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Original Article

Does Part-Task Training Increase the Success of Video-Based Feedback in Tracheal Intubation?

Ayten Saracoglu, Gamze Cabakli, Zuhal Aykac

Department of Anesthesiology and Reanimation, Marmara University Pendik Training and Research Hospital, İstanbul, Türkiye

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Correspondence: Gamze Cabakli, Marmara Üniversitesi Pendik Eğitim Araştırma Hastanesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İstanbul, Türkiye
E-mail: gamze_tanirgan@hotmail.com

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ABSTRACT

Objective: Tracheal intubation is a difficult procedure to be taught in clinical settings because complex psychomotor skills and repetitive practices are required. In this study, we aimed to evaluate the success and complication rates of tracheal intubation through part-task and whole task training as educational upper steps in video-based feedback.

Methods: In the part-task group, the process was taught in three steps: mask ventilation as step 1, laryngoscopy as step 2, and tracheal tube placement as step 3. Participants were questioned about the frequency of playing computer games. The duration of tracheal intubation, number of interventions, tooth pressure scoring, and optimization maneuvers were recorded. The data of 63 medical students were recorded.

Results: Successful intubation rate in the first attempt was 54.9% and 45.1% in the part-task group and the whole task group, respectively (p=0.033). The successful tracheal intubation rate in the second attempt was significantly lower in the part-task group than in the whole task group (12.5% vs 87.5% respectively, p=0.033).

Conclusion: In addition to video-based feedback, part-task training techniques to teach tracheal intubation skills to inexperienced users showed the success of these techniques, which can be integrated into resident training. Tracheal intubation training in novice users increased the chances of success without increasing the complication rate when applied using part-task training and video-based feedback methods together.

INTRODUCTION

Tracheal intubation is an application that requires skill and is used by many health professionals, as it is best suited for life-saving in many different settings. Laryngoscopy is the standard preferred for this purpose. As it requires complex psychomotor skills and recurrent practices, laryngoscopy is a difficult procedure to teach in clinical settings. Novice practitioners may perform rapid and uncontrolled actions during their first attempts. A survey including residents demonstrated that 18% of residents still needed assistance even after 80 tracheal intubations.[1]

It has been reported that video-mediated instruction significantly enhances the success of learning in tracheal intubation.[2] Another recently published study indicated that real-time video-based feedback increased success in tracheal intubation while reducing complication rate and shortening intubation time among inexperienced users.[3]

Part-task training has been employed in airway training. Part-task training has been reported to have a success rate of 90% when used for teaching effective cricothyroid pressure application.[4] Our hypothesis in this study was that using part-task training as an educational upper step in tracheal intubation training in addition to video-based feedback may increase the success of tracheal intubation and decrease the complication rate of the procedure. In this way, medical faculty students may better improve their techniques before intubating real patients. We expect to increase patient safety by using this method routinely.

MATERIALS AND METHODS

Following the Ethics Committee Approval and participants' informed consent, fifth-grade medical students, who attended their anesthesiology rotation between February and May 2018, were first subjected to an orientation program. They were informed of tracheal intubation and related devices, as well as indications and complications of the procedure. Also, they were given information on the features of the Laerdal airway management

mannequin. Thereafter, the participants were divided into two different groups. Randomization was performed using the sealed envelope method. The first group (n=31) received whole-task training and the second group (n=32) received part-task training. In the whole-task training group, tracheal intubation was described from the beginning as a single application. The training of the students in the first group included mask ventilation, laryngoscopy, and tracheal intubation under a single training program. In the part-task group, the tracheal intubation process was taught in three separate stages: the first stage included mask ventilation, the second stage included imaging of the glottis by laryngoscope, and the third stage included imaging of vocal cords and placement of a tracheal tube. Adequate lung inflation was defined as visible inflation of the mannequin's lungs during mask ventilation. Laryngoscopy was considered successful when the whole epiglottis was visualized. Successful tracheal intubation was achieved when the lungs could be visibly ventilated after successfully passing through the vocal cords. Each of these whole-task and part-task training sessions was recorded with a video camera and the participants were given educational video-based feedback at the end of the training. Once all training was completed, the participants were able to make enough practice with the mannequin to gain self-confidence. On the following day, the time for intubation was started when the participant took the laryngoscope in the hand and ended when the lungs were observed to be adequately ventilated. The number of attempts, complication incidence, success rate, and need for optimization maneuver were recorded. Statistical comparison was made between the results of the students who completed their training with whole-task training plus video-based feedback versus part-task training plus video-based feedback. It was also recorded if the participants had the habit of playing video games and the duration of that habit.

