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Does Video Laryngoscopy Offer Advantages over Direct Laryngoscopy during Cardiopulmonary Resuscitation?

Videolaringoskopi Kardiyopulmoner Resüsitasyon Sırasında Doğrudan Laringoskopiye Karşı Avantaj Sağlar mı?

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Abstract / Özet

Objective: Interruption of chest compressions should be minimized because of its negative effects on survival. This randomized, controlled, cross-over study aimed to analyze the effectiveness of Macintosh, Miller, McCoy and McGrath laryngoscopes during with or without chest compressions in the scope of a simulated cardiopulmonary resuscitation scenario.

Methods: The time required for successful tracheal intubation, number of attempts, dental trauma severity and the need for optimization manoeuvres were recorded during cardiopulmonary resuscitation with and without chest compressions. The experience with computer games during the last 10 years were asked to the participants and recorded.

Results: McCoy laryngoscope yielded the shortest time for successful tracheal intubation both in the presence of and without chest compressions. During the use of McCoy laryngoscopes, fewer tracheal intubation attempts, lower incidence of dental trauma and lower visual analogue scale scores on the ease of intubation were recorded. Participants who are experienced computer game players using Macintosh, McCoy and McGrath achieved successful tracheal intubation in a significantly shorter time during resuscitation without chest compressions. Dental trauma incidence and number of tracheal intubation attempts did not show any significant difference between the four laryngoscopes being related to the rate of playing computer games.

Conclusion: McGrath video laryngoscopes do not appear to have advantages over direct laryngoscopes for securing a smooth and successful tracheal intubation during rhythmic chest compressions. We believe that as McCoy laryngoscope provided tracheal intubation in a shorter time and with fewer attempts, this laryngoscope may increase the success rate of resuscitation.

Keywords: Tracheal intubation, resuscitation, chest compression

Amaç: Sağkalım üzerine olumsuz etkileri nedeniyle göğüs kompresyonlarına ara verilmesi minimalize edilmelidir. Bu randomize, kontrollü, cross-over çalışmada simüle edilmiş kardiyopulmoner resusitasyon senaryosunda Macintosh, Miller, McCoy ve McGrath laringoskopların etkinliğinin göğüs kompresyonları sırasında ve yokluğunda analizi amaçlanmıştır.

Yöntemler: Başarılı entübasyon için gereken süre, girişim sayısı, dental travma şiddeti ve optimizasyon manevrası gereksinimi kardiyopulmoner resusitasyon sırasında göğüs kompresyonları varlığında ve yokluğunda kaydedildi. Katılımcılara son 10 yıl içinde bilgisayar oyunları konusundaki deneyimleri soruldu ve kaydedildi.

Bulgular: McCoy laringoskop göğüs kompresyonları varlığında ve yokluğunda en kısa başarılı trakeal entübasyon süresini sağladı. McCoy laringoskop kullanımı sırasında daha az trakeal entübasyon girişimi, daha az dental travma insidansı ve entübasyon kolaylığı üzerine daha düşük Görsel Analog Skala skorları kaydedildi. Bilgisayar oyunlarında deneyimi olan katılımcılar Macintosh, McCoy ve McGrath kullanımıyla göğüs kompresyonu uygulanmayan resüsitasyon sırasında anlamlı olarak daha kısa sürede başarılı trakeal entübasyon sağladılar. Dental travma insidansı ve trakeal entübasyon girişim sayısı dört laringoskop arasında bilgisayar oyunları oynama oranıyla ilişkili olarak anlamlı bir farklılık göstermedi.

Sonuç: McGrath videolaringoskop ritmik göğüs kompresyonları sırasında doğrudan laringoskoplardan yumuşak ve başarılı bir trakeal entübasyon bakımından avantajlı görünmemektedir. Daha kısa sürede ve daha az girişimle başarılı entübasyon sağladığından McCoy laringoskopun resüsitasyon başarı oranını artırabileceğine inanmaktayız.

