Original Article

A study to evaluate the role of experience in acquisition of the skill of orotracheal intubation in adults

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Abstract

Background and Aims: To evaluate the role of experience in acquisition of skill of orotracheal intubation in adults.
Material and Methods: A prospective randomized study was conducted on 307 patients of either sex, belonging to ASA grade I and II (aged 18-60 years) posted for surgery under general anaesthesia. The patients were subjected to DL and ETI procedure, which was performed by five different groups of participants. Group 1 consisted of first-year resident of anaesthesiology with experience of less than 10 intubations, group 2 for second-year resident, group 3 for third-year resident, group 4 for senior resident and group 5 for consultant. Ease of mask ventilation, time taken for intubation, number of attempts, success rate, and ease of intubation were assessed for all the groups.
Results: Categorical variables were analysed using Chi-square test. For all statistical tests, a *P* value less than 0.05 was taken as a significant difference. Maximum difficulty in mask ventilation was encountered by group 1 anaesthesiologist, that is, in 69.2% of the patients. Group 1 took maximum time to intubate, that is, 47.98 ± 31.54 sec and least time was taken by group 5 anaesthesiologist (9.55 ± 6.93) sec. First attempt success rate was least in group (80.0%). Group 1 had success rate of 96.9%, whereas rest all groups had 100% success.
Conclusion: Skill of mask ventilation and intubation and time taken for intubation grossly improves with increasing experience. Minimum of 25 intubation attempts should be required by an anaesthesiologist resident in elective scenario to achieve 100% success rate in our study.

Keywords: Intubation skill, novice intubator, tracheal intubation

Introduction

Tracheal Intubation is one of the most important life-saving procedures. It is considered as the preferred technique to secure airway and apply mechanical ventilation in anaesthetized patients.[1-4] Maintenance of airway is prime responsibility of anaesthetist. Rapid and safe control of airway is crucial, and intubation must be accomplished early to maintain adequate oxygenation.[5-7]

Various patient-related factors can be associated with difficult direct laryngoscopy (DL).[2,5] There can be other factors related to anaesthesiologist, equipment, procedure and position that can cause difficulty in intubation.[8-10] The technical skills, knowledge and crisis management capabilities of the anaesthesiologist play a vital role in the occurrence and outcome of complications during laryngoscopy and endotracheal intubation.[10,11] Other contributing factors making learning of DL difficult are teaching techniques, limited opportunities for practice, restricted visualisation, and lack of documentation of the procedure.[4,11-14]

Laryngoscopy and tracheal intubation require a lot of clinical experience.[1,15-17] As documented by various authors, average

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of 57 attempts needed to achieve a 90% success rate of intubation.[14,18,19] Various studies are indicating conceivable connection between operator's tracheal intubation experience and patient outcome.[20-22] There is little information in the literature that indicates the extent of training required for competence in laryngoscopy and tracheal intubation.[19] Hence, the present study aims to establish the learning curve for bag-mask ventilation and for laryngoscopic intubation to determine the amount of experience required for the acquisition of skill of each technique.

Aim of the study was to evaluate role of experience in acquisition of skill of orotracheal intubation in adults under standard anesthetic condition. Primary objective was to establish the success rate of intubation, when intubation was performed by the different groups including residents, senior residents and consultants. Secondary objective was to observe varying haemodynamic response and complications, if any when intubation was performed by person having different experience of performing intubation.

Material and Methods:

The study was conducted in the department of anaesthesia of a teaching hospital after approval by the hospital Ethical Committee. Informed consent from all the participants was obtained. A total of 307 adult patients aged 18-60 years of either sex, with physical status of Grade I, or II according to American Society of Anaesthesiologists, scheduled for elective surgery under general anaesthesia and requiring orotracheal intubation were enrolled in the study. The patients with anticipated difficult intubation (MPG III, IV), risk of pulmonary aspiration, history of IHD and hypertension, BMI ≥35, and obstetric patients were excluded from the study. In the operating room, intravenous line was established and standard monitors (noninvasive blood pressure, electrocardiography, and pulse oximetry) were attached. After standard anaesthesia induction, patients were randomly subjected to DL and ETI procedure, which was performed by five different groups of participants. Group 1 consisted of first-year resident of anaesthesiology mostly with experience of less than 10 intubations, group 2 belonged to second-year resident, group 3 to third-year resident, group 4 to senior resident and group 5 was formed by consultant.

