ORIGINAL ARTICLE

Comparison of the C-MAC D-Blade videolaryngoscope and direct laryngoscope in pediatric patients: Randomized controlled trial

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ABSTRACT

BACKGROUND: Endotracheal intubation is a key skill for clinicians and may be challenging in some patients due to various reasons. Nowadays, various kinds of videolaryngoscopes are available and usually used as a rescue device when direct laryngoscopy failed. Pediatric airway has some differences when compared with adults and may be challenging. This study aims to compare and evaluate C Mac D-Blade and commonly used Macintosh laryngoscope in pediatric patients.

METHODS: In this study, 56 pediatric patients, 5–10 years old (10–40 kgs) who had undergone elective surgery and need endotracheal intubation were included after obtaining ethical board approval and informed consent from parents. The patients were randomized into two equal groups for laryngoscopy and intubation by either with Macintosh laryngoscope or C Mac D-Blade videolaryngoscope. Glottic view, number of attempts, intubation time, any complications and hemodynamic variables were recorded. A value of $p<0.05$ was considered significant.

RESULTS: In pediatric patients with unanticipated difficult airway, the mean intubation time was significantly shorter with C Mac D-Blade (21±9 and 41±7 seconds, respectively ($p<0.001$). The results of the two groups were similar concerning the remaining parameters.

CONCLUSION: C Mac D-Blade videolaryngoscope shortened intubation time about twice when compared to Macintosh blade C Mac D-Blade videolaryngoscope, Videolaryngoscopes may be a good alternative for routine intubation, education and a rescue device for difficult intubation.

Keywords: Endotracheal intubation; pediatrics; videolaryngoscopy.

INTRODUCTION

Airway management, including endotracheal intubation, is an indispensable skill for all clinicians, especially for doctors working in emergency medicine, intensive care units and operating rooms. Additionally, pediatric patients have many significant anatomic and physiological differences when than adults, which requires additional knowledge and experience for airway management.[1–4] The data about the incidence of difficult pediatric airway and optimal management are limited, but there is a lower incidence of the pediatric difficult airway as compared with adults and more pronounced in infants under one year of age.[1,5–8] Pediatric patients have the lower functional residual capacity and higher oxygen consumption, which makes them prone to hypoxemia and related adverse events, including desaturation, hypoxemia, bradycardia, unexpected admissions to the intensive care unit (ICU) and death.[9–12] Such difficulties during routine intubation occur in 1–6% of cases and failed intubation in 0.05% of cases but are much more common in the ICU and emergency departments.[13–15]

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As in adults, in pediatric patients, intubation is usually performed with conventional laryngoscopes via direct laryngoscopy (DL). Alternatives to the conventional laryngoscopes rely on fiberoptic or digital technology to transmit an image from the tip of the laryngoscope to an eyepiece or monitor, where it is viewed by the intubator. Nowadays, videolaryngoscopes (VL) are commonly used for routine practice, educational purposes and a rescue device after failed direct laryngoscopy and may reduce the need for fiberoptic intubation or invasive airway requirement.[16–22] Studies suggest that using a VL improves the view of the larynx during laryngoscopy and VLs therefore providing the possibility of a more successful intubation for patients in whom direct laryngoscopy is difficult.[20,22–31] However, some studies report that intubation with VLs may not always be easy or may require more attempts or may last longer even if the image is improved.[19,32,33]

Classic C Mac VL (Karl Storz, Tuttlingen, Germany) comprises a Miller or different sized Macintosh blades with a camera placed at its tip and a video display unit. C Mac D-Blade VL has a very similar structure with the existing C Mac system except D-Blade is more angled, almost half-moon shaped (C Mac 18° vs. C Mac D-Blade 40°) (Fig. 1).[34–36] This extra angulation usually prevents direct laryngoscopy with D-Blade but improves indirect visualization of glottis on the screen, especially in difficult airways. While the use of VLs may aid visualisation; evidence is required to establish if this is equivalent to increased success in tracheal intubation with reduced complications in different patient populations.

Figure 1. Left side Macintosh laryngoscope sizes 2 and 3. Top right side conventional C Mac size 3, bottom right side C Mac D-Blade pediatric size.

To our knowledge, this is the first randomized controlled study investigating the performances of the C-MAC D-Blade VL (Karl Storz, Tuttlingen, Germany) and conventional Macintosh laryngoscope in pediatric patients with normal airway concerning glottic view and intubation parameters, including success rate, number of intubation attempts, intubation time, changes in oxygen saturation and adverse effects, including abnormal haemodynamic response to endotracheal intubation.

