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Research Article

A Comparative Study of Video Laryngoscopy to Direct Laryngoscopy for Endotracheal Intubation in Pediatric Patients

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Abstract

Background: Direct laryngoscopy is the standard method for intubation in pediatric patients. The introduction of video laryngoscopy brought a paradigm shift in managing pediatric airways.
Objectives: We compared the tracheal intubation technique between direct and video laryngoscopy with McIntosh Blade 2 in pediatric patients 2 - 8 years of age requiring airway management. The glottic view and the first pass success rate were compared and analyzed.
Methods: An observational cross-sectional study was conducted with 120 children between 2 - 8 years with normal airways. They were divided into video laryngoscopy (Group V) and direct laryngoscopy (Group D). The primary outcome measures included time taken for intubation, number of attempts required, Cormack-Lehane glottic view, use of optimization maneuvers, the requirement of tube repositioning, and hemodynamic parameters before and after intubation.
Results: The time taken for intubation was longer in the video laryngoscopy group (group D, 24.28 sec vs. group V, 27.65 seconds ($P = 0.01$). The Cormack-Lehane glottic view was grade 1 in all the patients in the video laryngoscopy group, while only 35 children showed grade 1 in the direct laryngoscopy group. ($P < 0.001$). We observed a significant increase in both heart rate and mean arterial pressure in the video laryngoscopy group at 1, 3, 5, and 10 min after intubation (($P < 0.001$, $P < 0.05$).
Conclusions: The time taken for intubation was more in group V, but the glottic view was much better, and the requirement for external maneuvers was also less. Pressure response to intubation was more in group V compared to group D.

Keywords: Hemodynamics, Intubation, Video-Laryngoscopy, Direct Laryngoscopy

1. Background

Securing an airway in children is a challenging task for an anesthesiologist. Pediatric and neonatal anatomy differs from adult anatomy in multiple significant ways, making intubation of a pediatric or neonatal patient a unique challenge for medical and paramedical personnel. The proportionally larger tongue and smaller, more anterior airways of infants and young children can lead to obstruction and make visualization of the airway more difficult. This greatly impacts the tools and techniques the anesthetists might choose to provide a better view of the airway, and it all poses a great challenge (1). Endotracheal intubation is one of the most common techniques used in the operating room, emergency department, and intensive care unit to secure the patient's airway. Direct laryngoscopy is considered the gold standard, which provides visualization of the vocal cords after lifting the epiglottis with a curved blade. However, newer laryngoscopy techniques have evolved with time and proven to be more effective (2).

Video laryngoscopy is one of the latest technologies which uses a camera attached to the tip of the blade and aids in projecting an external view of the airway onto the screen. The video laryngoscopy provides an anterior view of the glottis and a wider field of vision of the larynx more clearly (3). Intubation through direct laryngoscopy needs alignment of the oral, pharyngeal, and laryngeal axis, which may be a problem for the anesthetist in difficult airway scenarios, where a video laryngoscope can be used as it does not require alignment (4).Video laryngoscopy provides a better glottic view, which is of high resolution compared to direct laryngoscopy (5). So, assistants can also view the image and coordinate easily with the operator (6). It can be used as an excellent teaching tool for residents during postgraduation training under the supervision of an experienced anesthetist (7).

There are various advantages and disadvantages of video laryngoscopes. Video laryngoscopy can be used in difficult airway scenarios as part of the teaching curriculum for emergency and pediatric intensive care unit students. Disadvantages are difficulty passing the endotracheal tube despite a clear glottic view, obscured view because of fogging and secretions on the camera lens, and varying learning curves for non-experienced trainees (8).

Evidence also shows that difficult laryngoscopy (Cormack Lehane grade 3) incidence is 4.7% among infants compared to 0.7% among older children (9, 10). Desaturation is also rapid in the pediatric age group. So, video laryngoscopy may reduce such incidents with an improved glottic view. Thorough knowledge of anesthesia in the pediatric age group and proper monitoring is required to avoid such complications during residential training (10).

2. Objectives

We hypothesized that video laryngoscopy could provide a better laryngeal view in pediatric patients as in the case of adults. In this study, we primarily wanted to observe and compare the success of first-attempt tracheal intubation between direct laryngoscopy and video laryngoscopy with McIntosh Blade 2 in pediatric patients of the 2 - 8 years age group. The secondary objectives of this study are to determine the time taken for intubation, laryngeal view during intubation, the number of attempts required, the need for any external maneuvers, tube repositioning, and hemodynamic response after intubation.