The following parameters were evaluated in video-based feedback:

1. Scale of mask ventilation,
2. Ability to hold the laryngoscope in the midline during laryngoscopy, displace the tongue to the left side, visualize the epiglottis, and visualize and successfully pass the vocal cords, and need for assistance and optimization maneuver,
3. Video loss, pressure on teeth, and need for assistance and optimization maneuver during ventilation,
4. Control of the situation and environment, ability to manage and interact with team members, and self-confidence.

According to the grading of dental pressure, Grade 0 = none, Grade 1 = mild pressure, Grade 2 = moderate pressure, and Grade 3 = severe pressure.[5] The need for optimization maneuver was assessed according to the following criteria: Maneuver 1 = head extension, Maneuver 2 = tracheal tube rotation, Maneuver 3 = assistance, and Maneuver 4 = external laryngeal pressure. Participants' mask ventilation skills were evaluated according to the mask ventilation classification and description scale based on the following criteria: Grade 0 = ventilation by mask not attempted, Grade 1 = ventilated with mask, Grade 2 = ventilated by mask with oral or nasal airway, Grade 3 = difficult mask ventilation (inadequate, unstable, or requiring two practitioners), and Grade 4 = unable to mask ventilate.[6]

Statistical analysis

While evaluating the data obtained from the study, we used the IBM SPSS Statistics 24 for statistical analyses. We used the descriptive statistics of mean, standard deviation, median, minimum, maximum, frequency, and ratio. The Kolmogorov–Smirnov test was used to measure the distribution of the variables. Quantitative independent data were analyzed using the Chi-squared test, but when the conditions for the Chi-squared test were not met, we used Fisher's test. For the comparison of the whole-task and part-task groups regarding numerical data, the independent sample t-test was used for normally distributed data and the Mann–Whitney U test was used for nonnormally distributed data. We used the Chi-squared test for the analysis of discrete variables and the one-way ANOVA plus correlation test for comparison of more than two groups. The results were evaluated in a 95% confidence interval and with a significant level of $p<0.05$.

RESULTS

The data belonging to a total of 63 participants were analyzed. No participant was excluded from the study. The mean age of the participants was 23.8±1.2 years. The time to successful tracheal intubation was 25.4±10.2 s. While 19 participants were not able to perform sufficiently successful mask ventilation, 44 participants were able to perform it at an adequate level. Whereas 23 participants did not require an optimization maneuver, 40 participants needed an optimization maneuver (Table 1).

There was no significant difference between the part-task and whole-task groups regarding age, gender distribution, and rate and duration of video game playing ($p>0.05$, Table 2). No significant difference was detected between the groups regarding time to tracheal intubation, rate of dental pressure, and rate of optimization maneuver required ($p>0.05$, Table 2). When the mask ventilation scale scores were compared, the unsuccessful ventilation rate was significantly higher in the whole-task group (46.9%) than in the part-task group (12.9%) ($p=0.003$, Table 2).

Participants in the part-task group showed a significantly higher rate of successful tracheal intubation than the whole task group in the first attempt, but it was significantly lower in the second attempt ($p=0.033$) (Table 3).

DISCUSSION

This prospective randomized study revealed that part-task

Table 1. Age, gender distribution, computer game play ratios and playing time, duration of tracheal intubation, number of interventions, analysis of adequate mask ventilation skills, and tooth pressure scores of the participants

	Minimum–Maximum	Median	Mean±Standard deviation	n (%)
Age (years)	21.0–30.0	24.0	23.8±1.2	
Gender				
Female				27 (42.9)
Male				36 (57.1)
Playing computer games				
(–)				48 (76.2)
(+)				15 (23.8)
Duration of playing (h)	156–36 400	1040	4474±9217	
Tracheal intubation time (s)	10.1–65.0	22.0	25.4±10.2	
Mask ventilation scoring				
(–)				19 (30.2)
(+)				44 (69.8)
I				42 (66.7)
II				1 (1.6)
III				1 (1.6)
Number of attendance				
1				50 (79.4)
2				10 (15.9)
3				3 (4.8)
Teeth pressure				
(–)				10 (15.9)
(+)				
Grade I				17 (27.0)
Grade II				26 (41.3)
Grade III				10 (15.9)
Maneuver				
(–)				23 (36.5)
(+)				40 (63.5)
Maneuver I				29 (46.0)
Maneuver II				14 (22.2)
Maneuver III				29 (46.0)
Maneuver IV				3 (4.8)

training plus video-based feedback provided to medical students who did not have tracheal intubation experience before increased the successful intubation rate in the first attempt and improved students' mask ventilation skills without increasing complication rate.

