indirect laryngoscopy, few have attempted to study the interaction between the two methods. Gu et al.[11] used the cumulative summation and risk-adjusted calculation (CUSUM) to objectively evaluate novice learning curves for DL and VL, respectively. After an initial training of 20 participants to perform DL and ETI in a simulation centre, they were randomly allocated to perform serial intubation on patients under supervision. Ten students were allocated to secure airway *via* DL for their first 10 patients and then switch to VL to intubate the next 10 patients. The order was reversed for the other 10 students. The group demonstrated significant improvement in time to intubate subsequent sets of patients by those students who were performing DL first implying steeper improvement of the learning curve. While 18 ETI were needed for 80% success rate in those taught DL first, more than 20 ETI were required for 80% success in the VL first group. The authors concluded that teaching DL initially followed by VL may be an appropriate teaching sequence for improved learning outcome of ETI in the novice population.[12] Their finding is significant as it reiterates the importance of teaching DL and intubation to novices and reserving VL as the second skill.

Herbsteit et al.[12] compared Macintosh DL with CMAC video-laryngoscopy which has a blade similar to Macintosh blade, and therefore, does not need a different set of psychomotor skill as seen for the more angulated blades. They could demonstrate a 19% higher success rate with a decrease in time by 11 seconds in those students who were taught using the CMAC when they performed ETI on a test mannequin. They explained that continual, stepwise visualization and guidance provided by the instructor by watching the video screen in the CMAC group during the training period may explain the superior result obtained in the CMAC group. They reiterated the fact that this novel video-laryngoscope can be used like the regular Macintosh blade. Their result may not apply to other video-laryngoscopes which have a steeper angulation of the blade and require a different skill set.[12]

Laryngoscopy performed using Macintosh blade is a widely accepted method of securing the airway and will continue to be a necessary skill for healthcare workers. This complex maneuver has been studied in different settings with an aim to determine the learning curve. Competency or the probability of "good intubation" ideally completed within 30 seconds has a 90% probability achieved after 47 attempts in the novice population.[13] Toda et al.[14] suggest 30 intubations to achieve 90% success rate in paramedics. These results indicate the intrinsic complexity of advanced airway management.

Safe ETI is not confined to correct placement of the ETT alone. There are vital components which need due consideration for a well-executed intubation.[15] In our study, we assessed respect to tissue, laryngoscope handling, head and neck positioning, flow of procedure, and overall performance. Julin et al.[13] found proper blade insertion and appropriate lifting force for glottic exposure as key steps in ensuring good outcome. While <30 seconds will qualify for good timing, they used a fitting model of 45 seconds. In our trial, the average time taken to complete ETI was 44.83 and 50.12 seconds, respectively, in the DL and VL groups, which is similar to the previous studies.[13,14]

Availability of King video-laryngoscope prompted us to consider studying its role as a teaching aid. The learning skill set for this VL was different, involving significant hand-eye coordination, as well as need for stylet due to angulated blade. Our focus was to improve the learning experience of DL by providing detailed visual cues to the interns on mannequin along with didactic teaching and practical session. Apart from overcoming the monocular nature of teaching conventional laryngoscopy, we felt that providing additional visual cues such as the base of the tongue, uvula, epiglottis, and glottic opening will reinforce the learning process especially as the base of tongue and uvula are not seen during traditional DL.

In our study, both groups were similar with respect to mean time to intubate, success rate in first attempt and incidence of esophageal intubation. Our study could not demonstrate statistically significant difference between the two groups with respect to other aspects of intubation as judged by the blinded observer. We did note a trend toward gentler tissue handing in the DL group, the incidence of audible clicks secondary to inappropriate force on upper incisors was lower. In the feedback analysis, we noted 33 (91.7%) students gave a perfect score of 10 to the conventional method vs 23 (69.7%) for VL aided teaching session ($p = 0.065$). The difference in rating of the teaching method employed suggests that conventional teaching of DL was better received by novices. Investigators have demonstrated that high

fidelity complex mannequins with continual feedback may not impact novice learning or performance.[16] Sensory overload with multiple inputs is known to detract from deliberate performance of a complex task. According to the Cognitive Load theory, human beings have severely limited working memory capacity leading to intrinsic, germane, or extraneous cognitive load.[17] We feel that the VL group may have experienced sensory overload during the teaching session, hence was rated lower. It is important to note that the interns in both groups reported high scores with regard to their knowledge acquisition after the teaching session. We assume that both groups acquired similar and good level of knowledge with high rates of successful intubation in both groups within an acceptable timeframe too. The trend to improved tissue handling in the DL group may be a direct result of improved working memory attributable to absence of cognitive overload. During introductory airway management teaching session, it may be prudent to avoid visualization of airway structures *via* the video-laryngoscope and other forms of cognitive loading in the novice group.

Limitations

Learning orotracheal intubation is an advanced, complex airway skill, and investigators suggest 15 trial intubations to achieve 80% success in a novice population using airway mannequin (Owen). This study was a snapshot assessment of intubation skill using a basic airway mannequin in a single teaching and subsequent test session with no crossover trial to judge the efficacy of two instruction modalities. The participants could not be blinded and the interval between teaching and testing varied from 5–7 days allowing participant to self-learn *via* text, videos etc., and discuss the study amongst themselves. Instructor bias was minimized by both investigators alternately teaching VL aided or conventional DL. The assessment was done by a single observer and we did not measure the force or torque used by the subjects during laryngoscopy.

Conclusion

Performance of interns who underwent VL aided teaching of DL was similar to those who were taught conventional DL and orotracheal intubation. A lower rating to VL aided learning session may suggest extraneous sensory overload perceived by interns. Both groups reported a significant increase in airway-related knowledge acquisition after completion of the session.

Clinical Significance

- Teaching medical and technical skills to students using mannequins is a well-accepted methodology for hands on experience and attain proficiency.
- Visualization of structures in video-laryngoscopy during ETI is assumed to enhance success rate. However, success rate of intubation was independent of the technique used, that is, DL and video-laryngoscopy.
- Tissue respect is superior with DL.

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