3. Methods

An observational cross-sectional study was conducted with 120 children aged 2 - 8 years with normal airways in a tertiary care training center between June 2021 and October 2022. A convenience sampling method with Single blinding was carried out, and all the participants were blinded. The study was approved by the Institutional Ethics Committee (IEC KMC MLR 12-2020/388), and written informed consent was obtained from the parent or legal guardian of the children. This study was done by final-year residents well-versed in direct and video laryngoscopic intubations. Pediatric patients of age between 2 - 8 years who needed airway management and underwent elective surgery under general anesthesia were included in this study. Patients with abnormal airway anatomy, obese patients, emergency surgery, and congenital syndrome involving any major organs were excluded from the study group. All patients have undergone thorough preanesthetic evaluation and investigations as per protocol. The patients were assigned into 2 groups-

Group D – Patient intubated with direct laryngoscope with 2-sized McIntosh blade

Group V – Patients intubated with Medscope® pediatric video laryngoscope with 2-sized McIntosh blade

Patients were shifted to a pre-operative room, a eutectic mixture of local anesthetic cream was applied to their hands, and the cannula was secured. Premedication was done with midazolam 0.02 mg/kg. The patient was shifted to the operating room and placed in a sniffing position using a donut-shaped jelly ring. Regular monitors were connected in the operation theatre, including an electrocardiogram, noninvasive blood pressure, and pulse oximetry. Preoxygenation was given with 100% oxygen. Induction of anesthesia was done with 2 mcg/kg fentanyl and propofol 2 mg/kg. After attaining an adequate depth of anesthesia, assisted ventilation was checked, and 0.5 mg/kg of atracurium was given intravenously. In the meantime, a suitable endotracheal tube was chosen and kept ready. Intubation was performed using a direct or video laryngoscope with a (Macintosh) blade 2. Intubation times were recorded from the beginning of insertion of the blade in the oral cavity until lung inflation was attained through the endotracheal tube and end-tidal carbon dioxide waveform confirmation. Auscultation was done to confirm bilateral air entry and tube repositioning was done accordingly if required. Cormack-Lehane grading was used to assess the glottis view for passage of the endotracheal tube. External maneuvers were done if there was any difficulty in visualizing the glottis. Any changes in heart rate, mean arterial pressure and saturation from baseline were noted after intubation at 1 min, 3 min, 5 min, and 10 min. Monitoring is done throughout the procedure. Maintenance of anesthesia was given by oxygen: nitrous oxide 1:1 and sevoflurane 1-2% to maintain an exhaled minimum alveolar concentration of 1.0. After surgery, the patient was extubated, fully awake, and shifted with stable vitals to the post-anesthesia care unit.

3.1. Sample Size and Statistical Analysis

SPSS software version 25.0 (IBM) was used to analyze the data after it was entered into Microsoft Excel. Descriptive statistics were reported. Frequency, the percentage for all the qualitative variables involved in the study, mean, standard deviation/median, and Interquartile range for quantitative variables. Inferential statistics: student t-test for the time taken for intubation, chi-square test for the number of attempts required for intubation, Mann-Whitney test for Cormack and Lehane grading between group D and group V. Sample size is calculated using the formula:

$$n = \frac{2\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{\alpha^2}$$

d = clinically significant difference = 13

σ = pooled statement deviation = 27.2

$Z_{1-\frac{\alpha}{2}}$ = 1.96 is a standard normal value at a 5% level of significance

$Z_{1-\beta}$ = 0.84 is a standard normal value of 80% power

Each group = 60 participants

Total sample size = 120, considering a mean difference of intubation time between direct and video laryngoscopy as 10 seconds with 80% power and 99% confidence interval the calculated sample size for the study was 120 (60 in each group).

4. Results

We recruited 60 patients each in Group D and Group V. The mean (± SD) age was 5 (± 2) years in Group D and 5.04 (± 1.91) years in Group V. There was no difference in age between the two groups (P = 0.90). Out of 60 patients in group D, more than half of them, 34 (56.7%), were males, and 26 (43.3%) were females. In group V, nearly two-thirds, 39 (65.0%), were males, and the rest of the 21 (35%) were females. There was no significant difference in gender between the groups, with a P-value of 0.87.

