

Video Laryngoscopy Versus Direct Laryngoscopy in Novice Users: A Manikin Study

Deneyimsiz Kullanıcılarda Videolaringoskopiye Karşılık Direkt Laringoskopi: Bir Manken Çalışması

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ABSTRACT Objective: Videolaryngoscopes are widely accepted and being commonly used by inexperienced medical staff. However, there is not a single satisfactory videolaryngoscope type that is suitable for all patients. We aimed to determine whether videolaryngoscopes are superior to direct laryngoscopes for novice users. **Material and Methods:** Seventy fifth-grade medical students without any experience of performing tracheal intubation, participated in the study. Size 3 blades of Macintosh, Miller, McGrath Mac and Airtraq laryngoscopes were used in the scope of the study. All intubations were performed on a manikin with normal airway using 7.5 mm internal diameter cuffed tracheal tube with a stylet. We compared the different laryngoscopes considering the time to intubation, success rate, ease of use, dental trauma incidence and requirement for optimization maneuvers. **Results:** Time to successful intubation, dental trauma incidence, the use of device rotation maneuver and user difficulty scores were significantly higher for Airtraq laryngoscope. According to the results of the questionnaire filled out by the participants, McGrath laryngoscope was found to provide the easiest use and be the most appropriate device for learning tracheal intubation. **Conclusion:** Although video laryngoscopy provides successful visualization, there is a possibility of failure in tracheal intubation. Therefore, advantages and disadvantages of each device should be judged on its own merits.

Key Words: Airway management; intubation, intratracheal; laryngoscopes

ÖZET Amaç: Videolaringoskoplara geniş oranda kabul edilmiş olup, deneyimsiz medikal personel tarafından sıkça kullanılmaktadır. Ancak tüm hastalar için uygun olan tek tatmin edici bir videolaringoskop tipi bulunmamaktadır. Deneyimsiz kullanıcılar için videolaringoskoplara direkt laringoskoplara karşı üstünlüğü olup olmadığını belirlemeyi amaçladık. **Gereç ve Yöntemler:** Daha önce trakeal entübasyon deneyimi bulunmayan 70 5. sınıf tıp fakültesi öğrencisi çalışmaya katıldı. Çalışmada Macintosh, Miller, McGrath Mac ve Airtraq laringoskoplara ait 3 numaralı bleydler kullanıldı. Tüm entübasyonlar normal havayoluna sahip bir manken üzerinde 7,5 mm iç çaplı kafalı trakeal tüp kullanılarak stile ile gerçekleştirildi. Farklı türde laringoskoplara entübasyon zamanı, başarı oranı, kullanım kolaylığı, dental travma insidansı ve optimizasyon manevrası gereksinimi bakımından karşılaştırdık. **Bulgular:** Başarılı entübasyon için gereken zaman, dental travma insidansı, rotasyon manevrası kullanımı ve kullanıcı zorluk skorları Airtraq laringoskop için anlamlı olarak daha yüksekti. Katılımcılar tarafından doldurulan anketin sonuçlarına göre McGrath laringoskop en kolay kullanım sağlayan ve trakeal entübasyonun öğrenilmesinde en uygun aygıt bulundu. **Sonuç:** Videolaringoskopiyle başarılı görüntüleme sağlanmasına rağmen trakeal entübasyonda başarısızlık oluşabilmektedir. Bu nedenle her aygıtın avantaj ve dezavantajları kendi içinde değerlendirilmelidir.

Anahtar Kelimeler: Havayolu yönetimi; entübasyon, intratrakeal; laringoskoplara

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Direct laryngoscopy performed with Macintosh or Miller laryngoscopes is commonly used as traditional method for tracheal intubation.¹ However, it is hard to become skillful at direct laryngoscopy.²

On the other hand, videolaryngoscopes are widely accepted and being commonly used by inexperienced medical staff or by those who have limited experience in tracheal intubation.^{3,4} There are a great variety of videolaryngoscopes used in clinical practice in order to improve the laryngoscopic view. It also means that there is not a single satisfactory design that is suitable for all patients.⁵