Many teaching methods have been tried to teach medical students the technical skills they can use during their professional life. A study addressing how to teach suture skills to medical students reported that the single instructional session method did not achieve sufficient efficacy.[7] On the other side, students who were subject to three different evaluations during the same period showed a success rate of up to 91.7%. Similarly, the training periods of the groups were equal and the success rates of the students who were trained at three different stages were found to be higher in our study. While experience may improve performance in an activity, repetition alone may not achieve a successful outcome in actions that require technical skill.[8] In this study, we indicated that training results can be significantly improved when recurrent trainings are added to video-based feedback.

Mulcaster et al.[9] and Harrison[10] reported that simulation training had to be applied before the clinical experience in tracheal intubation training. This practice is routinely implemented in our clinic. However, in the light of the results of this study, it has been decided to add video-based feedback plus part-task training to our standard simulation training. In a systematic review, Issenberg and colleagues reported that the most important factor determining the efficacy of simulation-based medical education is educational feedback.[11] It is, in this way, aimed to enhance procedural performance. However, it is not always possible to directly transfer mannequin-based training into clinical settings.[12] For this reason, the clinical experiences of students should be analyzed at intervals. It is important that the feedback has a permanent effect and that the acquired

Table 2. Comparison of groups regarding demographic features, duration of playing computer games, tracheal intubation time, mask ventilation scores, the grade of teeth pressure, and the required maneuver

	Whole task			Part task			p	
	Mean±SD	n (%)	Median	Mean±SD	n (%)	Median		
Age (years)	23.8±1.4		24.0	23.8±1.0		24.0	0.426	M
Gender								
Female		14 (43.8)			13 (41.9)		0.884	χ^2
Male		18 (56.3)			18 (58.1)			
Playing computer games								
(–)		23 (71.9)			25 (80.6)		0.414	χ^2
(+)		9 (28.1)			6 (19.4)			
Duration of playing (h)	2496±3135		1040	7440±14301		1040	0.722	M
Tracheal intubation time (s)	25.5±11.1		21.7	25.3±9.4		22.0	0.891	M
Mask ventilation scoring								
(–)		15 (46.9)			4 (12.9)		0.003	χ^2
(+)		17 (53.1)			27 (87.1)			
I		17 (53.1)			25 (80.6)			
II		0 (0.0)			1 (3.2)			
III		0 (0.0)			1 (3.2)			
Teeth pressure								
(–)		5 (15.6)			5 (16.1)		0.956	χ^2
(+)		27 (84.4)			28 (90.3)			
Grade I		10 (31.3)			7 (22.6)			
Grade II		12 (37.5)			14 (45.2)			
Grade III		5 (15.6)			5 (16.1)			
Maneuver								
(–)		11 (34.4)			12 (38.7)		0.721	χ^2
(+)		21 (65.6)			19 (61.3)			
Maneuver I		16 (50.0)			13 (41.9)		0.521	χ^2
Maneuver II		6 (18.8)			8 (25.8)		0.501	χ^2
Maneuver III		17 (53.1)			12 (38.7)		0.251	χ^2
Maneuver IV		0 (0.0)			3 (9.7)		0.113	χ^2

M: Mann–Whitney U test. χ^2: Chi-squared test (Fischer's test). SD: Standard deviation.

Table 3. Comparison of successful tracheal intubation attempts between groups

	Part task (n=32)	Whole task (n=31)	p
Number of attempts, n (%)			
First attempt	28 (54.9)	23 (45.1)	0.033[a]
Second attempt	1 (12.5)	7 (87.5)	
Third attempt	3 (75.0)	1 (25.0)	

[a]Chi-squared test. Values are given as frequency (percentage).

skills are transferred into clinical practice in the long term.[13] For this purpose, the video-based feedback method was applied in this study.

The results of our study showed that part-task training can improve the success rate of not only tracheal intubation but also mask ventilation which is the former step in intubation. Although the percentage of the participants performing insufficient mask ventilation was lower in the part-task group, the rate of patients easily ventilated with a mask (Grade 1) was higher in the part-task group. Difficult intubation guidelines suggest maintaining oxygenation with mask ventilation.[14–17] Our study is a contribution to the training of novice users in this regard. Complication rate, which was the secondary aim of our study, was also analyzed, and no difference was found between the groups. The fact that there was no increase in the rate of complications, such as tooth pressure, in the part-task training group supports that this technique can be easily integrated into the clinic. Besides, no significant difference was found regarding the need for optimization maneuver.

