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SCIENTIFIC ARTICLE

The role of videolaryngoscope in endotracheal intubation training programs

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Paramedic;
Emergency staff

Abstract
Background: Macintosh laryngoscopes are widely used for endotracheal intubation training of medical students and paramedics whereas there are studies in the literature that supports videolaryngoscopes are superior in endotracheal intubation training. Our aim is to compare the endotracheal intubation time and success rates of videolaryngoscopes and Macintosh laryngoscopes during endotracheal intubation training and to determine the endotracheal intubation performance of the students when they have to use an endotracheal intubation device other than they have used during their education.
Methods: Endotracheal intubation was performed on a human manikin owing a standard respiratory tract by Macintosh laryngoscopes and C-MAC® videolaryngoscope (Karl Storz, Tuttligen, Germany). Eighty paramedic students were randomly allocated to four groups. At the first week of the study 10 endotracheal intubation trials were performed where, Group-MM and Group-MV used Macintosh laryngoscopes; Group-VV and Group-VM used videolaryngoscopes. Four weeks later all groups performed another 10 endotracheal intubation trial where Macintosh laryngoscopes was used in Group-MM and Group-VM and videolaryngoscopes used in Group-VV and Group-MV.
Results: Success rates increased in the last 10 endotracheal intubation attempt in groups MM, VV and MV ($p = 0.011$; $p = 0.021$, $p = 0.290$ respectively) whereas a decrease was observed in group-VM ($p = 0.008$).
Conclusions: The success rate of endotracheal intubation decreases in paramedic students who used VL during endotracheal intubation education and had to use Macintosh laryngoscopes later. Therefore we believe that solely videolaryngoscopes is not enough in endotracheal intubation training programs.

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PALAVRAS-CHAVE
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Educação;
Reanimação cardiopulmonar;
Anestesiologistas;
Paramédico;
Equipe de emergência

O papel do videolaringoscópio em programas de treinamento de intubação endotraqueal

Resumo
Justificativa: Os laringoscópios Macintosh são amplamente utilizados para o treinamento de estudantes de medicina e paramédicos em intubação endotraqueal; contudo, há mais estudos na literatura que apoiam os videolaringoscópios no treinamento de intubação endotraqueal. Nosso objetivo foi comparar o tempo de intubação endotraqueal e as taxas de sucesso de videolaringoscópios e laringoscópios Macintosh durante o treinamento de intubação endotraqueal e determinar o desempenho da intubação endotraqueal dos alunos quando precisam usar um dispositivo de intubação endotraqueal diferente daquele que usaram durante seu treinamento.
Métodos: A intubação endotraqueal foi realizada em modelo humano com trato respiratório padrão usando laringoscópios Macintosh e videolaringoscópio C-MAC® (Karl Storz, Tuttligen, Alemanha). Oitenta estudantes paramédicos foram randomicamente alocados em quatro grupos. Na primeira semana do estudo, 10 tentativas de intubação endotraqueal foram realizadas, nas quais o Grupo-MM e Grupo-MV utilizaram laringoscópios Macintosh e o Grupo-VV e Grupo-VM utilizaram videolaringoscópios. Quatro semanas depois, todos os grupos realizaram mais 10 tentativas de intubação endotraqueal, nas quais laringoscópios Macintosh foram utilizados pelo Grupo-MM e Grupo-VM e videolaringoscópios pelo Grupo VV e Grupo-MV.
Resultados: As taxas de sucesso aumentaram nas últimas 10 tentativas de intubação endotraqueal nos grupos MM, VV e MV ($p = 0{,}011$; $p = 0{,}021$, $p = 0{,}290$, respectivamente), enquanto uma redução foi observada no Grupo-VM ($p = 0{,}008$).
Conclusões: A taxa de sucesso da intubação endotraqueal diminuiu nos estudantes paramédicos que utilizaram VL durante o treinamento em intubação endotraqueal e precisaram usar laringoscópios Macintosh posteriormente. Portanto, acreditamos que o uso isolado de videolaringoscópios não é suficiente em programas de treinamento de intubação endotraqueal.