MATERIALS AND METHODS

This prospective randomized controlled study was conducted after obtaining ethical approval from the Ethics Committee of Ankara University School of Medicine (M. Melli, 21.10.2016,19-955-16), and written informed consent was obtained from the parents of all children. Children who were scheduled for elective operation under general anesthesia at the Pediatric Surgery Operating Theatres in Ankara University School of Medicine Cebeci Hospital were enrolled in this prospective observational study.

The sample size was calculated using equivalence testing and Bland-Altman analysis. The inclusion criteria were to be an ASA I-III patient between 10–40 kg and to be scheduled for elective surgery that required endotracheal intubation. Patients with a BMI >35, chronic obstructive pulmonary disease and predicted difficult airway were excluded from this study.

Fifty-six patients participated in this study after parents' approval, and all children were premedicated with 0.3 mg/kg midazolam in 10 mg/kg paracetamol orally. When the patients arrived at the operating theatre, standard monitoring, i.e., non-invasive blood pressure measurement, electrocardiography, oxygen saturation, were performed. Intravenous access was provided after the induction with sevoflurane inhalation. Anesthesia was induced with 1 mg/kg lidocaine and 3–4 mg/kg propofol and 0.6 mg/kg rocuronium was administered as a muscle relaxant. Laryngoscopy was performed in two minutes.

Patients were randomly assigned in two groups: Patients to undergo intubation with a C Mac D-Blade (n=28; C Mac D-Blade Group) and patients to undergo intubation with a Macintosh Blade (n=28; Macintosh Group). All patients were intubated by a single anaesthesist, who had experience in using both of the laryngoscopes. The investigator, who performed the intubation in this study, had previously performed more than 50 intubations using C Mac D-Blade video laryngoscope in pediatrics. Anesthesia was maintained with sevoflurane, with the target hemodynamic values 20% of that of the pre-induction values. At the completion of the surgery, sugammadex was administered to antagonize any residual neuromuscular block.

In each group, tracheal intubation was considered as a failure if not accomplished within three attempts. Any single insertion of the laryngoscope past the patient's lips was consid-

ered an intubation attempt. The following outcomes were recorded by an unblinded observer:

1. Overall intubation success rate;
2. Number of intubation attempts;
3. Cormack–Lehane score: Visualization of the laryngeal inlet was assessed according to the classification by Cormack – Lehane;[37]
4. Intubation time (defined as the time from picking up the laryngoscope to confirmation of tracheal intubation by capnography);
5. Optimizing maneuvers were the external manipulation of the larynx, use of a stylet.
6. Mucosal trauma (i.e., blood detected on the device);
7. Lip or dental injury;
8. Desaturation (SpO_2 <90%)

Statistical Analysis

The analysis of the data was performed in the SPSS 15.0 windows version. Descriptive statistics were presented as mean±SD and median (minimum-maximum) for quantitative data and number (percent) for qualitative data. Whether there was a statistically significant difference between the categories of qualitative variable which had two categories in terms of quantitative variable; if normal distribution assumptions were provided, Student's t-test was used, and if not, the Mann-Whitney U test was examined. The Chi-Square test was used to examine the relationship between two qualitative variables. A value of $p<0.05$ was considered significant.

RESULTS

Data for all 56 patients were analyzed in this study. Demographic values and baseline airway assessments among the groups were similar (Table 1). The intubation success rate at the first attempt was 100% in the Macintosh Group, 92.9% in the C Mac D-Blade Group; this difference was not statistically significant, and all patients were intubated in the second attempt successfully. The mean intubation times were significantly shorter with C Mac D-Blade (21±9 and 41±7 seconds, respectively ($p<0.001$).

In this study, both devices provided excellent glottic visualization in pediatric patients within the same age group and with similar demographics who did not have predicted difficult airway, and Cormack-Lehane scores were similar (Table 1).

In both groups, when the heart rates compared with baseline values during laryngoscopy, 1st and 5th minutes of intubation, heart rate increased significantly ($p<0.05$), but these values were not significantly different at any time point between groups. There were also no significant differences in blood pressure, SpO_2 values between groups at any time point. Additionally, there was no need for optimizing maneuvers or mucosal trauma, lip or dental injury or desaturation in the two groups.

DISCUSSION

This study revealed that in pediatric patients with similar demographics, airway parameters and who did not have predicted difficult airway, C Mac D-Blade VL shortened intubation time about twice when compared to Macintosh blade (21.29±9.24 and 41.54±7.59 seconds, respectively).