McGrath Mac laryngoscope has a Macintosh type blade which is combined with video technology. It can be used both as a conventional direct laryngoscope and as an indirect videolaryngoscope.⁶ Airtraq optical laryngoscope is composed of two channels running parallel to each other. The curvature of its blade and special inbuilt optical system allows visualization of glottis without a need for the alignment of oral, pharyngeal and laryngeal axes.⁷ Video functions of the both devices provide a myriad of advantages for the coordination of optimal external manipulation and intubation training. Airtraq has been used for training novice personnel and reported to be superior to Macintosh laryngoscope for becoming skillful.⁸⁻¹⁰ On the other hand, McGrath has indicated to be associated with higher successful intubation rates compared to Macintosh laryngoscope.¹¹ However, Airtraq and McGrath videolaryngoscopes have not been compared before with Miller and Macintosh laryngoscopes regarding tracheal intubation in normal airway. In the present study, we compared direct laryngoscopes used for tracheal intubation in simulated normal airways with Airtraq and McGrath optical laryngoscopes. Our aim was to determine whether videolaryngoscopes are superior to direct laryngoscopes considering the time to intubation, success rate, ease of use, efficiency, dental trauma and requirement for optimization maneuvers.

MATERIAL AND METHODS

After ethics committee's approval and participants' informed consents were taken, we asked 70 fifth-grade medical students to participate the study and divided them into 7 different groups. The opaque envelopes containing sequent numbers were used for the randomization of groups and the order in which the devices would be used. Participants with

the previous experience of performing tracheal intubation were excluded from the study. Size 3 blades of Macintosh, Miller, McGrath Mac and Airtraq laryngoscopes were used in the scope of the study. All intubations were performed on a Simman manikin with normal airway using 7.5 mm cuffed endotracheal tube with a stylet. Before the study, students were given verbal instructions regarding the correct use of each device. Afterwards, the training went on watching a 5-min computer-based presentation explaining the use of each laryngoscope. This was followed by a practical demonstration. This training lasted 15 minutes for each group. Possible maneuvers required for intubation were also explained during demonstrations. Then, students were asked to intubate the mannequin five times with each device. All students started intubating-practice with Macintosh laryngoscope first, then used Miller, McGrath and Airtraq, respectively. All laryngoscopes were used according to the manufacturers' instructions. For determining the time for successful intubation, tracking time was started when the laryngoscope was passed through mannequin's teeth and stopped when we observed that mannequin's lungs were ventilated using the bag valve mask system. When intubation could not be performed within 40 seconds or oesophageal intubation was carried out, it was considered as an unsuccessful attempt. In case of three unsuccessful attempts or the mannequin could not be intubated within 120 seconds, 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 maneuvers such as head extension or vertical lifting; rates of device rotation and expert assistance were also recorded. 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). Afterwards, participants were given a questionnaire in order 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 hardest to get used to.

STATISTICAL ANALYSIS

In a previous manikin study, the clinicians used a Macintosh laryngoscope in an easy airway scenario and considered that a significant change in the duration of tracheal intubation would be 25%.¹² We considered that a difference of 2 s (with a standard deviation=4) between the groups would be clinically important. Thus, using an alpha value=0.05, beta value=0.2 and standard effect size=0.5 we estimated that 63 participants would be needed. SPSS software version 21.0 Armonk, NY: IBM Corp. was used for statistical analyses. The frequency, rate, average and standard deviation values were used for the descriptive statistics of the data. Distribution of the variances was controlled by using the Kolmogorov-Smirnov test. 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-analysis.