The mean (SD) time taken for intubation in direct laryngoscopy was 24.28 (± 5.0) seconds and 27.65 (± 8.6) seconds in the video group (Table 1). The time taken for intubation was 3.37 seconds higher in the video group compared to direct laryngoscopy. The difference in time taken for intubation between the groups was significant, with a P-value of 0.01. Out of 60 patients in group D, the majority, 59 (98.3%), required one attempt, and only one patient required two attempts for intubation.

In group V, all the patients had only one attempt. In group D, more than half of them that is 35 (58.3%), belonged to CL grade I and 24 (40%) belonged to grade II, and one patient (1.7%) to grade III. In group V, all the patients belonged to grade I. There was a significant difference in CL grading between the direct and video laryngoscopy group, with a P-value of < 0.001. The requirement of external maneuvers was comparatively high in the direct group when compared to the video laryngoscopy group (35% Vs. 0%) with a P-value of < 0.001 (Table 1). The proportion required repositioning was comparatively higher in group D than in group V (25% Vs. 6.7%) with a P-value of 0.006 (Table 1). There was no dental trauma or esophageal intubation noted in both groups.

Heart rate and mean arterial pressure were significantly increased at 1 min, 3 min, 5 min, and 10 min after intubation with video laryngoscope (Table 2).

Table 1. Comparison of Outcomes in Direct Laryngoscopy and Video Laryngoscopy Among Patients[a]

Outcomes	DL	VL	P-Value
Time to successful intubation*, sec	24.28 ± 5.0	27.65 ± 8.6	0.01
Number of attempts			NS
1	59 (98.3)	60 (100)	
2 or more	1 (1.7)	0	
Use of optimization maneuvers	21 (35)	-	< 0.001
Tube Repositioning	15 (25)	-	< 0.001
Cormack and Lehane glottic view			< 0.001
I	35 (58.3)	60 (100)	
II	24 (40)	0(0)	
III	1 (1.7)	0 (0)	

[a] Values are expressed as mean ± SD or No. (%).

5. Discussion

Anesthetists often encounter respiratory and airway complications during pediatric anesthesia, increasing morbidity and mortality. Interestingly, this is encountered in healthy and sick children, infants, and neonates (10). The anatomy of the pediatric airway differs from that of adults (higher placed larynx, larger occiput, larger tongue, depressed epiglottis, and a concave vocal cord). Hence, thorough knowledge of the anatomy and physiology of the pediatric airway is important before intubation (11, 12). Additionally, the functional residual capacity is lower, and oxygen consumption is higher in pediatric patients than in adults. These may cause hypoxemia, bradycardia, intensive care unit (ICU) admission, and death.

It was earlier shown that video laryngoscopy takes longer than direct laryngoscopy in children. Kim et al. have shown that the mean time for tracheal intubation was 36.0 ± 17.9 s in the video laryngoscopy group and 23.8 ± 13.9 s in the direct laryngoscopy group (P < 0.001) (13). Our study correlates with this regarding more time for intubation in video laryngoscopy (27.65 v 24.28, P = 0.01). In another study by Fiadjoe et al., video laryngoscopy was compared to direct laryngoscopy in the pediatric simulator in terms of intubation time. There were no differences in time for intubation with video laryngoscopy or direct laryngoscopy (61.4 vs. 67.4 s) or number of successful intubations (19 vs. 18). Also, in the difficult airway scenario, it took longer to intubate with video laryngoscopy than direct laryngoscopy (87.7 vs. 61.3 s, P < 0.05) (14).

Cormack-Lehane grading is commonly used to describe the laryngeal view. Fiadjoe et al. compared laryngeal view in children following direct and video laryngoscopes.

