Original Article

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Study on Traditional Didactic Teaching versus Videolaryngoscopy-Assisted Feedback for Teaching Endotracheal Intubation

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Abstract

Introduction: Direct laryngoscopy and endotracheal intubation is an integral part of many fields of medical care including anaesthesia, intensive care and emergency medicine. *Aim:* The aim of the study was to assess the relative efficacy of traditional didactic method of teaching and videolaryngoscopy-assisted feedback as instructional methods for endotracheal intubation. *Materials and Methods:* This was a prospective randomised study done in Kasturba Medical College, Manipal, over a period of 2 years. Sixty medical doctors doing a 15-day posting in the Department of Anaesthesiology as a part of their Compulsory Rotating Internship training were included in the study. They were divided into two groups of 30 each and received training for laryngoscopy and endotracheal intubation bydidactic method (DID) and by videolaryngoscopic method (VLS). Patients aged 18 to 60 years of either gender, belonging to American Society of Anesthesiologists Physical Status (ASA-PS) I and II, scheduled for elective surgery under general anaesthesia requiring oral endotracheal intubation were enrolled for the study. *Results:* The mean overall success rate in the DID group was 77.33±20.83% while it was 93.33±12.12% in the VLS group. The difference was statistically highly significant (p = 0.001). There was statistically significant difference in the first intubation success rate among DID and VLS groups 60% vs 83.3% (p = 0.042). Duration of laryngoscopy, intubation and total time, laryngopharyngeal morbidity, best laryngoscopic view obtained, ease of laryngoscopy and intubation were also compared. *Conclusion:* Teaching of endotracheal intubation to novice medical doctors using videolaryngoscopic feedback results in higher overall success rate, including first intubation success rate, when compared with conventional didactic method of teaching. The teaching technique used does not influence the time taken for intubation nor does it alter the degree of laryngopharyngeal morbidity.

Keywords: Endotracheal Intubation; Videolaryngoscopy; Didactic Teaching; Videolaryngoscopic Feedback.

Introduction

Direct laryngoscopy and endotracheal intubation are an integral part of anaesthesia, intensive care and emergency medicine. The laryngoscope is an instrument used to visualise the larynx and perform endotracheal intubation [1]. As outlined in the American Heart Association Guidelines for Life Support (2010), placement of an endotracheal tube using direct laryngoscopy provides better ventilation and oxygenation of lungs in cardiac arrest scenarios [2]. Complications like airway trauma, hypoxaemia and oesophageal intubation are higher when performed by untrained personnel [2]. Competence in performing laryngoscopy and endotracheal intubation is very important for health care providers.

The traditional method of teaching is the didactic method which is teacher-centric, and provides the framework of ideas and theories [3]. Video-assisted feedback during simulation enhances the development of complex psychomotor skills required for laryngoscopy and endotracheal intubation [4]. The

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technique of videolaryngoscopy provides rich, real-time video of the process of laryngoscopy that may facilitate such feedback.

Simulation-based learning is student-centric [3,4]. It provides experiential learning to acquire psychomotor skills. Simulation, as defined by Dr David Gaba, refers to "artificial replication of sufficient elements of real world domain to achieve a stated goal" [5]. Simulation creates patient care scenarios mimicking the clinical environment [6]. Simulation allows students to make mistakes and learn from their errors without harming patients. Thus, simulation acts as a powerful training tool with great potential to improve patient safety.

Several studies have compared the effectiveness of teaching methods on endotracheal intubation using either direct laryngoscopy technique or videolaryngoscopy. All these studies were conducted with currently available videolaryngoscopes which are expensive. We therefore used an indigenously developed videolaryngoscope by interfacing a digital camera through a USB cable to a personal laptop computer. This indigenous videolaryngoscope was used as one of the training methods and compared with direct laryngoscopy [7]. Addition of simulation to teaching methods have resulted in improved safety. Hence, mannequin-based training was also included in our study.

Aim of Study

The aim of the study was to assess the relative efficacy of traditional didactic method of teaching and videolaryngoscopy-assisted feedback as instructional methods for endotracheal intubation.