RESULTS

One hundred medical students from our medical faculty were informed about the study and invited for participation. Seventy students took part in the study, but one of them who did not completed measurements with all devices was excluded from the study. Therefore, this study analyzed the data of remaining 69 participants. Mean attempt numbers for tracheal intubation was significantly higher in Airtraq compared to the other devices ($p<0.05$). The numbers of successful intubation were 1.18 ± 0.36 , 1.24 ± 0.52 , 1.22 ± 0.66 and 2.09 ± 0.31 respectively for Macintosh, Miller, McGrath and Airtraq laryngoscopes. Time to successful intubation was 15.64 ± 8.37 minutes in Airtraq, and it was significantly higher than Macintosh, McGrath and Miller laryngoscopes ($p<0.05$) (Table 1). Four participants could not achieve successful tracheal intubation with Airtraq. However, the success rate was 100% for the other devices. While we detected oesophageal intubation 8 times in Macintosh and 6 times in Miller, we did not observe oesophageal intubation with Airtraq and McGrath laryngoscopes. User difficulty score (VAS) was significantly higher in Airtraq comparing with Macintosh, McGrath

and Miller laryngoscopes ($p<0.05$). The VAS scores of the Miller laryngoscope were significantly higher than McGrath ($p<0.05$) (Table 2).

While the rate of tracheal intubation without dental trauma was 52.1% for Airtraq, that rate was significantly higher for the other devices ($p<0.05$). Severity of dental trauma did not show a significant difference between Macintosh, Miller and McGrath laryngoscopes (0.98 ± 1.08 , 1.07 ± 1.14 , 1.02 ± 1.27 respectively). Head extension was most frequently applied for Macintosh laryngoscope. The device rotation was used significantly more frequently with Airtraq device. Any significant difference was not observed between the devices regarding the rates of vertical lifting and expert assistance. According to the results of the questionnaire filled out by the participants, McGrath was found to provide the easiest use and be the most appropriate device for learning tracheal intubation. Airtraq was found the most difficult device both to learn and to use. Participants reported that it was hard to get used to using Airtraq and they expected more complications compared to the other devices. They stated that they felt safest with the McGrath device (Table 3).

DISCUSSION

In this study, we compared the performances of direct laryngoscopes and indirect laryngoscopes used by novice laryngoscopists in normal airway scenario, and found out that Airtraq optical laryngoscope required longer time and more attempts for successful tracheal intubation. Also, the severity of

TABLE 1: Time for successful intubation (min) (mean \pm SD).

	Macintosh*	Miller*	Airtraq	McGrath*
Time	8.58 \pm 3.51	8.73 \pm 4.24	15.64 \pm 8.37	9.07 \pm 4.92

* Comparison with Airtraq, $p<0.001$; SD: Standart deviation.

TABLE 2: VAS scores for devices (mm).

	Macintosh*	Miller**	Airtraq	McGrath*
VAS	24.38 \pm 25.96	27.92 \pm 29.39	58.00 \pm 31.05	19.62 \pm 21.89

*Comparison with Airtraq, $p<0.001$.

** Comparison with McGrath, $p<0.001$.

VAS: User difficulty score.

TABLE 3: The short questionnaire about Macintosh, Miller, Airtraq and McGrath laryngoscopes.

	Macintosh	Miller	Airtraq	McGrath
Which device was the easiest one to use in endotracheal intubation?	29.2%	15.4%	6.2%	49.2%
Which device is easier to learn?	18.5%	9.2%	10.8%	61.5%
With which device did you feel safer?	20.0%	4.6%	10.8%	64.6%
By which device do you think the complication rate should be higher?	15.4%	21.5%	52.3%	9.2%
Which device is more difficult to get used to?	7.7%	16.9%	66.2%	6.2%

dental trauma and the difficulty scores were found to be higher for Airtraq. Additionally, McGrath laryngoscopes did not provide an advantage over direct laryngoscopes.

We used two different videolaryngoscopes in this study. One of them is Airtraq with a guiding channel, and the other is McGrath Mac which is used with steering technique. For direct laryngoscopy, we used Macintosh laryngoscope with a curved blade and Miller with a straight blade. Although Airtraq laryngoscope has a guiding channel, it did not precede the other laryngoscopes used with steering technique regarding time to intubation, success rate or ease of use. While using Airtraq, users required additional maneuvers; especially they used rotation frequently. We believe that all these factors were associated with the extended time to successful intubation. One needs time and training for using Airtraq properly, because, even very little head movements put the laryngeal view at risk while using this device. As our participants were novices, they easily failed to keep the laryngeal view, and this situation led to a delay in successful intubation attempts. It has been reported previously that although Airtraq ensured a good glottic view in Cormack and Lehane Grade 3 patient, tracheal intubation could be achieved only if Airtraq was accompanied with a fiberoptic bronchoscope.¹³ Wetsch et al. also stated that even though videolaryngoscopes provided a clear visualization of laryngeal structures, the time to successful intubation was found to be longer compared to direct laryngoscopes.¹⁴

