Role of video-based learning on competency level of direct laryngoscopic skills of novice anaesthesiologists - A randomised clinical trial

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ABSTRACT

Background and Aims: Video laryngoscopes are often used for education and training of intubation skills. This study aimed to examine the influence of video-assisted guidance and video replay on intubation skills of novice anaesthesiologists. Methods: Adult patients of American Society of Anesthesiologists physical status grade I–II, with a normal airway and scheduled to undergo elective surgical procedures requiring general anaesthesia and orotracheal intubation were included in this randomised study. Ten trainee anaesthesiologists, with no prior experience of performing tracheal intubation were enrolled and randomly divided into group STD (received traditional learning) and group VL (received video-based learning). After initial mannequin training, the first seven intubations in patients in both the groups were done under supervision. In group VL, in addition to traditional cues, posttracheal intubation, the trainee and instructor had a session of video replay to discuss the entire process of laryngoscopy and tracheal intubation with areas of improvement. For the subsequent 15 intubations in patients, the trainees intubated independently using a standard Macintosh blade. The primary objective was to compare time required to intubate (TTI) for both groups using Mann–Whitney U test. Secondary objectives included comparison of difficulty in intubation (using a 5-point Likert scale), self-confidence scores (1–10, 10 – most confident), and intubation-related trauma. Results: The mean TTI was significantly lower in group VL than in group STD - 40s [Interquartile range (IQR): 32–50] versus 52s [IQR: 39–76], P = 0.002. No difference was seen in self-assessed confidence levels, rating of difficulty in intubation, and airway trauma. Conclusion: Video replay of the intubation process has a positive impact on direct laryngoscopy learning.

Key words: Anaesthesiologists, intubation, laryngoscopy, learning curve

INTRODUCTION

Tracheal intubation via direct laryngoscopy is a difficult skill and with a definite learning curve. Instructors are often at a disadvantage due to limitations in sharing the glottis view during direct laryngoscopy. Improving the traditional teaching methods by advanced technology might provide suitable solutions. Sharing of laryngoscopic view is possible with the use of video laryngoscopes (VLs), as compared to conventional means. Due to the availability of live video image for guidance, an enhanced interaction between the instructor and trainee has been observed. The C-MAC® VL (Karl Storz, Germany) as an aid for teaching tracheal intubation procedure can be used either as a VL, where the trainee and instructor view the monitor or the scope can be used as Macintosh’s direct laryngoscope with recording features.

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There exists limited literature on the impact of video replay of one’s own attempt on learning. We hypothesised that video replay of tracheal intubation may benefit the novices and help them achieve better competency than traditional learning. The primary objective of the study was to determine the influence of video-assisted guidance and video replay during initial learning on the competence for tracheal intubation skill, measured in terms of “first attempt intubation success rate” and time required to intubate (TTI). The secondary objectives included comparing the self-assessed “intubation difficulty score”, confidence scores and complications of direct laryngoscopy.

**METHODS**

This randomised clinical study was approved by the Institutional Review Board (Project no 3040, approved on 4/05/2018) and was prospectively registered with the Clinical Trials Registry of India (CTRI/2018/05/013801). It was conducted in a stand-alone post graduate training institute from 28 May, 2018 to 21 August, 2018 in accordance with the principles of the declaration of Helsinki.

Adult patients belonging to American Society of Anesthesiologists (ASA) physical status grade I–II scheduled to undergo elective surgical procedures requiring general anaesthesia (GA), and orotracheal intubation were included after obtaining their informed consent. Patients with history of or with an anticipated difficult airway on clinical examination [Mallampati class III and IV, thyromental distance <6.5 cm, sternomental distance <12.5 cm, inter-incisor gap <3 cm, and restricted neck extension] were excluded. Patients planned for rapid sequence induction of anaesthesia or with body mass index (BMI) over 30 kg/m² were not included.