Objectives

To investigate the effectiveness of two different teaching methods for endotracheal intubation with respect to the following outcome measures:

Primary outcome

- Overall intubation success rate

Secondary Outcomes

- First intubation success rate
- Time taken for intubation
- Laryngopharyngeal morbidity

Tertiary Outcomes

- Best laryngoscopic grading obtained
- Ease of laryngoscopy
- Ease of intubation

Materials and Methods

This was a prospective randomized study carried out in the department of Anaesthesiology, Kasturba Medical College, Manipal, over a period of two years from October 2012 to September 2014. Informed consent was obtained from the patients participating in the study as well as the doctors who underwent training and performed endotracheal intubation.

Inclusion Criteria

Doctor: Compulsory Rotating Intern who was yet to complete Anaesthesiology posting and did not have any prior experience of performing laryngoscopy and endotracheal intubation.

Patient: Patients aged 18 to 60 years of either gender, belonging to American Society of Anesthesiologists Physical Status (ASA-PS) I and II, scheduled for elective surgery under general anaesthesia requiring oral endotracheal intubation were enrolled for the study. These patients had a modified Mallampati class of either 1 or 2 on airway examination.

Exclusion Criteria

Doctor: Compulsory Rotating Intern who had already completed internship posting in Anaesthesiology, or had previously watched or performed laryngoscopy and intubation.

Patient: Patients requiring nasal intubation or those posted for emergency surgery necessitating the use of rapid sequence induction of anaesthesia were excluded. Those with anticipated difficult airway or modified Mallampati Class 3 or 4, inability to insinuate tip of 1 finger into the temporomandibular joint, mouth opening < 2 finger breadth, thyromental distance < 3 finger breadth, buck teeth, edentulous patients, oropharyngeal/neck masses, limited neck movements and obese patients with body mass index > 30 kg/m^2 were excluded.

Allocation of Groups

Doctors performing intubation were randomly allocated into one of 2 groups using computer-generated randomisation sequence table. The group was concealed using opaque, sealed and sequentially numbered envelopes that were handed over to the investigator.

The study was carried out in *three phases*. In the *first phase*, trainee doctors were shown how to perform endotracheal intubation by one of the two senior investigators using either of the above two techniques on patients in the operating room. In the *second phase*, they were taken to the Medical Simulation Centre of the Manipal University where they were asked to perform intubation on an intubation trainer mannequin until they achieved ten successive successful intubations. The second phase was considered to be complete when they could, in addition, correctly state a checklist of ten crucial steps in performing laryngoscopy and intubation. During the *third and final phase*, the medical doctors intubated five patients each in the operating room and their performance was evaluated.

Didactic Training (Group DID) and Videolaryngoscopy -Assisted Feedback (Group VLS)

Laryngoscopy and endotracheal intubation were demonstrated in 3 patients by one of the two senior investigators, RamkumarVenkateswaran (RV) or John George Karuppacheril (JGK). The demonstrations consisted of intubation by conventional laryngoscopy performed for 2 to 3 persons belonging to the same group at the same time (with the group size never exceeding 3 for logistic reasons). The doctor was then asked to perform laryngoscopy and endotracheal intubation on the intubation trainer mannequin until (s)he performed 10 successful intubations by conventional laryngoscopy (the first 5 of them being untimed while the next 5 were timed). (S)he was then asked to perform conventional laryngoscopy and endotracheal intubation in 5 patients in the operation theatre in the presence of one of the above two senior investigators.

For the VLS group, similar demonstration was done using videolaryngoscopic feedback by using an indigenously developed videolaryngoscopy device. It was a novel digital video-endoscopic camera system attached to the conventional Macintosh blade. The device consisted of a waterproof endoscopic camera (*Shenzhen Electronic Technology Co Ltd, China*) that was 5 cm long and 10 mm in diameter. The camera was attached 40 mm from the tip of a conventional Macintosh blade using clean adhesive *Durapore tape (3M, USA)* (Figure 1). The video output from the camera was captured through a USB cable connection to the USB port of a laptop running either Ubuntu Linux 12.04 LTS operating system (*Canonical Inc., South Africa*) or Macintosh OS X 10.8 (*Apple Inc., USA*) (Figure 2). The software Guvcview v1.6.0 in Ubuntu Linux or QuickTime Player v10.2 in Macintosh OS X was used to record the videos in MPEG4-AVC format.