Anahtar Kelimeler: Trakeal entübasyon, resusitasyon, göğüs kompresyonu

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Introduction

According to the guidelines published by the European Resuscitation Council (ERC) and American Heart Association (AHA), interruption of chest compressions should be minimized because of its negative effects on survival (1, 2). The preferred method suggests that tracheal intubation should be conducted while chest compressions are performed continuously and compressions should be interrupted only when the tracheal tube passes through the vocal cords (1). Because there are movements on the chest wall and neck, direct laryngoscopy may be difficult even for the most experienced hands in the presence of chest compressions. Starting from this point of view, researchers started comparing different devices that can provide quick and easy intubation in the setting of cardiopulmonary resuscitation (CPR), such as the Glidescope (3-6), Pentax-Airwayscope (7) or Airtraq (8) McGrath laryngoscope (Aircraft Medical, Edinburg, UK) combines both direct and video laryngoscopy in a single, handheld device. There is a color liquid crystal (LCD) display attached to the handle of the McGrath laryngoscope. Because of its 90° arc, it can be adjusted and rotated to obtain the best view (9). McGrath has been used successfully for the management of difficult intubation (10, 11). Until recently, studies have not compared McGrath laryngoscopes with direct laryngoscopes during resuscitation, either in the presence of or absence of chest compressions.

This randomized, controlled, crossover study aimed to analyze the effectiveness of Macintosh, Miller, McCoy and McGrath laryngoscopes during chest compressions in the scope of a simulated CPR scenario.

Methods

Following the approval of the Bilim University Ethics Committee (date/reference no: 20.06.2013/08-57), 58 first year student nurse anaesthetists were invited to participate in this study. Students who agreed to participate in the study provided written consent. The students were randomly divided into four groups. We used the opaque envelopes for identifying the groups and the order in which the devices would be used. For randomisation, a physician who was not informed of the study had each participant choose the envelopes numbered from 1 to 58, followed by the envelopes with numbers from 1 to 4. A conventional Macintosh laryngoscope, Miller, McCoy and McGrath Mac laryngoscopes were used. All intubations were performed on a Simman manikin with normal airway using an 8-mm cuffed endotracheal tube with a stylet. Before the study, students were given verbal instructions, computer-based presentations and a practical demonstration about the correct use of each device. This training proceeded for 15 min for each group. Possible manoeuvres required for tracheal intubation were also explained during demonstrations. Before the study, participants were given 10 min to practice each device on the manikin. The same researcher performed all time measurements. The first recording was consisted of intubation attempts at rest. Students were asked to intubate the manikin five times with each device at rest. During their sixth attempt, the time required for successful intubation, number of attempts, dental trauma severity and the need for optimization manoeuvres were recorded. All students started intubating practice with the Macintosh laryngoscope first, and then used Miller, McCoy and McGrath. All laryngoscopes were used according to the manufacturers' instructions. For determining the time for successful tracheal intubation, the tracking time was started when the laryngoscope was passed through the manikin's teeth and stopped when we observed that the manikin's lungs were ventilated using the bag-valve-mask system. When intubation could not be performed within 20 s or oesophageal intubation was performed, it was considered as an unsuccessful attempt. In case of three unsuccessful attempts or if the manikin could not be intubated within 60 s, it was regarded as an unsuccessful intubation. Severity of dental trauma was measured with the pressure degree on the maxillary teeth (0: no pressure, 1: mild, 2: moderate, 3: severe). Optimization manoeuvres such as head extension or vertical lifting, rates of device rotation and expert assistance were also recorded.

The second recording was consisted of intubation attempts during chest compressions. While effective chest compressions were being sustained according to the recommendations in the last European Resuscitation Council Guideline (1), participants provided airway with each of the four devices and then the same measurements were repeated. At the end of the study, participants were asked to grade the difficulty of each device between 0 and 100 (0: extremely easy, 100: extremely difficult) using the visual analogue scale (VAS). Subsequently, participants were given a questionnaire to identify the devices which they found easiest to use, to learn, which they felt safest, which they expect the highest complication rate and which they found the hardest to get used to.

