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Comparison of direct and video laryngoscope endotracheal intubations by pediatric residents: A study of a child model with normal airway

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What is already known on this topic?

- *Video laryncoscope is primarily recommended in cases where a difficult airway is considered.*
- *When endotracheal intubations of patients with normal airways were performed by experienced physicians, no difference was found between standard direct laryngoscopy and videolaryngoscopy in terms of intubation success.*

What this study adds on this topic?

- *There is a very limited number of studies in the literature among pediatricians, especially in pediatricians who have never used a video laryngoscope and have limited endotracheal intubation experience.*
- *Residents in pediatrics with limited experience in endotracheal intubation use the videolaryngoscope more effectively than the standard direct laryngoscope after appropriate training.*

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ABSTRACT

Objective: This study aimed to compare the efficacy of direct and videolaryngoscopy procedures performed by pediatric residents who had limited experience of direct endotracheal intubation and had not previously used video laryngoscopes in a normal airway child manikin.

Material and Methods: The endotracheal intubations performed by pediatric residents with a direct laryngoscope and Storz C-MAC videolaryngoscope on a pediatric manikin with a normal airway were compared. Theoretical and practical training was given before the study. In the first attempt, the success of the intubation procedure, glottis visual duration, and endotracheal tube insertion time were determined. Practitioners grouped the glottis image between 1-4 according to the Cormack-Lehane Staging (Stage 1 ideal image). After the intervention, the participants scored one to ten points on direct and videolaryngoscopy (1 not useful, 10 very useful).

Results: The success of direct and videolaryngoscopy of 51 pediatric residents on the same manikin was 48 out of 51 (94%) for each method ($P > 0.05$). Glottis visual duration was similar in both methods ($P > 0.05$); tube insertion and total intubation time were shorter in the video laryngoscope group ($P < 0.05$); glottis image was better in the video laryngoscope group according to Cormack-Lehane Classification ($P < 0.05$). Participants' rating was higher on videolaryngoscope ($P < 0.05$).

Conclusion: Users with limited endotracheal intubation experience use Video laryncoscope more effectively than direct laryngoscope in children with normal airway model after training.

Keywords: Child, direct laryngoscope, endotracheal intubation, Video laryncoscope

Introduction

Endotracheal intubation (EI) is an essential part of advanced life support. It is applied in sudden clinical situations such as cardiopulmonary arrest or pre-foreseen clinical situations such as rapid sequential intubation, planned intubation in operating room conditions. After the discovery of the Macintosh and Miller type laryngoscope blades in the 1940s, direct laryngoscopy has been accepted as the "gold standard" in endotracheal intubation (1-3). video laryngoscope is produced by adding video and optical technologies to the standard direct laryngoscope. Intubation with a video laryngoscope is called indirect endotracheal intubation. These devices are specially designed for difficult airway situations where the risk of unsuccessful intubation or prolongation of the intubation procedure is high (4,5).

The most important complication of endotracheal intubation is hypoxemia. Prolonged intubation time or accidental insertion of the endotracheal tube into the esophagus may cause

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ischemic brain damage due to hypoxemia (6,7). The effectiveness and success of video laryngoscopy in reducing complications in children with normal airways is controversial. Clinical trials have often been conducted under pediatric anesthetic conditions (5,8).

We hypothesize that in children with normal airways, the video laryngoscope is more effective than the standard direct laryngoscope in the hands of users with limited experience. This study, after theoretical and practical training, it was aimed to compare the effectiveness of standard direct laryngoscopy and video laryngoscopy procedures performed by residents in pediatrics who had never used a video laryngoscope before in a pediatric manikin with the normal airway.

Materials and Methods

The study was conducted in the Izmir Tepecik Training and Research Hospital, Department of Pediatrics. Residents in pediatrics were included in the study voluntarily. Those who did not want to participate in the study and those with health problems during the study were excluded from the study.