Video feedback was provided. The doctor was

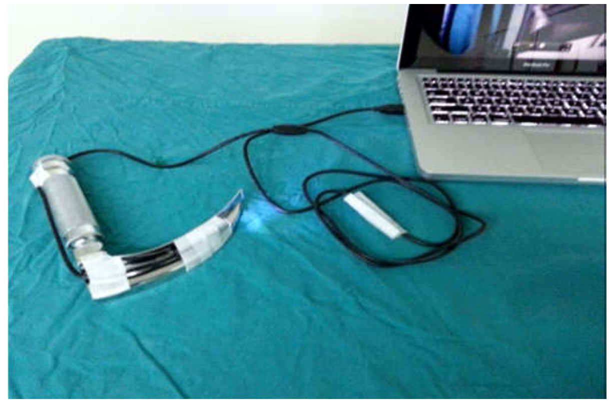

Fig. 1: Picture of device assembly

Fig. 2: Image obtained by the device

asked to perform video-assisted laryngoscopy and endotracheal intubation on the intubation trainer mannequin until they achieved 10 successful attempts (first 5 untimed using video-assisted laryngoscopy followed by 5 timed intubations using conventional laryngoscopy). (S)he was then asked to perform conventional laryngoscopy and endotracheal intubation in 5 patients in the operation theatre in the presence of one of the same two senior investigators.

Observers

Observer 1: Dr. Roopa K (RK) who performed preoperative assessment of patients and noted intraoperative observations (*vide infra*).

Observer 2: Anaesthesiology consultant (RV or JGK) demonstrated laryngoscopy and endotracheal intubation by either method as per group allocation. They also provided mannequin-based training followed by supervising their performance of endotracheal intubation on 5 patients in the operation theatre. They evaluated the performance and noted the grade of laryngoscopic view obtained.

Knowledge of the steps in laryngoscopy and endotracheal intubationwere also assessed by the 10-point criteria as detailed below:

Criteria to be Achieved before Considering that Training is Complete

1. State and demonstrate the ideal position for laryngoscopy
2. State the need for preoxygenation
3. Demonstrate ability to assist ventilation with bag-mask
4. Demonstrate correct method of sweeping tongue to left without hinging on the tonsillar pillars
5. Demonstrate proper technique of lifting epiglottis without levering on the upper incisors
6. Demonstrate best laryngeal view (Cormack and Lehane grade 1 or 2)
7. Perform successful intubations on a mannequin on 10 consecutive occasions within a timing of 120 seconds per intubation
8. Voice the need to perform a 5-point auscultation
9. State the importance of square-wave capnograph waveform in the clinical situation for confirming proper tube position
10. Fix endotracheal tube

Procedure

On the day before surgery, Observer 1 performed preoperative evaluation of the patient including a detailed airway assessment. Patients were kept nil per oral (6 hours for solids and 3 hours for clear fluids).

In the operation theatre, patients were positioned,intravenous infusion and necessary preinduction monitors were set up. Neuromuscular blockade was assessed. Preoxygenation was done with 100% oxygen for 3 minutes. Analgesia was provided with intravenous fentanyl (1.5 to 2 ìg/kg) and anaesthesia induced with propofol 2.5 to 3 mg/kg titrated till the patient became unresponsive. After checking the adequacy of mask ventilation, neuromuscular blockade was achieved with vecuronium bromide 0.1 mg/kg. Anaesthesia was maintained with 1.5% to 2% isoflurane in oxygen and intermittent positive pressure ventilation (IPPV) using a semiclosed circle absorber (SCCA) system for 3 minutes. After ensuring complete neuromuscular blockade, laryngoscopy and endotracheal intubation were performed by the doctor as per group allocation under the supervision of Observer 2.