After induction mask ventilation was assessed and it was graded as easy, difficult, and impossible.[23] Easy was defined as single-handed successful ventilation without any assistance, difficulty mask ventilation was defined by one of the following criteria: (Inability for an unassisted anaesthesiologist to maintain O_2 saturation greater than 90% using 100% oxygen and positive pressure ventilation; necessity to perform a two-handed mask ventilation; gas flow leak from face mask; no perception of chest movement; need for an oropharyngeal airway). Impossible mask ventilation was defined as inability to ventilate the patient. Time taken for intubation in seconds was noted. It was time from introduction of laryngoscope blade into patient's mouth until capnographic trace of CO_2 obtained after ETI. Number of attempts required for successful intubation was recorded. If intubation was not successful after three attempts or time taken for intubation was more than 180 sec, it was assigned as failed intubation. Success rate of intubation was noted as Yes or No. Success was called 'Yes', when ETT successfully placed in trachea within 180 sec. It was labelled 'No' if not placed successfully. Ease of intubation noted based on intubation difficulty score (IDS) was graded by anaesthesiologist as easy (IDS = 0), slight difficult (IDS = 0-5), moderate to major difficult (IDS >5) or impossible (IDS = ∞). To know the exact role of experience in intubation difficulty, IDS[24] was modified by us keeping number of operator (N_2) and number of alternative technique (N_3) constant.

Total IDS = sum of scores (N_1-N_7) [Table 1].

Besides above observations, various approximate intubations done by operator till date were noted. Anaesthesiologist was questioned about factors considered important for success rate. Haemodynamic parameters (heart rate, mean arterial pressure Oxygen saturation (%), and arrhythmias), if any were recorded preoperatively, just before intubation and 1, 3 and 5 min after intubation. Any complication following ETI was also noted.

Sample size:

Researchers have reported that the success rate of Tracheal intubation changed from 27% to 88% before and after the minimum training of residents.[23] Therefore, assuming 50% as the success rate and 7% margin of error, the minimum required sample size at 5% level of significance is 196 patients.

Formula used:

$$n = \frac{Z^2_{\alpha/2} pq}{d^2}$$

where p is the observed incidence

$q = 1 - p$

d is the margin of error

$Z_{\alpha/2}$ is the ordinate of standard normal distribution at α% level of significance.

Table 1: Intubation difficulty score

Parameters					Score
Number of attempts (N_1)	I		II	III	
Number of operators (constant) (N_2=0)					
Number of alternative technique (constant) (N_3=0)					
Cormack grade (N_4)	Grade I	Grade II	Grade III	Grade IV	
Lifting force required (N_5)	Normal		Increased		
Laryngeal pressure (N_6)	Not applied		Applied		
Vocal cord mobility (N_7)	Abduction		Adduction		
Total IDS					

Table 2: Demographic data of patients

	Age (years) Mean±SD	Wt (kg) Mean±SD	Ht (cm) Mean±SD	Sex		Total (*n*)
				F	M	
Group 1	37.66±13.14	57.68±6.08	164.91±6.79	43 (66.2%)	22 (33.8%)	65
Group 2	38.18±12.67	58.26±5.54	164.35±6.6	40 (64.5%)	22 (35.5%)	62
Group 3	41.32±13.58	58.47±6.24	166.07±5.85	35 (58.3%)	25 (41.7%)	60
Group 4	35.03±13.03	58.07±6.35	165.98±5.75	31 (51.7%)	29 (48.3%)	60
Group 5	35.13±13.39	57.15±7.47	166.03±5.79	36 (60.0%)	24 (40.0%)	60
P	0.059	0.804	0.405	0.500		