Figure 1. Endotracheal intubation with a direct laryngoscope

A standard training model simulating the head of a 5-year-old child head size (Life/form® Child Airway Management Trainer with Stand, Product Code: LF03609, Nasco-Simulaids, Wisconsin, USA) was used for the endotracheal intubation procedure.

Two different ways were compared in intubation: 1. Direct laryngoscopy (standard laryngoscope handle, Macintosh 2 curved blade, plusMED, Istanbul, Turkey) (Figure 1). 2.Video (indirect) Laryngoscopy (C-MAC PM® Video laryngoscope, Macintosh 2 curved blade, Karl Storz GmbH & Co. KG Tuttlingen, Germany) (Figure 2). Uncuffed endotracheal tubes having an inner diameter of 5 mm with inserted stylets (plusMED, Istanbul, Turkey) were used in both types of intubation. Ventilation was performed with a pediatric balloon mask after intubation (Ambu® Resuscitator Pediatric, balloon volume 635 ml, Ambu A/S, Ballerup, Denmark).

Participants' seniority (in months), their intubation training, their experience of performing endotracheal intubation on real patients up to that time, and whether they had used a video laryngoscope before were recorded. A 30-minute theoretical training was given on endotracheal intubation with a PowerPoint presentation. Then, the project was explained with an additional 15-minute presentation. The presentations were made by the same instructor. Direct and indirect laryngoscopy were demonstrated on a model by an instructor. Practical training was given to all participants by the same two trainers. Participants had practical training until they had at least one successful intubation with both methods.

The study was initiated after the training. In turn, each participant was asked to perform endotracheal intubation using a direct laryngoscope once on the model they trained, and once using a video laryngoscope. The residents were given a five-minute break between each attempt. At this stage, oth-