Laryngoscopy was performed using a size 3 or size 4 Macintosh blade respectively for women and men. Observer 2 performed a baseline laryngoscopy and noted the best laryngoscopic view obtained as detailed below:

Grade 1 Entire glottis seen including vocal cords, arytenoids and glottic inlet

Grade 2 Only posterior part of vocal cords and arytenoids seen

Grade 3 Only epiglottis seen

Grade 4 No glottic structures seen

This information was not communicated to the doctor who then performed laryngoscopy and endotracheal intubation only if the view obtained by Observer 2 was Grade 1 or 2. Patients were mask-ventilated again with 1.5 to 2% isoflurane in 100% oxygen till a MAC of 1.0 was achieved, and an additional bolus of 20 mg of propofol was given. Observer 2 assessed the laryngoscopy grade obtained by the doctor performing intubation. External laryngeal manipulation was provided when requested and its use was noted. If the best laryngoscopic view obtained by the doctor was only grade 3 or 4, Observer 2 took over and performed endotracheal intubation. Successful endotracheal intubation was confirmed by appearance of ETCO2 trace and bilateral equal air entry.

The doctor was allowed only one intubation attempt per patient. In the event of failure, observer 2 took over and performed intubation and further management was left to the discretion of the in charge anaesthesiologist.

Observer 1 noted parameters such as success of intubation, duration of laryngoscopy and intubation, Cormack-Lehanelaryngoscopic grades obtained by Observer 2 and the doctor performing intubation, and airway trauma. Ease of laryngoscopy and ease of intubation were graded by trainees for each intubation.

Intubation Attempt

An intubation attempt was defined as either introduction of the laryngoscope blade into the oral cavity and appearance of capnogram following successful intubation, or withdrawal of the laryngoscope from the oral cavity should the attempt fail. An intubation attempt was terminated after 120 seconds or if oxygen saturation dropped below 94% before 120 seconds, whichever was earlier. A "failed" attempt was an unsuccessful tracheal intubation, or when the attempt exceeded 120 seconds or produced a drop in saturation below 94%. In such cases observer 2 immediately took over and performed the intubation.

Observations

- Overall success rate
- First intubation success rate
- Duration of laryngoscopy (T1) and intubation (T2) and total time (T)
- Laryngopharyngeal morbidity
- Bestlaryngoscopic view obtained by Observer 2
- Bestlaryngoscopic view obtained by doctor performing intubation
- Ease of laryngoscopy
- Ease of intubation

Overall Success Rate and First Intubation Success Rate

Overall success rate = Number of successful intubations in each group/ Total number of intubations in each group x 100

First intubation success rate = Number of successful first intubations in each group/ Total number of first intubations in each group x 100

Duration of Laryngoscopy and Intubation

Laryngoscopy time (Time T1 in seconds) was the time from introduction of the laryngoscope blade into the oral cavity till the time for obtaining the best laryngoscopic view. Intubation time (Time T2 in seconds) was the time taken from visualisation of the glottis till confirmation of intubation by capnography. The total intubation time (T) was T1 + T2 in seconds.

Ease of Laryngoscopy

The participants graded the ease of laryngoscopy as:

Easy: Able to obtain Cormack and Lehane grade 1 or 2 without external laryngeal manipulation

Slightly difficult: Able to obtain Cormack and Lehane grade 1 or 2 with external laryngeal manipulation

Difficult: Unable to obtain Cormack and Lehane grade 1 or 2 even with external laryngeal manipulation.

Ease of Intubation

The participants graded the ease of intubation as:

Easy: Smooth passage of endotracheal tube into the glottis without hinging against the arytenoids

Slightly difficult: Hinging of endotracheal tube against the arytenoids

Difficult: Inability to insert endotracheal tube in first attempt, requiring a second attempt for intubation

Laryngopharyngeal Morbidity

Observer 2 inspected the oral cavity after intubation and while removal of laryngoscopic blade for any evidence of airway trauma. Presence of blood on tube on extubation was also noted. Observer 1 noted any change of voice and sore throat as present or absent 24 hours after the procedure.

A pilot study was done with 5 doctors in each group, each performing 5 intubations on patients in the operating room. The overall mean success rate in DID group was 64% with SD of 16.73 while it was 80% with SD of 14.14 in VLS group. The final sample size was calculated for minimum expected clinical difference of 15% between the groups with an alpha error of 0.05 and power of 80%. Sixteen doctors were required in each group. We recruited 30 doctors per group. Variables are analysed in SPSS version 16.0.