The participants' experience with computer games more than 1 h per week during the last 10 years were asked and recorded. The exclusion criteria were as follows: students who did not provide written consent and had previous intubation experience with one of the four laryngoscopes. Both the researcher informing students about the study and the other researcher maintaining the records were professional anaesthetists with at least a 5-year experience.

Statistical analysis

We calculated the sample size from a preliminary study including 10 residents. The mean [±standard deviation (SD)] time required to ventilate the lungs after tracheal intubation in manikin was 10.4±4.5 s. We considered that a difference of 2.5 s (roughly one quarter of 10.8 s) between the groups would be clinically important. To detect this difference with a power of 80% (α=0.05, β=0.2 and effect size=0.56), approximately 51 participants would be required. Statistical Package for the Social Sciences (SPSS Inc., IBM Corp. Armonk, NY, USA) software version 21.0 was used for statistical analyses. The frequency, rate, average and standard deviation values were used for the descriptive statistics of the data. The Kolmogorov–Simirnov test was used to control the distribution of the variances. While the Friedman test was used for the analysis of repeated measurements, the Wilcoxon test, the Cochran Q test and the McNamara test were used for sub-analyses. The McNemar test was used in the analysis of qualitative data between groups, and Wilcoxon test was used for quantitative data, which have nonparametric distribution. Bonferroni correction was performed in post hoc analysis. A p value <0.05 was considered statistically significant.

Results

The data of 58 participants were analysed. None of the participants were excluded. The McCoy laryngoscope yielded the shortest time (7.29±4.92 s) for successful tracheal intubation, whereas the Macintosh laryngoscope yielded the longest tracheal intubation time (p<0.001, Table 1). In the presence of chest compressions, the McCoy laryngoscope secured successful tracheal intubation in the shortest time (6.26±4.38 s), The McGrath laryngoscope achieved intubation in the longest time (p<0.001, Table 1). The tracheal intubation time was significantly shorter with the Miller laryngoscope than the Macintosh and McGrath laryngoscopes in the presence of chest compressions (p<0.001, Table 1).

The participants' experience with computer games using Macintosh, McCoy and McGrath achieved successful intubation in a significantly shorter time at rest than non-players (p<0.05, Table 2). There was no significant difference between non-players and players when the Miller laryngoscope was used (p=0.254). Successful tracheal intubation time did not differ during chest compressions (Table 2). There were significantly fewer successful tracheal intubation attempts with the McCoy laryngoscope both in the presence of and without chest compressions than the Macintosh, Miller and McGrath laryngoscopes. While this ratio was 51.7% at rest, it was 65.5% in the presence of chest compressions (p<0.001, Table 3). The incidence of dental trauma was significantly lower during the use of the McCoy laryngoscope than the Macintosh and Miller laryngoscopes (p=0.014). However, there were no significant differences between the four laryngoscopes regarding the occurrence of dental trauma during chest compressions (p=0.122, Table 3).

Dental trauma incidence and number of tracheal intubation attempts did not show any significant difference between the four laryngoscopes being related to the rate of playing computer games (Table 4).

Table 1. Time required for successful tracheal intubation with and without chest compressions

	Macintosh	Miller	McCoy	McGrath
T1	10.40±7.98*	8.48±3.37*	7.29±4.92	10.24±5.76*
T2	7.59±3.58*,‡	6.35±2.68	6.26±4.38	8.33±4.42*,‡

Friedman test
T1: Time required for providing airway without chest compressions (s)
T2: Time required for providing airway during chest compressions (s)
*Comparison with McCoy laryngoscope, p<0.001
‡Comparison with Miller laryngoscope, p<0.001

Table 2. Time to successful tracheal intubation during cardiopulmonary resuscitation (s) (mean±SD)

		Playing computer games (+)	Playing computer games (–)	p
T1	Macintosh	7.75±4.04	12.87±9.85	0.013
	Miller	7.96±3.21	9.00±3.51	0.254
	McCoy	5.86±2.81	8.63±6.03	0.030
	McGrath	8.61±3.53	11.77±6.97	0.034
T2	Macintosh	7.11±3.27	8.03±3.85	0.330
	Miller	6.04±2.12	6.66±3.13	0.387
	McCoy	5.11±1.91	7.33±5.64	0.288
	McGrath	7.46±2.87	9.13±5.42	0.153