Figure 2. Indirect endotracheal intubation with a video laryngoscope

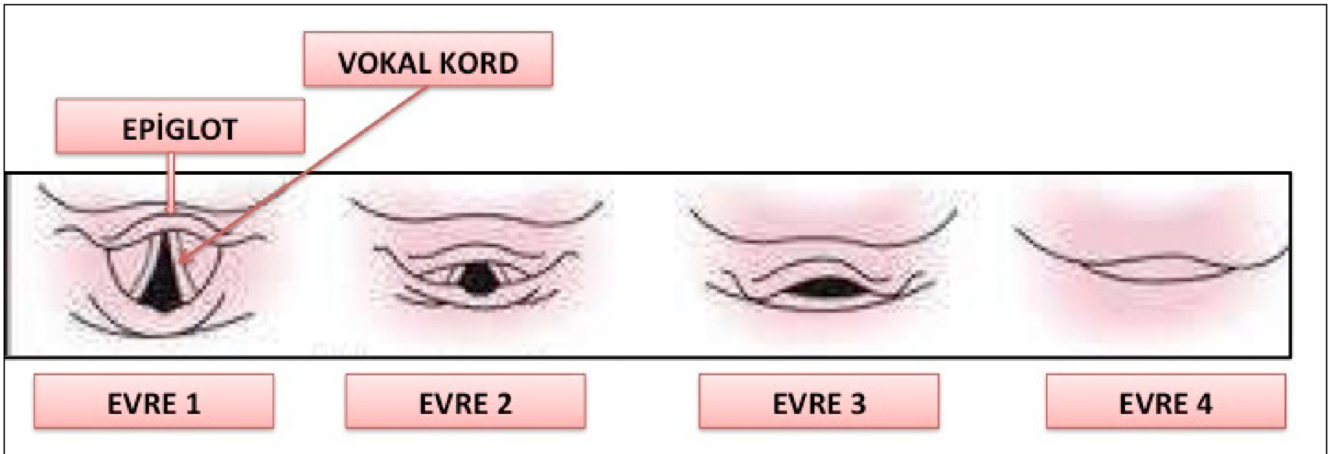

Figure 3. Cormack - Lehane classification

er participants were not allowed to follow the attempts. The duration of all procedures was determined by an instructor with a stopwatch and another trainer recorded the times. After the intubation procedure, ventilation of the lungs with a balloon mask was considered a "successful attempt" (even if one lung was ventilated). The attempt time was limited to 60 seconds and one attempt. Those who could not perform "lung ventilation" within 60 seconds were considered unsuccessful. The intubation attempt started with the sign of the instructor who determined the time with the stopwatch. When the participant saw the glottis, he called out loud "glottis", the stopwatch was stopped, and this time was recorded (glottis visualization time). Then the time was restarted. When the participant inserted the endotracheal tube, he called it "OK" and the stopwatch was stopped to determine the "endotracheal tube insertion time". Accordingly, "total intervention time = glottis visualization time + endotracheal tube insertion time" was calculated. After each procedure, the practitioner was asked to classify the glottis image in direct and indirect laryngoscopes according to Cormack-Lehane Grading. According to this classification, image quality was divided into four stages: Grade 1: A full view of Glottis (ideal viewing angle). Grade 2: Partial view of the glottis. Grade 3: Only the epiglottis is visible. Grade 4: Neither glottis nor epiglottis visible (Figure 3) (9). After the interventions were completed, the participant scored between one and ten points for direct and video laryngoscopy in terms of ease of use (1 not useful at all, 10 very useful).

Approval for the study was obtained from the non-invasive clinical research ethics committee (Date: 24.03.2020; No: 2020/08). Ethics committee approval was received from İzmir Katip Çelebi University, School of Medicine Ethics Committee and the study was conducted in accordance with Helsinki Declaration.

Statistical Analysis

The time measurements of the participants in endotracheal intubation performed by direct and video laryngoscopes, successful intubation rates, and the appreciation points of the participants for the methods were compared in the statistical analysis. Categorical data in the two dependent groups were expressed as number (n) and percentage (%) and analyzed using the McNemar's Test. Numerical data are expressed as the median and interquartile range (IQR) as the data do not conform to normal distribution. The Wilcoxon test was used in the analysis of the two dependent groups. A $P<0.05$ was considered statistically significant. Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM SPSS Corp.; Armonk, NY, USA) was used.

Results

A total of 51 residents (mean age: 28±2.3; maximum: 33-minimum: 25; 38 F/13 M) participated in the study. The median time (seniority period) they spent in the Department of Pediatrics was 21 months (IQR: 12-36; minimum: 1; maximum: 49). All residents had intubated at least once on a manikin directly with a laryngoscope during their training. There were 16 residents (31.4%) who did not perform endotracheal intubation in the real case. A total of 23 residents (22.5%) had a prior Neonatal Resuscitation Program (NRP) course, 16 (15.7%) had received advanced life support (PALS) training in children. None of the residents had used a video laryngoscope before this study. Direct laryngoscope and video laryngoscope interventions of pediatric residents were compared. When the glottis visualization at intubation was evaluated according to the Cormack-Lehane classification, Grade-1 was detected by 26 (51%), Grade-2 by 24 (47%), and Grade-3 by 1 (2%) in the direct laryngoscope. Grade-1 view was obtained by 44 residents (86.3%) and Grade-2 by 7 (13.7%) in the video laryngoscope (P:0.001). The median time for endotracheal tube insertion was measured as 8 seconds in direct laryngoscopy and 6 seconds in video laryngoscopy (P: 0.028). The median of the total intervention time was 16 and 12 seconds in direct and video laryngoscopy, respectively (P:0.035). 48 (94.1%) of 51 attempts were successful in both methods ($P>0.999$). Practitioners' median score for liking the device was 6 for direct laryngoscope and 8 for video laryngoscope ($P<0.001$) (Table 1).

Six different residents were unsuccessful in endotracheal intubations with direct and video laryngoscopes. These six participants were different from each other. No participant failed an intubation attempt with both direct and video laryngoscopes (Table 2).