All 20 trainee anaesthesiologists of the 2018 batch were offered participation in the trial. Based on the willingness and eligibility, 10 consenting trainees, with no prior experience of performing tracheal intubation in patients, were enroled. The airway training included a lecture and demonstration in direct laryngoscopy, tracheal intubation, and optimisation manoeuvres (use of external laryngeal manipulation, need of change in blade size, intubating aids like stylet and bougie etc.) followed by hands-on training on the Laerdal Airway Management Trainer (Laerdal Medical, Stavanger, Norway). Each trainee had to perform five successful tracheal intubations with a Macintosh laryngoscope on the trainer to complete their mannequin training. The ten novices then received a trial code and were randomised equally to either group STD or VL using sealed chits.

Patients after consenting and satisfying inclusion criteria were allocated to intubators as per computer-generated random sequence charts, by an independent group to ensure allocation concealment. In the operating room, baseline vital parameters including heart rate, blood pressure, and oxygen saturation were recorded. After pre-oxygenation for 3 minutes using 6–8L of oxygen through a closed circuit, the patient was administered GA. The steps for GA were standardised for the study and included injection propofol (1.5–2 mg/kg), injection fentanyl (1–1.5 µg/kg), and injection vecuronium (0.15 mg/kg) intravenously for muscle relaxation. The patient’s lungs were then ventilated for 4 min to achieve adequate muscle relaxation, using 100% oxygen with appropriate dial setting of isoflurane/sevoflurane [to achieve 0.7–1 minimum alveolar concentration (MAC)]. The initial training on patients (first seven tracheal intubations by novices) was in accordance to the group. During this period, C blade of C-MAC VL was used as a direct laryngoscope for either groups, and patients were intubated using the “sniffing the morning air” position. For group STD (traditional learning), the trainees received instructions based on standard cues, which included guidance on body and hand positioning, laryngoscope placement, and anatomic landmarks. The instructor was expected to peer over the trainee’s shoulder to check on the laryngoscope view prior to tracheal intubation and as per need. To avoid variability in the instructor’s feedback, two experts supervised the training sessions for both the groups.

In Group VL (video-assisted learning), in addition to standard cues mentioned above, the trainees received cues based from the video images during tracheal intubation. Only the instructor could visualise and provide additional cues of the live video images from the VL. The recording facility of the C-MAC scope was used to record the entire intubation process. Post tracheal intubation, the trainee and instructor had a session of video replay with the aim to enhance the trainees’ understanding of the intubation process and suggest areas for improvement.

Literature shows that 22–29 intubation attempts are required to achieve an 80% orotracheal intubation success rate using the Macintosh laryngoscope by non-experienced personnel.⁷ ⁸ At least 50 endotracheal
intubations are needed to achieve 90% competency at intubations suggesting a flattening of the learning curve between the two benchmarks. To study the maximum impact on learning, we restricted to the steep part of the learning curve i.e., the initial 22 intubations. The supervised attempts at intubations during clinical training for each intubator were standardised and restricted to the first seven intubations in this study. In our previous study, we did not encounter high failure rates in the novice group at tracheal intubation with direct laryngoscopy. But there was a substantial difference in the time needed to intubate between experts and novices; hence TTI was set as primary endpoint and intubation attempts were limited to 15 independent attempts post clinical training for each trainee. With the inclusion of 10 trainees, the total sample size was 220 intubation attempts.

After the initial seven supervised tracheal intubations, each trainee had to perform 15 independent tracheal intubations in patients. Tracheal intubation was attempted by the trainee anaesthesiologist with a Macintosh direct laryngoscope, and the visualisation of the glottis as per the Cormack Lehane (CL) grading was noted. No guidance or aid was given to the intubator during tracheal intubation, with the exception of external manipulation of the larynx or providing a stylet/bougie when asked by the intubator. TTI was defined as the time elapsed from the insertion of the blade between the dental arches to the passage of tracheal tube into the trachea. The endotracheal tube placement was confirmed by capnography. All data was recorded by an independent observer.