Mann–Whitney U test.
T1: During cardiopulmonary resuscitation without chest compressions
T2: During cardiopulmonary resuscitation with chest compressions

Table 3. The incidence of dental trauma and additional tracheal intubation attempts with and without chest compressions

		Macintosh		Miller		McCoy		McGrath		
		n	%	n	%	n	%	n	%	p
T1	Dental trauma incidence	10	17.2%*	8	13.8%*	1	1.7%	4	6.9%	0.014
	Additional intubation attempts	57	98.3%*	54	93.1%*	30	51.7%	56	96.6%*	<0.001
T2	Dental trauma incidence	7	12.1%	6	10.3%	2	3.4%	2	3.4%	0.122
	Additional intubation attempts	58	100.0%*	57	98.3%*	38	65.5%	55	94.8%*	<0.001

McNemar test
T1: Time required for providing airway without chest compressions (s)
T2: Time required for providing airway during chest compressions (s)
*Comparison with the McCoy laryngoscope

Table 4. Dental trauma incidence and number of tracheal intubation attempts during cardiopulmonary resuscitation

		Playing computer games (+)		Playing computer games (-)		
T1		**n**	**%**	**n**	**%**	**p**
Additional intubation attempts	Macintosh	2	7.1	8	26.7	0.049
	Miller	2	7.1	6	20.0	0.156
	McCoy	0	0.0	1	3.3	1.000
	McGrath	1	3.6	3	10.0	0.612
Dental trauma	Macintosh	27	96.4	30	100.0	0.483
	Miller	27	96.4	27	90.0	0.612
	McCoy	14	50.0	16	53.3	0.800
	McGrath	27	96.4	29	96.7	1.000
		Playing computer games (+)		**Playing computer games (–)**		
T2		**n**	**%**	**n**	**%**	**p**
Additional intubation attempts	Macintosh	3	10.7	4	13.3	0.760
	Miller	3	10.7	3	10.0	0.929
	McCoy	0	0.0	2	6.7	0.492
	McGrath	0	0.0	2	6.7	0.492
Dental trauma	Macintosh	28	100.0	30	100.0	-
	Miller	28	100.0	29	96.7	1.000
	McCoy	15	53.6	23	76.7	0.064
	McGrath	27	96.4	28	93.3	1.000

Chi Square test
T1: During cardiopulmonary resuscitation without chest compressions
T2: During cardiopulmonary resuscitation with chest compressions

The VAS score on the ease of intubation was found to be significantly lower for the McCoy laryngoscope (12.93±11.66 mm) than the Macintosh, Miller and McGrath laryngoscopes (31.24±23.48 mm, 41.34±31.56 mm, 40.66±23.11 mm, respectively) (p<0.001). The difficulty VAS score of the Macintosh laryngoscope was significantly lower than the VAS scores of Miller and McGrath (p<0.001, Table 5).

There was no significant change in our results according to the Bonforenni correction.

Table 5. Visual analogue scale scores

	Min	Max	Mean	p
Macintosh	0	98	31.24±23.48*	<0.001
Miller	0	100	41.34±31.56*,∫	<0.001
McCoy	0	50	12.93±11.66	>0.05
McGrath	0	90	40.66±23.11*,∫	<0.001

Friedman test
*Comparison with the McCoy laryngoscope
∫Comparison with the Miller laryngoscope

Discussion

The results of the present study demonstrated that the use of the McGrath video laryngoscope during rhythmic chest compressions did not yield any advantages over various direct laryngoscopes with respect to successful tracheal intubation time, number of intubation attempts, dental trauma incidence or the need for optimization manoeuvres. No significant difference could be documented regarding the time to tracheal intubation with or without rhythmic chest compressions.

The McCoy laryngoscope provided the shortest time for successful tracheal intubation during cardiopulmonary resuscitation. Also, contrary to expectations, usage of the McGrath optical laryngoscope brought about the longest tracheal intubation time during resuscitation. Additionally, the McGrath laryngoscope did not demonstrate any advantages during chest compressions with respect to dental trauma incidence, number of intubation attempts or need for optimization manoeuvres.