The various kinds of VLs use a blade to retract the soft tissues and transmit a video image to a screen attached to the

Table 1. Demographic and airway parameters of patients

	C-Mac Group (n=28)	Macintosh Group (n=28)	p-value
Age (year)	5.86±3.41	5.75±3.62	0.644
Weight (kg)	22.89±9.29	19.79±7.89	0.183
Mallampati score, n (%)			
Class I	23 (82.1)	25 (89.3)	0.420
Class II	5 (17.9)	3 (10.7)	
Class III	0 (0.0)	0 (0.0)	
Class IV	0 (0.0)	0 (0.0)	
C-L score*, n (%)			
Class I	28 (100)	25 (89.3)	0.340
Class II	0 (0.0)	3 (10.7)	
Class III	0 (0.0)	0 (0.0)	
Class IV	0 (0.0)	0 (0.0)	
Thyromental distance (cm)	6.95 (6.50–7.00)	6.96 (6.50–7.00)	0.642
Sternomental distance (cm)	12.96 (12.50–13.00)	12.86 (12.50–13.00)	1.000

*C-L score: Cormack-Lehane score.

end of the handle or a monitor.[20–22] This design enables an illuminated view of the larynx without the direct 'line of sight' and can therefore help when a difficulty is encountered (or predicted) when using direct laryngoscopy.[22] During intubation with C Mac system, bringing phryngeal and laryngeal axes in same plan (no need to bring oral axes in same plan as in DL) is enough to visualize the glottis. This feature can make the glottic visualation easier in patients with limited neck extension and in whom the larynx is located more anteriorly as in pediatric patients.

Recently, published Cochrane metaanalysis (12 studies with 803 patients) revealed that in pediatric patients VLs improved glottic visualization but prolonged intubation time; 5.49 seconds (1.37 to 9.60, 95% CI) with a similar first attempt success rate.[32] Description of intubation time and experince of the intubator were different between studies in this metanalysis, so authors remarked the results with low-quality evidence due to heterogeneity of the included studies.

One of the first studies performed with C Mac D-Blade, in which intubators expereinced and patients were with normal airway, intubation time was median 15 (8–26) seconds which is very similar to our results.[36] In the same study, C Mac D-Blade was used as a rescue device in 20 patients with unanticipated difficult airway with C/L score of 3 and 4. C Mac D- Blade decreased C/L score 1–3 in all patients and intubation time was median 17 (3–80) seconds. Jain et al. conducted a study to compare direct (Macintosh and McCoy laryngoscopes; DLs) and indirect laryngoscopy (conventional C Mac and C Mac D-Blade, VLs) in a simulated cervical spine injury on manikins.[38] All performers were residents with different levels of experience in DL, but they had a short education before studying both VLs. Concerning the best glottic view, first attempt success rate and time for intubation were in favor of conventional C Mac VL compared to all the rest. Although C Mac D- Blade provided the best glottic imaging, the success rate of the first trial was lower than direct laryngoscopes and the duration of intubation was significantly longer compared to the others. This difference may be due to extra angulation of the C Mac D blade, which extended the intubation time and decreased the first attempt success rate of inexperienced users despite providing good imaging. Mulcaster et al. have found that people experienced in standard laryngoscopy must perform 47 successful intubations using videolaryngoscope to be considered experienced in VL.[39] In our study, the same investigator (KH) performed all laryngoscopies and intubations who was experienced DL and VL in pediatric patients and intubation time was by half with C Mac D-Blade (21±9 vs 41±7 seconds, ($p<0.001$).

In the study performed with pediatric mannequins, results revealed that experienced users' intubation times were significantly shorter than inexperienced intubators with all laryngoscopes (DL with Miller and Macintosh blades, VL with C Mac and Glidescope).[40] In this study, experience is defined as one with performance experience of pediatric endotracheal intubations for more than two years or intubation of more than 100 pediatric patients using DL, but no comment about VL experience.

Vlatten et al. have performed a study with 56 children and simulated difficult airway with cervical in line immobilization conducted by another investigator.[41] They compared GlideScope with Miller or Macintosh blade laryngoscopes by experienced intubators with both VL and DL. The mean (min-max) intubation times were 27 seconds for the VL and 21 seconds for the DL with Macintosh or Miller blade. Similarly, Serocki et al. have shown that in patients with anticipated difficult airway the intubation time was significantly longer with VLs when compared DL with Macintosh despite better glottic views.[42] Both VLs intubation success rate was 100%, whereas four patients could not be intubated by conventional DL. Sinha et al. conducted a randomized crossover study in simulated cervical spine injury in children to evaluate the efficacy of the CMAC size 2 D-Blade with the conventional CMAC size 2 Macintosh blade for ease of intubation.[43] All intubations were performed by experienced anesthesiologists. The blade insertion was significantly difficult and the glottic view was significantly better in D blade group. The time for intubation was comparable between the groups. These results suggest that as experience of the intubator with VLs increases, possibly due to the use of less power and manipulation for better visualisation and additionally larger images on the screen allows successful intubation in a short time, even in patients with a difficult airway.