Table 1. Comparison of the endotracheal intubation procedures performed by 51 participants in total with direct and video laryngoscopes on a model

Intubation parameters	Direct Laryngoscope	Video Laryngoscope	*P*
Glottis visionalisation time, seconds Median (IQR)	5 (2.8-10)	5 (3.4-7.9)	0.5661
Tube insertion time, seconds Median (IQR)	8 (6-12)	6 (5-10)	0.0281
Total intervention time, seconds Median (IQR)	16 (10-20)	12 (9-20)	0.0351
Cormack-Lehane Classification, n (%)			
Grade 1	26 (51)	44 (86.3)	0.0012
Grade 2-4	25 (49)	7 (13.7)	
Successful intubation, n (%)	48 (94.1)	48 (94.1)	>0.999
The score given by the participants to the device, Median (IQR)	6 (5-8)	8 (8-10)	0.0071

IQR: inter quartile range; 1: Wilcoxon Testi; 2: McNemar's Test

Table 2. Characteristics of 6 different residents who failed direct and video laryngoscopy

	Failed in Direct Laryngoscope			Failed in Video Laryngoscope		
Participant features	**Participant 1**	**Participant 2**	**Participant 3**	**Participant 4**	**Participant 5**	**Participant 6**
Seniority	13	2	42	14	22	34
Gender	M	F	F	F	F	F
Neonatal intubation in real case	NO	NO	YES	YES	YES	YES
Child intubation in the real case	YES	NO	YES	NO	YES	YES
NRP Course	NO	NO	YES	YES	NO	YES
PALS Course	NO	NO	YES	NO	YES	NO

NRP: neonatal resuscitation program; PALS: pediatric advanced life support

Discussion

The efficacy of endotracheal intubation interventions performed by child health and diseases residents with standard direct and video laryngoscope on a child model with normal airway was compared. Pediatric residents, who had never used a video laryngoscope before and had limited intubation experience, performed 94% successful intubation in both direct laryngoscopy and Videolarygoscopy after a standard training. Users achieved better glottis view and shorter intubation time with video laryngoscopy. Video laryngoscope is more appreciated by users than standard direct laryngoscope.

The purpose of endotracheal intubation is to place the endotracheal tube into the trachea in the shortest time and at the first attempt, without damaging the airway. The critical stage of this intervention is to obtain the ideal glottis view as soon as possible. Hypoxemia is the most important complication of intubation as it increases the risk of ischemic brain damage and mortality. Endotracheal intubation time is 30 seconds or longer is the most important risk factor in the development of hypoxemia. Complications are seen much less in intubation performed in a short time and at the first attempt (6,7). In studies conducted by experienced pediatric anesthesiologists, direct and video laryngoscopes were compared in children with normal airways; although the video laryngoscope provides a better view, the duration of the intervention is shorter in direct laryngoscopy, and the intubation success is similar in both methods. (10-13). The number of studies conducted in the pediatric emergency department is extremely limited. Eisenberg et al. (14) compared the results of 240 direct laryngoscopy and 199 Videolarygoscopy interventions on real patients over 10 years in the pediatric emergency department. The intubation success rate at the first attempt was 71% and 72% in direct and video laryngoscopies, respectively, and there was no difference between complication rates. However, parameters such as intubation times and glottis view quality could not be analyzed in this retrospective study (14). In intubations performed by child health and diseases residents on three different sizes of models, the success of intubation in newborn and infant models was similar in direct and video laryngoscopies. Videolarygoscopy success was found to be higher in adult model intubation. It has been stated that the glottis view obtained with video laryngoscope is better than direct laryngoscopy in all model types (15). We believe that hand-eye coordination, practical training, and a certain number of patient experiences are necessary for a successful, safe, and fast endotracheal intubation intervention. It was observed in our study that pediatric residents, who had no previous experience of a video laryngoscope and had limited direct laryngoscopy experience, used the video laryngoscope at least as effective as the direct laryngoscope on a child model with normal airway after theoretical and practical training. Also, a better glottis view was obtained with the video laryngoscope and the intubation time was shortened. These results suggest that video laryngoscope may also be an effective option in children with normal airways. When we collate the literature with our own experiences, we think that the advantages of the video laryngoscope in the hands of people experienced in endotracheal intubation, such as anesthesiologists, cannot be revealed, especially in children with normal airways. In these patients, experienced users can use a direct laryngoscope much faster, although they can obtain better views with a video laryngoscope. Using a video laryngoscope does not increase the success and prolongs the procedure time. However, conditions vary in users with limited intubation experience, such as pediatric residents working in the pediatric emergency department. Pediatrics residents obtain good views with the video laryngoscope and perform intubation easily and quickly following the training. Although the success rates are similar, we think that a shorter duration will decrease the risk of hypoxemia in the real patient. In conclusion, we think that videolaryngoscopy may be the first choice in pediatric patients with normal airway, especially in emergency room conditions where physicians with limited experience are working, after the necessary training is provided. The biggest obstacles to this view are the opposing views of the physicians with high intubation experience and the price of video laryngoscopes.