Success at first attempt was recorded as “Successful first pass attempt”. In case of second attempt, TTI was cumulative of the two attempts. Failed attempt meant failure of the trainee to intubate after two attempts; each attempt permitted maximum up to 90 seconds or fall of oxygen saturation to 90% whichever was earlier. The attending consultant then performed the tracheal intubation with any laryngoscope of his/her choice, the event was recorded and the data was not included in the analysis for TTI, but was considered for all secondary outcomes. Cause of failure was recorded under three categories, Anatomical (unanticipated difficult airway), Procedural (related to skill of the trainee), and Technical (scope malfunction).

Other secondary outcome measures included the need of optimisation manoeuvres like external laryngeal pressure and airway aids like stylet/bougie. Airway trauma was assessed in terms of blood on laryngoscope blade and visible trauma to the lips, or teeth. In all cases of blood on the laryngoscope blade, check laryngoscopy was performed by the attending Anaesthesiology consultant, after the airway was secured. The operating room anaesthesiologist was permitted to administer additional doses of opioids and anaesthetic drugs pre- and during intubation. Haemodynamic responses during intubation were not considered for any analysis.

Following each intubation, the trainees had to rate their difficulty at intubation – “intubation difficult score”, on a 5-point Likert scale (very easy, easy, moderate, difficult, and very difficult). In addition, confidence of successful intubation self-assessed by the trainee – “confidence score”, was captured on a Numeric Rating Scale (NRS) from 1–10 (10- most confident).

Following surgery, (12-24 hours post-surgery) the patients were evaluated for subjective symptoms of sore throat and hoarseness on the NRS, which were then grouped as: none (0), mild (1–3), moderate (4–6), severe (7–10).

Parametric data like age, BMI, were compared using independent t-test. As TTI was not normally distributed, it was compared using Mann–Whitney, non-parametric test. The same test was used for comparing self-assessed confidence levels. Categorical data were compared using Chi-square test. P value of < 0.05 was considered significant. Statistical Package for Social Sciences version 25.0 (International Business Machines, New York, USA) statistical software was used to perform statistical analysis.

RESULTS

Five hundred and forty-two patients were screened, and 221 were randomised in the study [Figure 1]. The first 71 patients participated in the clinical training of both groups. In one patient, there was bradycardia at the time of the trainee’s initial attempt at tracheal intubation and the attempt had to be terminated. The patient was intubated by the attending consultant anaesthesiologist after the administration of a vagolytic (injection atropine 0.6 mg) intravenously. The tracheal intubation attempt was considered null and void. For the initial teaching session (first 70 intubations), TTI for group STD was 95.5 seconds versus 82 seconds.
for VL group. The incidence of failure was higher in group STD (12/35) as compared to group VL (6/35).

Data from 150 patients, independently intubated by the trainees were analysed and compared. Patients in the two groups were comparable with respect to the baseline demographic characteristics [Table 1]. Cormack-Lehane grades in both the groups were comparable, $P = 0.44$ [Table 2].

In group STD, median TTI was 52 s (IQR: 38.5–75.5 s), whereas in VL group it was 40 s (IQR: 32.3–49.9 s), $P = 0.002$ [Figure 2]. The first pass success rate was 54/75 in group VL versus 54/75 in group STD, $P = 0.046$ [Table 2]. The number of failures due to various reasons were comparable in both groups: group VL (07/75) versus group STD (10/75), $P = 0.60$ [Figure 1]. With respect to median confidence for successful intubation, the two groups were comparable: group VL 8 (IQR: 7-9) versus group STD 7 (IQR: 6-8), $P = 0.06$.

The incidence of airway trauma was similar in both the groups [Table 2]. Check laryngoscopy was performed in all the patients with trauma. No further intervention was needed for any of the cases. No incidence of moderate/severe sore throat or hoarseness was reported. Eighteen patients (12%) reported mild sore throat, 12 in the group STD and 6 patients in group VL, $P = 0.13$. Incidence of mild hoarseness was
6.6%, 6 patients in group STD, and 4 in group VL, \( P = 0.51 \).