Introduction

Macintosh laryngoscopes (ML) is the standard equipment worldwide for both the anesthesiologists and emergency staff. In the last decades to overcome visualization problems in difficult airway cases, Videolaryngoscopes (VL) are developed by integrating conventional laryngoscopes to camera systems.[1,2] There are several types of videolaryngoscopes available by many manufacturers today,[3,4] but unfortunately it has not been widespread in all emergency kits yet.[5]

In the recent resuscitation guideline published in 2015 states that emergency staff must do Endotracheal Intubation (ETI) without interrupting chest compressions during Cardiopulmonary Resuscitation (CPR) otherwise the success rate of CPR will decrease.[6,7] Assertion of unexperienced staff for ETI may both frequently interrupt chest compressions and may lead to lethal complications due to unsuccessful intubation.

The paramedics who have a limited time to secure airway before transportation of patient to hospital must become experts of ETI and must perform it very fast. Paramedics should learn the equipment that are used for successful and fast ETI and should perform adequate number of ETI trials.[8] Simulation workout is advised for the team to preserve their ETI ability.[9] Beginners can start with human models during ETI training.[10,11] The advantage of VL for the students during ETI education is that they can see both the upper airway anatomical landmarks and the maneuvers on the screen at the same time.[4] Some recent studies suggests ETI performance time is shorter with a higher success rate with VL compared to ML which primes VL for ETI training.[12,13]

Primary goal of our study is to detect the effect of VL and ML on ETI timing. Secondary goals of our study are to detect the ETI success rate and ETI performance of the students when they have to use a laryngoscope other than they used during their ETI training program.

Materials and methods

After receiving approval from Ahi Evran University Ethical Committee, 80 paramedic students, who have not experienced ETI before, studying at Ahi Evran University Health Services Vocational High Scholl Emergency and First Aid Program, were enrolled into the study after signing their written informed consents. Theoretical ETI education was thought and ETI was performed by the trainer on a human manikin. In this study, GD/J5S Electronic Tracheal Intubation Simulator (General Doctor, PRC) were used as the manikin type.

Effect size was calculated from the study by Kim et al.[14] Seventy-six participants ($n1 = 19$, $n2 = 19$, $n3 = 19$, $n4 = 19$) was needed for an effect size of $f = 0.4$, $\beta = 0.20$ with a statistical significance of $\alpha = 0.05$. In the current study sample

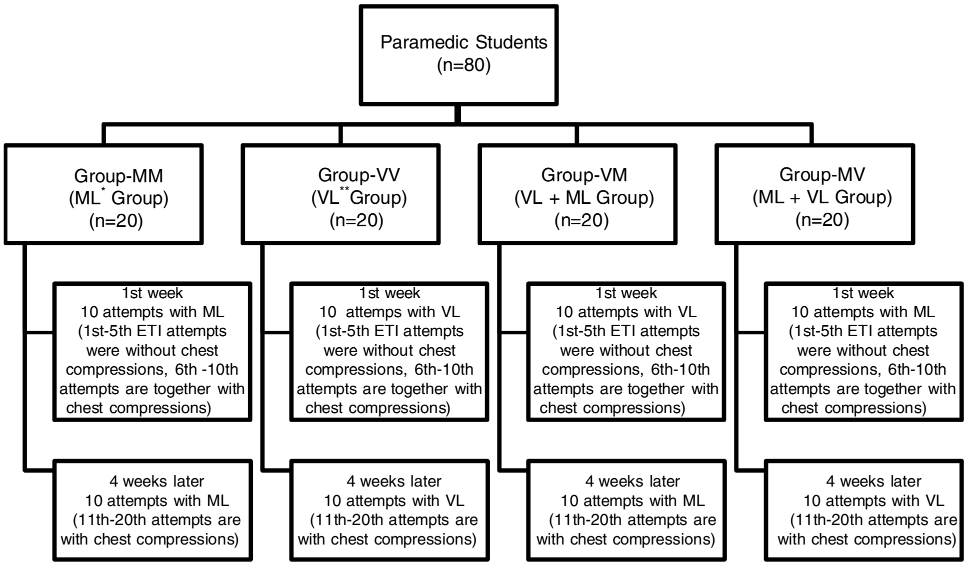

Figure 1 Groups and application scheme (*ML, Macintosh laryngoscope; **VL, videolaryngoscope).

size was 80 (n1 = 20, n2 = 20, n3 = 20, n4 = 20) to compansate probable dropouts.