Observations and Results

Demographic Data

The groups were comparable with respect to age and gender. Each group had 30 participants. The DID group had a mean age of 23.7±1.73 years, 14 male and 16 females. The VLS group had 24.17±1.46 years, 17 males and 13 females.

Overall Success Rate and First Intubation Success Rate

Overall success ratewas the primary outcome parameter in our study. In DID group 116 intubations, and in the VLS group 140 were successful out of 150 intubations. The mean overall success rate in the DID group was 77.33±20.83% while it was 93.33±12.12% in the VLS group. The difference was statistically highly significant (p = 0.001). Independent samples t- test.

The *first intubation success rate* was the percentage of first intubations (in a series of 5 intubations done by the same participant in 5 different patients) that were successful. It was (18/30) 60% in the DID group as compared to (25/30) 83.3% in the VLS group. The difference was statistically significant (p = 0.042). Chi square test, $p < 0.05$ (SS)

Unsuccessful Intubations

Out of 150 intubations in each group, unsuccessful intubations were 34 and 10 in DID and VLS groups respectively. There were 30 oesophageal intubations in DID which is comparatively more than VLS group. Total of 5intubations were timed out according to protocol of stipulated time of 120 seconds.

Table 1: Unsuccessful intubations

Reason	DID (n= 150 intubations)	VLS (n= 150 intubations)	Total
Oesophageal intubation	30	9	39
Timed out (>120 sec)	4	1	5
Total	34	10	44

DID=Didactic group, VLS=Videolaryngoscopy group

n=30 x 5 intubations = 150 intubations in each group

Laryngoscopy time, Intubation time and Total time

A few doctors were unable to complete laryngoscopy and intubation on their first attempt within the stipulated maximum time frame of 120 seconds. We therefore took an average of the times T_1 and T_2 for the second through fifth intubations (*i.e.*, average of four independent timings for four intubations performed by each doctor which were within 120 seconds).

Table 2: Laryngoscopy time (T_1), intubation time (T_2) and total time (T)

Parameter	DID (n=30)	VLS (n=30)	P value
Average T_1 (seconds) (Mean ± SD)	31.34±11.37	33.99±9.01	0.321*
Average T_2 (seconds) (Mean ± SD)	33.93±7.07	34.71±7.67	0.682*
Average T (seconds) (Mean ± SD)	65.27±16.01	68.70±14.40	0.386*

*Independent samples T test, $p < 0.05$ (SS)

DID=Didactic group, VLS=Videolaryngoscopy group, n=Number of participants

Comparison of the two groups with respect to T_1, T_2 and total time T revealed no significant difference.

Laryngopharyngeal morbidity

Out of 150 intubations, 7 patients in the DID group and 5 patients in the VLS grouphad laryngopharyngeal morbidity and the groups were comparable.

Cormack-Lehanelaryngoscopic grade obtained by trained observer and medical doctors

Following induction of anaesthesia, the best Cormack-Lehanelaryngoscopic grade obtained by the trained observer ("trainer") and the "trainee" were noted. Patients in whom a Cormack-Lehanelaryngoscopic grading of 1 or 2 was obtained by the trainer, they were anaesthetised using bag-mask ventilation and then the "trainee" performed laryngoscopy and intubation. The best laryngeal view obtained by the medical doctors in both the groups was 1 or 2 with or without external laryngeal manipulation. Pairs of observation by the trainer and trainee on the same patient were then compared to see whether the laryngoscopic views remained unchanged, improved or worsened from trainer to trainee. The results of this comparison are summarised in Table 3

Table 3: Comparison of Cormack-Lehanelaryngoscopic grading between trained observer and trainee medical doctors

Group	No change	Worsened	Total
DID(n= 150 intubations)	131	19	150
VLS(n= 150 intubations)	133	17	150
Total	264	36	130

n=30 x 5 intubations =150 intubations in each group

No change= Grading of 1 remained 1, or 2 remained 2 between trained observer and trainee medical doctor

Worsened= Grading of 1 became 2 from trained observer to trainee medical doctor

Use of External Laryngeal Manipulation

The use of external laryngeal manipulation during laryngoscopy performed by the trainee was noted. External laryngeal manipulation was used for 59 intubations in the DID group and for 53 intubations in the VLS group to obtain the best laryngeal view.