Table 3: Various parameters

	Mask ventilation		Time taken for intubation (sec) Mean±SD	Number of attempts			Success rate		Factors important for success	
	Easy	Difficult		One	Two	Three	Yes	No	BURP	Stylet
Group 1 (*n*=65)	20 (30.8%)	45 (69.2%)	47.98±31.54	52 (80.0%)	11 (16.9%)	2 (3.1%)	63 (96.9%)	2 (3.1%)	57 (87.7%)	8 (12.3%)
Group 2 (*n*=62)	55 (88.7%)	7 (11.3%)	11.37±3.13	62 (100%)	0 (0.0%)	0 (0.0%)	62 (100%)	0 (0.0%)	6 (9.7%)	0
Group 3 (*n*=60)	57 (94.6%)	3 (5.4%)	10.33±1.94	59 (98.3%)	1 (1.7%)	0 (0.0%)	60 (100%)	0 (0.0%)	2 (3.3%)	1 (1.7%)
Group 4 (*n*=60)	58 (96.7%)	2 (3.3%)	11.42±22.17	59 (98.3%)	1 (1.7%)	0 (0.0%)	60 (100%)	0 (0.0%)	1 (1.7%)	1 (1.7%)
Group 5 (*n*=60)	58 (96.7%)	2 (3.3%)	9.55±6.93	59 (98.3%)	1 (1.7%)	0 (0.0%)	60 (100%)	0 (0.0%)	1 (1.7%)	1 (1.7%)
P	<0.001		<0.001	<0.001			0.112		<0.001	

Results

Data of all 307 patients enrolled in the study were included in the analysis. The age, sex, weight, and height, of the patients were comparable in the five groups [Table 2]. Mask ventilation, time taken for intubation, number of attempts, success rate and factors affecting success rate are shown in Table 3.

Discussion

Medical students are required to master the skill of laryngoscopy and endotracheal intubation.[16,17] Experience and training level of anaesthetist is very important for timely and atraumatic performance of DL and ETI.[25] Ample training is required before a trainee become proficient in this procedure. Hence students must acquire this skill through repetitive task practice.[21,22,26] Present study evaluated the role of experience in acquisition of skill of orotracheal intubation to evaluate how experience of intubator is important in achieving the success of intubation and minimizing the associated complications.

In current study, we formed five groups of doctors who had variable experience in the skill of DL and ETI. Majority of group 1 subjects had experienced less than 10 intubations while few had attempted 10-25 intubations before study. The subjects in group 2 had experienced 26-50 intubations. Participants of group 3, group 4 and group 5 had performed more than 50 intubations before this study.

Mask ventilation was assessed in current study and group 1 subjects were having less experience in this skill and faced difficulty in mask ventilation (69.2% patients). It was observed that with increasing experience, as in group 2 success of mask ventilation increased to 88.7% and 94.6% in groups 4 and 5 ($P < 0.001$). Soleimanpour *et al*. also observed significant differences ($P = 0.0004$) in bag and mask ventilation before and after anaesthesiology rotation training.[23] Before rotation, the participants had a successful bag-mask ventilation rate of 6 out of 36. After the rotation, this rate increased to 32 out of

36 cases. This difficulty were due to improper holding of mask, wrong mask selection, leak from facemask and wrong technique of chin lift and jaw thrust Rescue options were double-handed bag-mask ventilation, use of airway during ventilation and modification of technique of chin lift and jaw thrust.

Time to intubate the patients was noted in our study and group 1 participants with least experience took 47.98 ± 31.54 sec to intubate the patients. Group 5 participants with maximum experience and expertise took shortest time as 9.55 ± 6.95 sec. This difference of approximately 38 sec was statistically significant ($P < 0.001$). Though resident with experience of around 25 intubation took reasonable time (11.37 ± 3.13 sec) to intubate the patients. Takeuchi *et al*. proved that there was a significant change in intubation performance and time required to intubate the patients was reduced after completion of 1 year of clinical training. They showed that median time of intubation 43.5 sec before clinical training reduced to 34.5 sec after 1 year of clinical training ($P < 0.001$).[17] Similarly, Mulcaster *et al*. showed that intubator with experience of five intubations took 62.3 ± 34.0 sec to successfully intubate the patients and this time decreased to 23.0 ± 5.7 sec after 35 intubation attempts. They found 80% probability of performing a 'good' intubation after 35 trials.[19] Soleimanpour *et al*. observed average time taken for ETI was 18.6 ± 1.67 sec before 1 month anaesthesiology rotation, but this time decreased to 13.6 ± 1.34 sec at the end of the rotation in the same group.[23] In agreement to data obtained by all the studies it was concluded that with increased level of training and increased intubation performances, significantly decreases time taken for successful intubation.