ETI was performed by ML and C-Mac® videolaryngoscope (Karl Storz, Tuttligen, Germany). Macintosh n° 3 blade was used in both laryngoscopes. ETI was performed on a human manikin in the supine position owing a standard respiratory tract with a 7.5F intubation tube all loaded with a stylet.

Intubation time was defined as the time from the entrance of laryngoscope blade through the right edge of the lips till the passage of intubation tube between the vocal cords. The ETI times were recorded.

False intubations and ETI time longer than 30 s were accepted as unsuccessful attempts. The same anesthesiologist confirmed success of ETI with VL. The success rate of ETI was recorded.

Groups were allocated to four groups of 20 students each as follows: ML Group (Group MM), VL Group (Group VV), VL+ML Group (Group VM), ML+VL Group (Group MV) (Fig. 1). First week ten ETI attempts were performed using ML in Group MM and Group MV, and VL in Group VV and Group VM. Four weeks later Group MM and Group VM used ML and other two groups used VL for 10 ETI attempts. At the first week 1st to 5th ETI attempts were without chest compressions. Other ETI attempts were done together with chest compressions at a rate of 100—120 compressions per minute.

We analyzed if ETI success rate and speed of the students significantly changed when chest compressions coincided to ETI attempts. We analyzed if there is a correlation with the number of ETI attempts and time needed to perform a successful ETI and we also analyzed the presence of intergroup statistically significant differences.

Statistical analysis

Data was analyzed by IBM SPSS 23.0 package program. Descriptive statistical methods (frequency, percentage, mean, standard deviation, median, interquartile range) were used to analyze the collected data. Normal distribution of data was analyzed by Kolmogorov-Smirnow and Shapiro—Wilk tests. The data was not normally distributed. Kruskal Wallis test was used to analyze time data and Wilcoxon Signed Rank test was used to analyze ETI attempts data between groups. Fischer's Exact Test was used to analyze successful ETI numbers and their rates. Tukey HSD test was used to determine the Group that is responsible for the difference in cases where a significant difference is detected in intergroup comparisons. $p < 0.05$ is accepted as statistically significant difference and commented as there is a difference between groups. Analysis with a $p > 0.05$ is accepted insignificant and commented as groups are similar.

Power analysis was done by G*Power 3.1.9.2 statistical package program; $n_{MM} = 20$, $n_{VV} = 20$, $n_{VM} = 20$, $n_{MV} = 20$, $\alpha = 0.05$, effect size (f) = 0.4 and power (1β) was calculated 0.85.

Results

ETI times of attempts, successful ETI numbers and rates are given in Table 1.

There was a statistically significant difference ($p < 0.05$) between the ETI times at 5th and 6th attempts. 6th attempt time was longer in all groups. Although statistically insignificant, successful ETI number at 6th attempt was lower in all groups.

When we compared 10th and 11th ETI attempts, the time was longer in 11th attempt and this difference was statistically significant in all groups except Group MM ($p < 0.05$) (Table 2). Unlike other three groups, ETI success rate was same at 10th and 11th attempts in Group VV but the change was statistically insignificant. There was no statistically significant difference in intergroup comparisons in both ETI attempts ($p < 0.05$).

In-group comparisons of the means for the first ten and last ten ETI attempt times revealed a statistically significant difference in all groups ($p < 0.05$) except Group VM ($p = 0.126$) that showed a longer time at first ten attempts

Table 1 Endotracheal intubation (ETI) attempt time, success rate and numbers.