In the present study, McGrath required 9 seconds to ensure intubation and that was close to time obtained with Macintosh and Miller laryngoscopes. As Savoldelli et al. stated in their study, Mc-

Grath is similar to Macintosh laryngoscopes in terms of its shape.¹⁵ That may be the reason why participants thought that McGrath would provide more advantages for intubation. Similarly, in previous studies conducted with novices, participants found McGrath easier to use.² Experienced laryngoscopists (with conventional laryngoscopes) may have difficulty in getting used to McGrath or becoming skillful at using that device; however, McGrath's Macintosh-like shape is a reason for novice users' preference. Also, the thin disposable acrylic cover placed on the McGrath blade ensures indirect glottic view with a viewpoint of 60°. We think that the time to intubation may be shorter in McGrath compared to Airtraq. Nevertheless, some studies comparing Airtraq with Macintosh laryngoscope in normal and difficult airway scenarios reported that Airtraq caused less dental trauma, required less optimization maneuvers; was faster and showed a lower failure rate.¹⁶⁻¹⁹ However, all participants taking part in those studies were experienced laryngoscopists. Users having tracheal intubation experience do not have trouble placing the endotracheal tube (ETT) after ensuring a good view of the glottis. On the other hand, as novice users do not have enough laryngoscopy skill, like in our study, they probably have trouble directing the tube even if they have a clear glottic view.

It is controversial whether videolaryngoscopes are superior to direct laryngoscopes or not. It was concluded in the review of Niforopoulou et al. that videolaryngoscopes extend time to intubation in Cormack and Lehane grade 1 and grade 2 patients.²⁰ On the other side, a meta-analysis involving 12 randomized, controlled trials declared that novices perform tracheal intubation with Airtraq in a significantly shorter time than Macintosh laryngo-

scopes.⁷ In the same meta-analysis, the success rate of novices was higher at the first intubation attempt, but there was no decrease in complication rate. In another meta-analysis analyzing data of 1305 participants, videolaryngoscopes did not have any advantage over direct laryngoscopes for tracheal intubation in the emergency setting.²¹ Sakles et al.'s study analyzing 822 tracheal intubation reported that although oesophageal intubation numbers were lower with video laryngoscopy, the success rates were higher (57%) with direct laryngoscopy in the cases requiring more than one attempt.²² However, the overall success rate was similar in both laryngoscopes. In another study comparing video laryngoscopy and direct laryngoscopy, no difference was documented between the groups regarding glottic view and time required for securing that view.²³ It is stated in Stroumpoulis et al.'s study, similar to our results, that inexperienced users found video laryngoscopy easier than direct laryngoscopy, but there was no difference between the laryngoscopes regarding the time required for successful intubation.²⁴ In a review analyzing 77 studies, the successful intubation rate was found above 95% for direct laryngoscopy, and above 94% for videolaryngoscopes.²⁵ Direct laryn-

gосcopy has been reported to have a high success rate even in the presence of unclear glottic view. Therefore, it was suggested that videolaryngoscopes should be used only in the settings where direct laryngoscopy fails.

LIMITATIONS

Manikin studies are useful for evaluating new intubation equipments and learning required techniques.²⁶ However, unlike the studies conducted with human subjects, mannequin studies lack factors that negatively affect glottic view such as salivation, secretion, fogging or bleeding. Therefore, we cannot evaluate the success of tracheal intubation in case of such factors' presence. That is the main limitation of this study.

CONCLUSION

Although video laryngoscopy provides successful visualization, there is a possibility of failure in tracheal intubation. The reviews published in recent years have reported there is not enough evidence suggesting that videolaryngoscopes could take the place of direct laryngoscopy. For this reason, advantages and disadvantages of each device should be judged on its own merits.

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