The number of attempts is also affected to great extent with experience. In present study, group 1 subjects who were less experienced in intubating skill took more than one attempt in 20% of the patients but in remaining groups who had more expertise, only 1.7% of the patient required more than one attempt. Stewart *et al*. documented that more experienced group had 1.6% prolonged intubation which was significantly less than remaining groups which were less experienced (P value <0.05) and Soleimanpour *et al*. observed that the prolonged intubation was encountered in 20 out of 36 patients before anaesthesiology rotation which was reduced to 4 after rotation completion.[22,23] Hence common inference was drawn that with training, number of performed intubations and seniority of the intubator, first attempt tracheal intubation success was improved. Contrasting results were observed by Clark *et al*., who found that additional ETI experience during a post graduate first year, anaesthesiology, 4-week rotation did not significantly improve their intubation success.[9] They compared anaesthesiology rotation (AR) group with non-rotation (NO-AR) group. The AR group had a first-attempt success rate of 78.4% and an overall success rate of 95.7%, whereas the NO-AR group had a first-attempt success rate of 83.4% and an overall success rate of 94.5%. First-attempt and overall success rates were compared between the two groups and showed no statistically significant difference ($P = 0.30$ and $P = 0.66$, respectively). This study showed different results because participants in this study were already having experience of 1 year in the ETI skill, which was enough to achieve more than 95% of success rate in this skill.

The success rate was 96.9% by trainees who had experienced of at least 10 intubations and 100% after performing 25 intubations in this study. In contrast, Rujirojindakul *et al*. observed that at least 22 procedures were required to reach success rate of 80% for orotracheal intubation.[15]

Ease of intubation was graded based on DS).[24] Number of attempts, Cormack grade, requirement of lifting force, laryngeal pressure, and vocal cord mobility was assessed to calculate the score. In current study, novice performer applied more lifting force (70.8% patients) while performing intubation than performers of other groups ($P < 0.001$). Takeuchi *et al*. noticed, median force of 28.0 N was applied on oral structures during laryngoscopy and intubation before 1 year of clinical training and significantly less force was applied after completion of training with median force 19.5 N, $P < 0.001$.[17] Inexperienced performer uses faulty technique of laryngoscopy and faces poor visualisation of the vocal cords because of which they use more lifting force. Simultaneously, requires more laryngeal pressure in form of BURP to improve the success of intubation. In this study, we reached an inference that with experience and increasing number of intubations, participants encountered less difficulty and less IDS was achieved which was beneficial for patient's outcome.

Use of BURP or stylet can improve the success of intubation. Inexperienced residents used BURP in majority of cases and stylet in almost left out cases. After attempting 25 intubations, the use of BURP and stylet decreases grossly. The main reason for requirement of assistance was inadequacy of subject's skill that leads to improper laryngoscopy. There was poor visualisation of vocal cords and tongue was obstructing the path of endotracheal tube. Mulcaster *et al*. has commented inappropriate head position and improper laryngoscope blade insertion can result in faulty DL. They predicted that subjects insert and lift the laryngoscope successfully after 35 trails of intubation with 80% probability of performing good intubation.[19] Similar to our study Chao *et al*. proved that incidence of failed intubation was more with inexperienced intubators, due to poor holding of laryngoscope and they try to

use BURP for better visualization of vocal cord. They proved that students would have to practice more than 27 intubations to achieve a success rate of more than 90%.[27]

Faulty laryngoscopy, excessive force applied and prolonged duration of intubation of novice intubators resulted in significant haemodynamic changes in patients. Laryngoscopy and intubation produces reflex sympathetic stimulation that leads to hypertension, tachycardia and arrhythmias.[26,28] Prolonged laryngoscopy can also result in desaturation and hypoxia.[25] Experience in intubation helps in overting all these deleterious effects.[22,29]

Both DL and ETI were associated with complications like lip injury and soft tissue trauma. More complication rate is encountered with learners.[7,10,25] This study showed that with increased experience of intubator there was reduction in complication rate. After performing minimum of 25 DL and intubation, refinement in technique of inserting and lifting of laryngoscope occurs. Hence, all the studies infer that in the hands of experienced intubator there was less complication which was beneficial for patient's outcome.[20,22]

Conclusion

We concluded that experience plays an important role in acquisition of the skill of efficient and accurate DL and ETI. Minimum of 25 intubation attempts should be required by an anaesthesiologist resident in elective scenario to achieve 100% success rate in our study. Moreover, skill of mask ventilation also improves with practice. Hence experience plays the major role in reducing the intubation attempts, minimising the risk of complications and less use of additional gadgets for intubation. We recommend repetitive task practice and minimum of 25 intubations by novice anaesthesiologist to achieve skill proficiency before they are allowed to manage airway independently with reduced incidence of complications and safe airway management.

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Conflicts of interest
There are no conflicts of interest.

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