It is thought that videolaryngoscopy is an effective method in terms of education, especially during the first intubation training, and the experienced trainer guides the practitioner better when the intervention is performed on the real patient. It was observed that the trainees who had their first training with a video laryngoscope used the standard direct laryngoscope easily at a later time. For this reason, it is thought that the first intubation training of young physicians should be done with a video laryngoscope, if possible (16,17). In our study, following approximately half an hour of theoretical training, one-on-one video laryngoscope and standard direct laryngoscopy training were given by the trainers. We think that the result we obtained during the study shows the benefit of training with a video laryngoscope. It is also an important result that the participants liked the video laryngoscope more than the direct laryngoscope. Although we do not make a standard measurement, we think that the reason for this appreciation and success is that they give their body a more comfortable position during video laryngoscopy, they can see the glottis easily and completely, and they can easily direct the endotracheal tube to the glottis.

Coronavirus disease (COVID-19) is a highly contagious infectious disease linked to SARS-CoV-2, a newly discovered coronavirus. It started for the first time in Wuhan, China in December 2019 and was declared as a pandemic by the World Health Organization in March 2020. The disease is transmitted by droplets. Especially during aerosol-generating medical procedures such as intubation, the risk of infection to healthcare personnel is very high. Therefore, it is recommended that patients who are thought to have COVID-19 should be intubated with a video laryngoscope, if possible (18-20). In our study, as can be seen very clearly in Figures 1 and 2, the face of the person performing the intubation during the video laryngoscopy procedure is located at a greater distance from the patient model's face compared to direct laryngoscopy. This feature of the video laryngoscope reduces the risk of infection to healthcare personnel. The importance of the video laryngoscope has increased as the world struggles with the COVID-19 pandemic.

The most important limitation of the study is that it is a manikin study. The ideal is to observe the results obtained on the real case, to record and analyze the intubation time, success rate, and adverse events that may develop, especially hypoxemia. However, we think it is important to compare two different intubation techniques performed in the same model with normal airway after giving standard training to young pediatricians. In the literature, studies in this sense were mainly performed by anesthesiologists on adult models or patients with difficult airways. There are very few studies in the literature evaluating the video laryngoscopy procedure performed by pediatric residents in a child model with a normal airway. Therefore, our study highlights video laryngoscopy as the first method of choice in pediatric intubation with normal airway for inexperienced physicians. As a result, users with limited endotracheal intubation experience can use video laryngoscope more effectively than direct laryngoscope in a child model with normal airway following training. Video laryngoscope is more appreciated by young physicians. However, patient studies are needed for video laryngoscopy to be the first method of choice for intubation performed by users with limited experience in children with the normal airway.

Ethical Committee Approval: Ethical committee approval was received for this study from the ethics committee of İzmir Katip Çelebi University, School of Medicine (Date: March 24, 2020; No: 2020/08).

Informed Consent: Verbal and written consent was obtained from the research participants.

Peer-review: Externally peer-reviewed.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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