Previous studies have shown that playing computer games increases the success rate in applications that require complex motor skills, such as laparoscopic surgery.[18] On the other hand, this issue has been controversial, and there are studies reporting that playing games does not affect the skills related to clinical device use.[19] In this study, we investigated how often and how long participants played computer games. However, contrary to previous studies, the

difference was not statistically significant, but it was shown that the students in the whole-task group more frequently played video games. Nonetheless, the rate of successful tracheal intubation and mask ventilation was higher in the part-task group. One of the most important factors that enabled success in the part-task training was the effectiveness of the fragmented training approach. It was developed by psychologists to improve human performance in completing tasks that require complex skills. This technique has been successfully applied in a series of simulator-based professional training and has provided higher success rates in environments where students are asked to manage multiple tasks.[20] According to the results of this research, adding video-based feedback to part-task training increases the success rate in airway management training.

Limitations

One of the major limitations of this study is that it was performed before clinic experience. We, therefore, were not able to evaluate medical students' skills in transferring their tracheal intubation experiences in the operating room into clinical practice. However, this practice has become a necessity for tracheal intubation in real patients under today's conditions. The data related to tracheal intubation on the mannequin was analyzed, but it was not possible to evaluate the adverse events such as blood, mucus, secretion, and time pressure related to hypoxia on a mannequin. However, we only analyzed psychomotor skills. Nontechnical skills such as decision-making, which are important during tracheal intubation, were assessed. It is clear that there is a need for further studies based on these parameters.

CONCLUSION

This prospective randomized simulation-based training study showed that tracheal intubation training in novice users increased the chances of success without increasing the complication rate when applied using part-task training and video-based feedback methods together.

Ethics Committee Approval

This study approved by the Marmara University Faculty of Medicine Clinical Research Ethics Committee (Date: 02.02.2018, Decision No: 09.2018.139).

Informed Consent

Prospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: A.S.; Design: A.S., Z.A.; Supervision: Z.A.; Materials: G.C.; Data: G.C., Z.A.; Analysis: G.C., Z.A.; Literature search: A.S., G.C.; Writing: A.S., G.C.; Critical revision: A.S., Z.A.

Conflict of Interest

None declared.

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Kısmi Görev Eğitimi, Trakeal Entübasyonda Video Tabanlı Geribildirimin Başarısını Arttırır Mı?

Amaç: Trakeal entübasyon, karmaşık psikomotor beceriler ve tekrarlayan uygulamalar gerektirdiğinden klinik ortamlarda öğretilmesi zor bir işlemdir. Bu çalışmadaki amacımız, video temelli geri bildirimde eğitimsel bir üst basamak olarak kısmi görev veya tam görev eğitimi ile öğrenilen trakeal entübasyonun başarı ve komplikasyon oranlarını değerlendirmektir.

Gereç ve Yöntem: Kısmi görev grubunda süreç üç adımda öğretildi: 1. bölümde maske ventilasyonu, 2. bölümde laringoskopi, son adım olarak trakeal tüp yerleştirme. Katılımcılara bilgisayar oyunları oynama sıklığı soruldu. Trakeal entübasyon süresi, müdahale sayısı, diş basınç skorlaması ve optimizasyon manevraları kaydedildi. Toplam 63 tıp öğrencisinin verileri kaydedildi.

Bulgular: İlk denemede başarılı entübasyon oranı kısmi görev ve tam görev gruplarında sırasıyla %54.9'a karşı %45.1'di (p=0.033). 2. denemedeki başarılı trakeal entübasyon oranı, kısmi görev grubunda tüm görevden anlamlı olarak daha düşüktü.

Sonuç: Video tabanlı geri bildirime göre, deneyimsiz kullanıcılara trakeal entübasyon becerilerini öğretmek için kısmi görev eğitim tekniklerinin kullanılması, asistan eğitimine entegre edilebilirse başarının artmasına sebep olacaktır. Acemi kullanıcılarda ise trakeal entübasyon eğitiminde, kısmi görev eğitimi ve video tabanlı geri bildirim yöntemlerinin bir arada kullanılmasının komplikasyon oranını artırmadan başarı şansını yükselttiği gözlemlenmiştir.

Anahtar Sözcükler: Entübayon; kısmi görev eğitimi; laringoskopi.