Attempt number	Group MM (ML+ML Group) (*n* = 20)		Group VV (VL+VL Group) (*n* = 20)		Group VM (VL+ML Group) (*n* = 20)		Group MV (ML+VL Group) (*n* = 20)	
	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)
1[a]	15.1 ± 10.1 10.6 (6.8–28.3)	15 (75)	9.8 ± 5.9 7.9 (6.6–10.4)	19 (95)	13.5 ± 6.7 12.1 (7.3–20.9)	20 (100)	17.2 ± 9.0 15.7 (8.6–26.0)	16 (80)
2[a]	13.7 ± 11.8 7.1 (4.2–29.4)	15 (75)	7.8 ± 6.5 4.8 (4.0–10.2)	19 (95)	10.3 ± 9.2 7.4 (4.7–10.0)	17 (85)	13.6 ± 11.0 7.7 (5.2–26.9)	16 (80)
3[a]	10.5 ± 9.8 6.8 (3.7–15.0)	17 (85)	5.2 ± 3.3 3.9 (2.9–7.7)	20 (100)	6.6 ± 3.5 6.9 (3.5–7.8)	20 (100)	10.2 ± 8.7 6.6 (4.0–15.3)	18 (90)
4[a]	9.3 ± 9.4 4.8 (3.9–11.6)	18 (90)	5.8 ± 4.8 3.6 (2.5–7.8)	20 (100)	6.3 ± 4.2 5.0 (3.1–8.6)	20 (100)	9.7 ± 8.4 6.8 (4.0–10.6)	18 (90)
5[a]	4.8 ± 1.9 4.7 (3.4–5.2)	20 (100)	6.9 ± 4.9 5.4 (3.1–9.2)	20 (100)	6.7 ± 6.2 4.6 (4.2–7.4)	19 (95)	8.3 ± 6.7 6.1 (3.6–12.0)	19 (95)
6[b]	10.9 ± 10.6 6.9 (3.8–10.4)	16 (80)	15.0 ± 9.8 10.6 (7.1–20.8)	16 (80)	15.9 ± 8.2 13.0 (9.5–20.7)	17 (85)	15.9 ± 8.9 13.5 (9.0–21.8)	17 (85)
7[b]	11.9 ± 11.6 5.6 (3.8–26.4)	15 (75)	8.4 ± 8.3 5.2 (3.4–10.0)	18 (90)	8.4 ± 6.4 5.9 (4.2–12.6)	20 (100)	13.2 ± 11.2 9.1 (4.3–27.7)	15 (75)
8[b]	11.9 ± 11.5 6.2 (3.6–23.9)	16 (80)	9.4 ± 8.8 6.8 (3.3–11.8)	18 (90)	8.8 ± 7.0 7.1 (4.5–9.1)	19 (95)	12.5 ± 10.1 9.6 (5.4–14.8)	16 (80)
9[b]	13.9 ± 12.1 7.5 (4.3–31.0)	14 (70)	7.8 ± 7.0 4.9 (3.6–10.6)	19 (95)	6.8 ± 4.5 5.6 (4.6–8.4)	20 (100)	11.9 ± 9.6 7.9 (4.2–16.8)	17 (85)
10[b]	10.2 ± 9.6 6.9 (3.6–12.4)	17 (85)	8.7 ± 9.8 4.3 (3.6–8.5)	17 (85)	6.7 ± 6.6 4.6 (3.4–5.6)	19 (95)	8.7 ± 6.8 5.7 (4.4–11.8)	19 (95)
11[b]	13.6 ± 10.1 9.1 (5.8–20.7)	16 (80)	13.5 ± 10.3 8.0 (4.8–23.8)	17 (85)	13.8 ± 8.4 11.9 (7.6–17.2)	17 (85)	16.0 ± 10.5 13.9 (5.2–29.5)	15 (75)

Table 1 (*Continued*)