Ease of Laryngoscopy and Ease of Intubation

The medical doctors who performed intubations were asked to grade their subjective experience of both laryngoscopy and intubation as easy, slightly difficult or difficult. The results are summarised in Table 4.

Table 4: Ease of laryngoscopy and ease of intubation

Parameter	DID (n=150 intubations)			VLS (n=150 intubations)		
	Easy	Slightly difficult	Difficult	Easy	Slightly difficult	Difficult
Ease of laryngoscopy	89	59	2	97	53	0
Ease of intubation	105	11	34	128	12	10

DID= Didactic group, VLS= Videolaryngoscopy group, n=30 x 5 intubations =150 intubations in each group.

Discussion

In our study, the technique of endotracheal intubation was taught using one of two instructional methods, the didactic and thevideolaryngoscopic methodto two groups of trainee medical doctors. The overall success rate of intubation of 93.33% in the VLS group in our study was significantly higher compared to 77.33% in the DID group. Many studies have concluded that videolaryngoscopy training was superior to direct laryngoscopy in terms of overall success rate. These results are supported by a study of training of non-anaesthesia personnel with Glide Scope that reported a 93% success rate in the videolaryngoscope group as compared to laryngoscopy with Macintosh [7].

The authors concluded that in persons with no or minimal experience with intubation, video-assisted techniques would significantly increase the success rate [7].

However, in this study, assessment of intubation success rate was done with videolaryngoscopy in one group and direct laryngoscopy in the other. Our methodology was different as we used two methods (didactic and videolaryngoscopy-assisted feedback) during the phase of demonstration and training. All participants performed intubation in the third phase on elective surgical patients in the operating rooms using *conventional* laryngoscopy.

Our results are also in accordance with a study by Quijanoet alwhere video-assisted instruction had 69% success with less incidence of oesophageal intubation [8].

When teaching of intubation was compared between Airtraq and rigid laryngoscopy, participants in the Airtraq group had a higher success rate of 23/30 as compared to 8/30 in the rigid laryngoscopy group [9].

The higher success rate in VLS group can be attributed to better appreciation of airway anatomy on the video monitor by both learner andinstructor [10]. Many studies have established the usefulness of videolaryngoscopy in teaching endotracheal intubation to novices and non-anaesthesia personnel [11]. Studies also mention that intubation using avideolaryngoscope requires hand-eye coordination for success [12].

This limitation of intubation training using videolaryngoscopy was overcome in our study by switching the participants trained using the indigenous videolaryngoscope to perform their first 5 intubations on the mannequin using the same indigenous videolaryngoscope before doing the next five intubations on the mannequin by conventional laryngoscopy. In the final phase of the study where the participants performed intubation in the operating room on patients, all had to use a conventional Macintosh laryngoscope.

In our study, all participants performed intubations on five patients undergoing elective surgery. The **f***irst intubation success rate* was 83.3% in the VLS group. This was significantly higher as compared to 60% in the DID group. We believe that ours is the first clinical study that has compared first intubation success rate using conventional Macintosh laryngoscope following two methods of teaching.

The average total time (from second through fifth intubations) taken to intubate was 68 seconds in the VLS group which was comparable to 65 seconds in the DID group. This result is in agreement with a study where no difference was found in the time taken to intubate with Glide Scope and Macintosh laryngoscopes [13]. Many other studies had a significantly shorter time for intubation with videolaryngoscopes such as GlideScope and C-MAC [14]. On the other hand, time to intubate was significantly higher with McGrath videolaryngoscope, with the latter offering no advantage over direct laryngoscopy [15].