**DISCUSSION**

Trainees in group VL achieved greater competency that is reflected by the difference in TTI and superior first pass success rate.

Previous studies have shown the benefits of improved visibility of the glottis by VLs during the time of tracheal intubation when compared with conventional Macintosh laryngoscope in terms of successful intubations by novices, even in difficult airway scenarios.\(^{4,12,13}\) Video-laryngoscopic monitoring in a teaching scenario enables the instructor to immediately recognise and correct problems related to direct laryngoscopy, tracheal tube insertion and placement, as well as to give early and precise guidance to the trainee based on the live video findings.\(^{14-17}\) Studies using VL as a teaching tool for novices performing tracheal intubation in neonates and infants, showed a greater success rate of tracheal intubation.\(^{18-21}\) The influence of video-based learning is also seen in our study. The first seven intubations by each trainee (training period), revealed that the VL group did better than the trainees with traditional learning. However, since suggestions by the supervising instructor were permissible, the data was not formally analysed for failure rates or time to intubate. To be sure that the difference in TTI was not influenced by an unanticipated difficult airway, the CL gradings were compared for in both the groups and were found to be similar which were comparable. (CL I/II/III/IV for group STD 21/11/1/2 and group VL 26/7/2/0) \( P = 0.289 \).

There remains limited literature on the impact of this learning on competency. Our trial aimed to evaluate the subsequent independent tracheal intubations that followed the initial learning. In a previous study that used instructional video to teach tracheal intubation, novice intubators were required to watch a 26-minutes videotape made with a direct laryngoscope imaging
system (video group) as a part of the initial training process.\textsuperscript{2} When compared with the traditional group, in an operating room setting, it was found that the instructional videotape helped improve the initial success rates of novice intubators. A previous study showed that the videotape feedback of one’s own tracheal intubation attempt, changed the students’ perception of how they performed laryngoscopy, especially with respect to patient positioning.\textsuperscript{22} However, in their study, they were unable to record the intraoral steps of the orotracheal intubation process, as VLs were not available then. In our study, we used C-MAC VL (during the training period) to record the intraoral steps of passing the endotracheal tube into the glottis. The post intubation video-replay session of the trainee’s own attempt at intubation with the instructor, helped the trainee to review each step of the intubation procedure. This session helped the trainees to understand their errors and introspect on the same. The results of our study strongly suggest that this process of debriefing and reviewing one’s own attempt helps in faster learning.

With regards to the secondary end points, we did not find any significant difference in terms of difficulty at intubation, confidence of successful intubation and intubation related trauma. A previous study reported higher level of confidence, when trainees intubated successfully.\textsuperscript{23} In our study, though group VL participants rated their confidence score higher than group STD, this was not statistically different. The difference in failure rate was not statistically significant between both groups, and this could have influenced the confidence level and self-assessed difficulty scores.

This study is not without limitations. Though we used TTI as the primary endpoint, we were looking at competency and hence the sample size had to be limited by the number of attempts per intubator and was not powered for a change in TTI. Literature on competency at intubation reveals varied results.\textsuperscript{7,24} To target the steep part of the competency curve, the sample size was calculated considering 22 intubations as a fair mark of achieving competency. This number could be an underestimation. A positive impact so early in the curve, as seen in our results, further defends the effectiveness of our intervention.

We were limited by the number of trainees based on the inclusion criteria (trainees with no prior experience in intubation in patients). In this study, all seventy intubations (training period) were performed using the C blade of C-MAC VL and not the conventional Macintosh laryngoscope. However, the blades are similar in design with additional video recording features, which was essential for our study.

**CONCLUSION**

Video-assisted guidance followed by video replay of the tracheal intubation process has a positive impact on learning of direct laryngoscopy by decreasing the time to intubation and first attempt success rate. Thus, we propose the use of this technique for training novice anaesthesiologists in direct laryngoscopy.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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