Attempt number	Group MM (ML+ML Group) (*n* = 20)		Group VV (VL+VL Group) (*n* = 20)		Group VM (VL+ML Group) (*n* = 20)		Group MV (ML+VL Group) (*n* = 20)	
	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)	ETI time (s)	Success rate *n* (%)
12[b]	11.5 ± 9.2 8.0 (5.4–12.9)	17 (85)	7.0 ± 4.6 5.4 (3.6–9.9)	20 (100)	17.0 ± 12.1 9.9 (7.2–31.0)	12 (60)	15.4 ± 11.6 10.3 (4.5–31.0)	14 (70)
13[b]	10.3 ± 9.3 6.8 (4.9–9.9)	17 (85)	5.9 ± 5.0 5.1 (3.5–6.9)	20 (100)	10.5 ± 9.4 6.7 (4.5–11.7)	17 (85)	6.8 ± 6.4 5.1 (3.7–6.0)	19 (95)
14[b]	9.5 ± 8.4 6.1 (4.2–10.0)	18 (90)	5.1 ± 1.9 5.1 (3.4–7.2)	20 (100)	10.7 ± 9.2 7.3 (5.2–10.0)	17 (85)	9.4 ± 10.0 4.9 (3.8–8.7)	17 (85)
15[b]	8.4 ± 6.9 6.2 (4.2–9.5)	19 (95)	6.9 ± 6.7 4.4 (3.5–7.7)	19 (95)	8.8 ± 8.4 5.0 (4.1–8.8)	19 (95)	12.0 ± 8.8 10.3 (5.6–12.9)	17 (85)
16[b]	7.4 ± 2.6 7.3 (5.6–8.2)	20 (100)	8.3 ± 8.6 4.7 (3.4–8.5)	18 (90)	11.0 ± 9.6 6.5 (4.7–13.1)	17 (85)	8.7 ± 7.6 4.7 (3.8–13.5)	19 (95)
17[b]	8.8 ± 8.2 5.1 (4.0–9.6)	18 (90)	5.8 ± 3.9 4.7 (3.3–7.0)	20 (100)	12.8 ± 11.3 7.3 (4.9–27.8)	15 (75)	6.7 ± 4.2 5.7 (3.6–8.8)	20 (100)
18[b]	8.2 ± 6.7 7.4 (3.2–11.9)	19 (95)	5.3 ± 2.9 4.4 (3.5–6.5)	20 (100)	10.3 ± 9.4 6.5 (4.3–11.8)	17 (75)	7.2 ± 4.8 5.9 (3.6–9.3)	20 (100)
19[b]	6.8 ± 3.6 6.2 (3.5–8.5)	20 (100)	5.4 ± 3.6 4.3 (3.2–5.8)	20 (100)	9.3 ± 8.7 6.2 (3.4–12.3)	18 (90)	6.4 ± 6.3 4.6 (2.8–7.5)	19 (95)
20[b]	7.4 ± 5.8 6.0 (3.9–7.6)	20 (100)	6.2 ± 4.3 5.1 (2.8–7.9)	20 (100)	11.0 ± 10.2 6.2 (4.1–11.9)	17 (75)	5.5 ± 2.6 4.9 (3.7–7.1)	20 (100)

All values are mean ± SD and median (Quartile 1–Quartile 3). ML, Macintosh laryngoscope; VL, videolaryngoscope.

[a] 1st to 5th ETI attempts were without chest compressions.

[b] With chest compressions at a rate of 100–120 min^{-1}.

Table 2 Comparisons of 10th and 11th endotracheal intubation (ETI) attempt times (s).

	Group MM (ML+ML Group) ($n=20$) ETI time (s)	Group VV (VL+VL Group) ($n=20$) ETI time (s)	Group VM (VL+ML Group) ($n=20$) ETI time (s)	Group MV (ML+VL Group) ($n=20$) ETI time (s)	p[a]
10th attempt times	6.9 (3.6–12.4) 10.2 ± 9.6	4.3 (3.6–8.5) 8.7 ± 9.8	4.6 (3.4–5.6) 6.7 ± 6.6	5.7 (4.4–11.8) 8.7 ± 6.8	0.243
11th attempt times	9.1 (5.8–20.7) 13.6 ± 10.1	8.0 (4.8–23.8) 13.5 ± 10.3	11.9 (7.6–17.2) 13.8 ± 8.4	13.9 (5.2–29.5) 16.0 ± 10.5	0.713
p[b]	0.084	0.010	0.005	0.044	

All values are mean ± SD and median (Quartile 1–Quartile 3). ML, Macintosh laryngoscope; VL, videolaryngoscope.
[a] Kruskal Wallis.
[b] Wilcoxon Signed Ranks.

Table 3 Comparisons of the means of Endotracheal Intubation (ETI) attempt times (s) for the first ten and last ten attempts.