All the above studies varied slightly in their methodology and the intubation times were measured while intubating with videolaryngoscopes. So our finding of similar intubation timing between the groups cannot be compared to the times obtained with these studies. In our study, the Intubation times in the two groups could have been similar due to the fact that whatever may be the training method they received, the final evaluation of the participants wasdone when they intubated patients by conventional laryngoscopy. We believe that the anatomical knowledge and skills required for performing intubation were acquired during the training period with videolaryngoscopic feedback and simulation-based training. Such acquisition of knowledge and skills translated to a higher success rate in the VLS group with no difference in intubation timings between the two groups.

Videolaryngoscopic devices are costly and may have limited availability. They may not be cost effectivefor teaching intubation [37]. Inour study, we used a custom-made videolaryngoscopeand the relative cost was less than 3% the cost of a company-made commercially available videolaryngoscopic device. A study by Karippacheril and colleaguesusing this custom-made device has already proved its usefulness in intubation [16].

Wefurther tested the efficacy of the device to teach endotracheal intubation to novices by providing videolaryngoscopy-assisted feedback through this device. The success rate in the VLS group who received teaching through this device was higher, indicating its usefulness in teaching also. The ability to provide effective teaching and training at less than 3% of the cost is also very relevant in the Indian context.

This custom-made device has added advantage over traditionally available videolaryngoscopes such as Airtraq and C-MAC where the monitor is small and the relative anatomy of airway structures less easily discernible. For our custom-made videolaryngoscope, we used a personal computer to capture the videos onto a wider screen, providing a clearer view of the structures as the laryngoscope is passed into the mouth. This setup has an additional option of storing and retrieving the intubation procedure which is useful to provide the feedback and also for research purposes.

Apart from all these, other factors that could have influenced were anxiety of performing the procedure, stressful environment of the operation theatre, individual knowledge and psychomotor skillswhich could not be standardised in our study.

Only one study published by Lowand colleagues has used the same methodology. The performance of the novices was assessed in conventional manner which still remains the standard method of managing the normal airways in a cost effective manner. The novices in the videolaryngoscope group had better performance in terms of number of attempts and less dental trauma compared to the group who were trained in conventional manner [17]. The participants in the videolaryngoscope group had better knowledge of airway anatomy which could have led to the higher success rate similar to our study.

Addition of simulation to either conventional or video-assisted training improved the safety and strength of the study. Due to performance anxiety, novices may not do well directly on the patients. This poses significant risks to the patients besides raising ethical concerns. Simulation based medical education (SBME) allows the individuals to practice on mannequins at their own pace and improves the acquisition of skills by learning from one's own mistakes. Provision of feedback during simulation sessions further improves the learning outcome, which was strictly adhered to in our study [18].

But the validity of outcomes of simulation-based studies alone translating into better clinical practice is questionable. Such training must be combined with clinical situations to maintain the safety and evaluation of the training method or airway device [12].

In our study, addition of simulation to both the methods of teaching improved success and safety which was reflected bylesser incidenceof airway trauma.

Limitations

The custom-made device was not tested for its efficacy for teaching purposes with other videolaryngoscopes which are available in the market. We had a limited duration of 15 daysto train the interns then practice on mannequins and then perform intubations under controlled clinical conditions. Learning a skill such as endotracheal intubation might take longer in some individuals, making a stipulated time of 2 weeks less.

Only 5 intubation attempts were given to each intern and success rate was noted. Many studies state that for a novice to attain 90% success rate, about 47 intubations are required [19].

Patients with normal airways only were studied.

As the efficacy of this new equipment was not tested on difficult airways, the beneficial effects described with normal airways cannot be extrapolated to patients with difficult airways.

However, we took this initiative to teach medical doctors the skill of endotracheal intubation with the aim of improving standards of education for future generations to come. We also tested the efficacy of this custom-made, low-cost videolaryngoscope for teaching intubation to novices as this might prove useful in the Indian context, especially in institutes that cannot afford more expensive videolaryngoscopes that are currently available.

Conclusion

Teaching of endotracheal intubationto novice medical doctors using videolaryngoscopic feedback results in higher overall success rate including first intubation success rateas compared to conventional didactic method of teaching. The teaching technique used does not influence the time taken for intubation nor does it alter the degree of laryngopharyngeal morbidity.

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