Alignment of oral, pharyngeal and laryngeal axes provides a clear and direct view during direct laryngoscopy. However, because the McGrath laryngoscope does not secure the alignment of these axes, there should be a relative angle, which lets the tip of the endotracheal tube enter into the larynx. During the use of the McGrath laryngoscope, pharyngeal tissues cannot move anteriorly as much as they do in direct laryngoscopy, thus, there is only a limited area for the tube insertion (9). Despite a good laryngeal view it provides, one may find forwarding the endotracheal tube to be difficult while using the McGrath laryngoscope. This is a problem which has been already acknowledged during the use of the McGrath laryngoscope (9). It was reported in a previous manikin study conducted in the setting of normal airway that although the participants were experienced anaesthesiologists, the tracheal intubation time was longer with McGrath laryngoscopes than other laryngoscopes (12). In the study of Ray et al. (13), although the McGrath laryngoscope provided a better view of the glottis than the Macintosh laryngoscope, the tracheal intubation time was similar with both laryngoscopes. In the same study, the McGrath laryngoscope could not demonstrate any advantage regarding the ease of use because participants of the study found laryngoscopy easy to perform; however, it was more difficult to move the tube forward with the McGrath laryngoscope. Ng et al. (14) compared the McGrath laryngoscope with a straight blade in the setting of difficult airway, and they reached the conclusion that although the McGrath laryngoscope provided a better Grade 1 laryngoscopic view in patients with lower Mallampati score, it did not guarantee quicker or more successful tracheal intubation. Moreover, there are other laryngoscopes apart from McGrath laryngoscopes that have difficulty in securing the intubation even though there is a relatively good laryngoscopic view. In their review, Niforopoulou et al. (15) reported that video laryngoscopes extend the intubation time in Cormack and Lehane Grade 1–2 patients. Another meta-analysis evaluating the data of 1305 participants concluded that video laryngoscopes do not have any superiority to direct laryngoscopes in emergency tracheal intubation (16). Recently published reviews have subsequently reported that there is not enough evidence suggesting that video laryngoscopes can be a substitute for direct laryngoscopes (17, 18).

The superiority of video laryngoscopes to direct laryngoscopes during cardiopulmonary resuscitation is also a controversial issue. In a study involving experienced emergency physicians, Pentax-Airwayscope was found to be a better device to achieve successful tracheal intubation during continuous chest compressions than the Macintosh laryngoscope (7). On the other hand, a manikin-based study including 25 emergency physicians who were experienced in direct laryngoscopy but did not have any experience with video laryngoscopes reported that Macintosh and GlideScope were not affected by chest compressions; however, the use of Pentax-Airwayscope prolonged the time required for tracheal intubation (19). Koyama et al. (20) indicated that, compared to Macintosh and Airtraq laryngoscopes, Pentax-AirwayScope increased the success rate of tracheal intubation and reduced the intubation time in the presence of rhythmic chest compressions.

All these studies have led us to question the place of video laryngoscopes for tracheal intubation during the rhythmic chest compressions practiced in cardiopulmonary resuscitation. To the best of our knowledge, this is the first study that has evaluated the performance of the McGrath laryngoscope for tracheal intubation during cardiopulmonary resuscitation. In addition, we think that there should be further randomized clinical studies comparing McGrath laryngoscopes with direct laryngoscopes.

Manikin studies are beneficial for evaluating new intubation devices and learning required techniques (21). However, the data obtained from manikin studies should be verified in clinical practice. The second limitation of the study is that because this is a manikin study, we could not simulate blood, vomit or secretions in the oropharynx.

Conclusion

McGrath laryngoscopes do not appear to have advantages over direct laryngoscopes for securing a smooth and successful tracheal intubation during rhythmic chest compressions performed for cardiopulmonary resuscitation. We believe that because the McCoy laryngoscope provided tracheal intubation in a shorter time and with fewer attempts, this laryngoscope may increase the success rate of resuscitation.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Bilim University.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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