	Group MM (ML+ML Group) ($n=20$) ETI time (s)	Group VV (VL+VL Group) ($n=20$) ETI time (s)	Group VM (VL+ML Group) ($n=20$) ETI time (s)	Group MV (ML+VL Group)($n=20$) ETI time (s)	p[a]	
1st ten ETI attempt times (s)	11.3 (9.6–14.9) 11.2 ± 4.0	8.0 (5.6–10.7) 8.5 ± 3.7	7.8 (6.7–10.4) 9.0 ± 3.7	11.5 (8.8–14.6) 12.1 ± 4.5	0.010	VV/MM-MV
Last ten ETI attempt times (s)	8.9 (6.1–11.3) 9.3 ± 4.0	6.0 (4.6–8.6) 6.9 ± 3.4	10.9 (7.0–13.6) 11.5 ± 5.0	8.6 (7.5–11.3) 9.4 ± 2.8	0.003	VV/VM-MV
p[b]	0.040	0.040	0.126	0.044		

All values are mean ± SD and median (Quartile 1–Quartile 3). ML, Macintosh laryngoscope; VL, videolaryngoscope.
[a] Kruskal Wallis.
[b] Wilcoxon Signed Ranks.

(Table 3). There was a statistically significant difference in both first and last ten ETI attempt times between groups ($p < 0.05$). At the first attempt time there was a statistically significant difference between Group VV and Groups MM and MV; at the last 10 ETI attempts there was a statistically significant difference between Group VV and Groups VM and MV. Group VV had a shorter ETI attempt time mean in both intergroup comparisons.

The in-group comparison of successful ETI at first 10 and last 10 attempts revealed an increase in Group MM ($p = 0.011$), Group VV ($p = 0.021$) and Group MV ($p = 0.290$) whereas Group VM success rate decreased in Group VM ($p = 0.008$) (Table 4) There was a statistically significant difference in mean successful ETI numbers in both first ten and last ten attempts ($p < 0.05$). There was a statistically significant difference between Group MM compared to Group VV and Group VM at first 10 attempts and there was a significant difference between Group VV and Group VM at last 10 attempts.

Discussion

In the current study, we compared the ETI time and success rates of VL and ML during ETI training and to determine the ETI performance of the students when they have to use an ETI device other than they have used during their education. We found that the successful ETI rates decrease in students who used VL in their ETI training program and had to use ML thereafter.

ETI is commonly used to maintain emergency airway however unsuccessful intubation rates were reported with different rates in previous studies. For example; Katz et al. reported the unsuccessful ETI rate of paramedics outside the hospital as 25%.[15] Unsuccessful ETI rates differs depending on where ETI is done and the experience of the implementer.[16] Paramedics, who has to perform ETI outside the hospital during CPR, have to perform fast and accurate ETI therefore they have to do adequate numbers of ETI attempts during their training program.[8]

Simulation manikin is used to provide fast and accurate ETI ability to paramedics and other medical students during their education. The absence of oropharyngeal secretions and anatomical structures on simulation manikin, which are usually present with human victim, comes into mind that intubation education may be inadequate. On the other hand some literature proves that working with normal manikin improves the success rate of human victim ETI therefore simulation manikins can be successfully used for ETI training.[10,11] In the recent study, all paramedic students performed their ETI attempts on a human manikin owing standard upper airway anatomic structures to obtain standardization.

Table 4 Comparisons of the means of successful Endotracheal Intubation (ETI) attempts for the first ten and last ten attempts.

	Group MM (ML+ML Group) ($n=20$) ETI time (s)	Group VV (VL+VL Group) ($n=20$) ETI time (s)	Group VM (VL+ML Group) ($n=20$) ETI time (s)	Group MV (ML+VL Group) ($n=20$) ETI time (s)	p[a]	
1st ten successful	8.0 (7.3–9.0)	10.0 (9.0–10.0)	10.0 (9.0–10.0)	9.0 (8.0–10.0)	0.001	MM/VV-VM
ETI attempts	8.2 ± 1.4	9.3 ± 0.9	9.6 ± 0.8	8.6 ± 1.4		
Last ten successful	10.0 (9.0–10.0)	10.0 (10–10)	8.5 (7.3–10.0)	9.0 (8.3–10.0)	0.009	VV/VM
ETI attempts	9.2 ± 1.1	9.7 ± 0.7	8.3 ± 1.8	9.0 ± 1.0		
p[b]	0.011	0.021	0.008	0.290		

All values are mean ± SD and median (Quartile 1–Quartile 3). ML, Macintosh laryngoscope; VL, videolaryngoscope.
[a] Kruskal Wallis.
[b] Wilcoxon Signed Ranks.