Traditionally, VLs have been brought to use as an alternative to direct laryngoscopy in patient groups with a predicted difficult airway, particularly in preoperative evaluations. Nowadays, VLs are more often used in daily practice instead of conventional laryngoscopes, teaching purposes and rescue devices in the unanticipated and difficult airways in operating rooms, ICUs and emergency departments.[17,18,35,36,39] In our study, no difference was detected between both laryngoscopes concerning intubation success and complications, but intubation time was significantly shortened by half with C Mac D-Blade VL in pediatric patients. Given that the metabolic rate and oxygen consumption are higher and oxygen reserve is lower in children and especially in neonates than the adults, successful and non-traumatic intubation performed within a short time is very important for patient safety. This can also be vital for adult and pediatric patients with the poor overall condition and requiring emergency intubation in the operating room or at the ICU, prehospital setting and emergency departments. Airway management in ICU and emergency circumstances is more challenging and difficult intubation; and related complications are more often due to inadequate patient positioning, place constraints and comorbidities of the patient. Additionally, prolonged intubation process and repeated intubation attempts increases the risk of complications.[8,14]

It is essential for anesthesiologists and other clinicians who may need to intubate patients in their daily practice should gain experience with different laryngoscopes, including VLs and blades. This will significantly contribute to the management of patients with difficult airway in particular, as well as other critically ill patients.

There are some limitations to this study. Firstly, we did not compare different VLs and blades. Secondly, this comparison should be also made in different patient populations, including patients with difficult airways. Lastly, in our study, the person who performed intubations was experienced with both laryngoscopes, so our results cannot be generalized to all performers.

Conclusion

In conclusion, this study demonstrated that C Mac D-Blade videolaryngoscope provided shorter intubation time in pediatric patients than DL by Macintosh blade with similar success rate and it can be used confidently in pediatric patients.

Ethics Committee Approval: This study approved by the Ankara University Clinical Research Ethics Committee (Date: 21.10.2016, Decision No: 19-955-16).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Pediatrik hastalarda C-MAC D-Blade videolaringoskop ve direkt laringoskopinin karşılaştırılması: Randomize kontrollü çalışma

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AMAÇ: Endotrakeal entübasyon klinisyenler için önemli bir beceridir ve bazı hastalarda çeşitli nedenlerden dolayı zor olabilir. Günümüzde çeşitli tiplerde videolaringoskoplar mevcuttur ve genellikle direkt laringoskopi başarısız olduğunda kurtarma cihazı olarak kullanılmaktadır. Pediatrik hava yolunun; yetişkinlerle karşılaştırıldığında bazı farklılıkları vardır ve bunlar zorlayıcı olabilir. Bu çalışmanın amacı pediyatrik hastalarda C-Mac D-Blade ve yaygın olarak kullanılan Macintosh laringoskopu karşılaştırmak ve değerlendirmektir.

GEREÇ VE YÖNTEM: Etik kurul onayı ve ebeveynlerden bilgilendirilmiş onam sonrası, elektif cerrahi geçirecek ve endotrakeal entübasyon gereksinimi olan 5–10 yaş arası (10–40 kg) toplam 56 pediatrik hasta çalışmaya dahil edildi. Hastalar Macintosh laringoskop veya C-Mac D-Blade videolaringoskop ile laringoskopi ve entübasyon için eşit iki gruba randomize edildi. Glottik görünüm, girişim sayısı, entübasyon süresi, herhangi bir komplikasyon ve hemodinamik veriler kaydedildi. İstatistiksel anlamlılık düzeyi $p<0.05$ olarak kabul edildi.

BULGULAR: Zor hava yolu beklenmeyen pediyatrik hastalarda; ortalama entübasyon süresi C-Mac D-Blade ile anlamlı olarak daha kısaydı (21±9 ve 41±7 saniye, sırasıyla) ($p<0.001$). İki grubun sonuçları geri kalan parametreler açısından benzerdi.

TARTIŞMA: Mac D-Blade videolaringoskop, güvenli bir şekilde ve benzer bir başarı oranı ile Macintosh Blade'e kıyasla entübasyon süresini yaklaşık iki kat kısalttı. Videolaringoskoplar rutin entübasyon, eğitim ve zor entübasyon için bir kurtarma cihazı için iyi bir alternatif olabilir.

Anahtar sözcükler: Endotrakeal entübasyon; pediatrik hasta; videolaringoskopi.

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