Paramedics use ML during CPR worldwide which is one of the standard equipment of emergency set. Today, with the assistance of developing technology VL are produced to provide a better vision especially for difficult airway cases which obliges to learn how to use it.[17]

In a study comparing the success rate of ETI with VL vs. ML during CPR at the hospital, VL was reported to be superior.[18] In another literature which was conducted at emergency department on experienced staff during CPR to compare VL and ML for ETI and there was no difference between success rate, performance time and complications.[19] Kim et al. has conducted a study with two different VL and ML and reported that time necessary for ETI, when ETI attempt was performed with chest compressions or not by an experienced staff, are similar.[14] In another study, anesthesiologists used ML and C-Mac® videolaryngoscope for ETI on a human manikin resulting in no superiority of VL.[20] Another study reports no difference of ML to videolaryngoscopes to do ETI during CPR.[21] In another study paramedics have performed ETI prior to hospital with either ML or one of the two VLs and no difference was reported in respect of ETI success rates.[22] In our study, unexperienced paramedic students have performed their first 5 ETI attempts without chest compressions. After the 5th attempt, chest compressions coincides CPR and the time necessary for ETI have increased significantly in all groups. The success of ETI also decreased in all groups but this was not statistically significant. There were no differences between groups on ETI time and success rate basis.

In some recent study comparing the success rate of ML and VL, VL is reported to be superior since it provides a larger vision and a higher successful ETI rates.[23] Wetch et al. have compared 5 different VL against ML on a simulation study and reported that VL are not superior to ML.[3] VL are structurally different from ML and they are also different from each other which of all are produced to provide a better vision for difficult airway cases. Even different blades are produced for a device to be used at difficult airway cases.[24] For this reason we believe that comparing ML to VL will be no sense therefore we did not collect the visual field data to compare between ML and VL. In our study we used #3 blades for both ML and VL to minimize structural differences. We believe that when ETI is performed at different time periods with VL which are structurally highly different than ML, the difference in time necessary for ETI and success rates will be more prominent.

VL may be more advantageous than ML during ETI training since it both provides the vision of anatomical structures and the maneuvers of ETI on the monitor.[2,4] There are many literature reporting VL can be successfully used for ETI training.[12,13,25] Kaplan et al. have reported that ETI training shortens with VL therefore can be chosen for teaching ETI.[12] Another study was conducted on medical students who underwent clinical training with ML and C-Mac® videolaryngoscope on anesthetized patients for 60 h to compare the success rate and time necessary for ETI.[13] No difference was present between groups prior to training but after training the success rate of ETI was higher and the time necessary for ETI was shorter. In the study of Zhao, unexperienced medical students have attempted 149 ETI. The time necessary for ETI was shorter and success rate was higher with Airtaq® VL and they concluded VL is superior to ML during ETI education.[25]

The difference of the current study from the literature is that chest compressions started after the 5th ETI attempts in our study. At the beginning we observed higher success rates and shorter ETI times with VL than ML in accordance with the literature. Four weeks after the first 10 ETI attempts, at the first attempt time necessary to perform ETI significantly increased in all groups. The change in successful ETI numbers were not statistically significant. In addition, we determined that students that used VL at the 1st 10 ETI attempts had a lower success rate and slower performance time when they face to ML at the last 10 ETI attempts.

Limitations

One of the limitations in our study was students had single ETI attempt chance to obtain standardization. Second limitation in the current study is that we neglected the pressure applied on the teeth of the manikin whereas some of the literatures have considered the pressure applied on the teeth of the manikin. Third limitation was the total number of ETI attempts for each precipitant paramedic was 20 which were lower than the accepted number to learn ETI successfully.[8] Last limitation of our study was the time gap between the ETI attempts of the groups was four weeks. New studies are needed to determine the change in success rate and time needed to perform ETI with a wider time gap between the attempts that is conducted on a wider precipitant population.

Conclusion

As a result, successful ETI numbers decreases in students who used VL at first and used ML at the last part of their ETI training program. Therefore we believe that only VL is not sufficient to teach ETI and adequate numbers of ETI attempts should be performed with ML for a successful ETI training.

Ethics approval

Ethics approval for this study came from Ahi Evran University Ethical Committee (Decision Number: 2016-03/02), Kirsehir, Turkey.

Conflicts of interest

The authors declare no conflicts of interest.

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