Table 2. Comparison of Mean Values of Parameters in Direct Laryngoscopy and Video Laryngoscopy Among Patients [a]

Parameter	Direct Laryngoscopy	Video Laryngoscopy	P-Value
Before induction			
Heart rate, beats per min	98.3 ± 11.7	101.4 ± 8.1	0.1
MAP, mmHg	70.2 ± 5.4	68.6 ± 6.1	0.1
SPO_2, %	100	100	-
At 1 min after intubation			
Heart rate, beats per min	96.9 ± 12.2	107.8 ± 13.5	< 0.001
MAP, mmHg	70.1 ± 4.6	72.6 ± 4.5	0.003
SPO_2, %	100	100	-
At 3 min after intubation			
Heart rate, beats per min	95.9 ± 10.4	105.8 ± 13.3	< 0.001
MAP, mmHg	69.6 ± 3.9	72.5 ± 5.6	0.001
SPO_2, %	100	100	-
At 5 min after intubation			
Heart rate, beats per min	95.8 ± 10.4	104.6 ± 14.4	< 0.001
MAP, mmHg	69.5 ± 3.9	72.6 ± 5.7	0.001
SPO_2, %	100	100	-
At 10 min after intubation			
Heart rate, beats per min	93.4 ± 10.2	103.6 ± 14.9	< 0.001
MAP, mmHg	69.4 ± 3.6	72.7 ± 6.5	0.001
SPO_2, %	100	100	-

[a] Values are expressed as mean ± SD unless otherwise indicated.

It was found that video laryngoscopy improved the view in patients more than direct laryngoscopy ($P < 0.05$) (14). These results are similar to our study's with $P < 0.001$. Vanderhal et al. showed an improved anatomic view in pediatric patients with video laryngoscopy compared to direct laryngoscopy (15).

The number of intubation attempts is directly proportional to morbidity resulting from airway-related complications. It has been recommended to limit the number of intubations in pediatric patients to 2-to-3, provided that an experienced anesthetist should ideally perform the second or third attempt. Ensuring a clear line of sight between the laryngeal inlet and the anesthetist's eyes is essential for successful endotracheal intubation in children. Because of all these reasons, difficulties are encountered during intubation in children. Modern equipment, including pediatric indirect video laryngoscopes, has obviated the need for eye alignment and has reduced the failure rate in pediatric intubation (16). Nowadays, video laryngoscopes are more commonly used than traditional direct laryngoscopes, although video laryngoscopes were originally brought to use as an alternative to direct laryngoscopy in patients with anticipated difficult airways only. Garcia-Marcinkiewicz et al. aimed to investigate whether video laryngoscopy with a standard blade improves the first-attempt success rate of orotracheal intubation and reduces the risk of complications compared to direct laryngoscopy. In the video laryngoscopy group, 254 (93%) infants were successfully intubated in the first attempt compared to 244 (88%) in the direct laryngoscopy group ($P = 0.024$) (17). However, in our study, 59 patients (98.3%) were intubated in one attempt with direct laryngoscopy and 60 patients (100%) with video laryngoscopy.

Repositioning of the tube is required if ETT is accidentally deep-inserted during intubation. Endobronchial intubation is one of the most commonly seen complications because of this. It can be identified by auscultation of the chest bilaterally or through chest X-rays. Pinheiro and Munshi (18) have shown that many neonatologists were uncertain about the vocal cord markings on ETT and that the deep intubation frequency was estimated at greater than 5% by 39% of respondents. Our study has shown that there was a requirement of repositioning by 25% in group D. In contrast, group V did not require any, as the markings on the endotracheal tube were visible through video laryngoscopy.

The requirement for airway maneuvers is to provide a better laryngeal view for the passage of the endotracheal tube. They are used when a suboptimal laryngeal view or resistance to ETT passage exists. The requirement for additional maneuvers (33 v 7, $P < 0.01$) was significantly higher in the direct laryngoscopy group than in the video laryngoscopy by Jagannathan et al. (19) In our study; there was a higher requirement for external maneuvers in the direct group than in the video group (35% v 0%, $P < 0.01$). Gupta et al. mentioned that fewer esophageal intubations occurred in the video laryngoscopy group compared with the direct laryngoscopy group (9). No esophageal intubations were noted in both of our study groups.

Laryngoscopy and intubation have transient hemodynamic responses and are mostly well tolerated. It is a reflex phenomenon mediated by the vagus and glossopharyngeal nerves. It carries afferent signals from the epiglottis and infraglottic region and activates the vasomotor center to cause peripheral sympathoadrenal response leading to hypertension, tachycardia, and elevated serum catecholamines. Regarding the hemodynamic findings, elevated heart rate after video laryngoscopy was reported in the study by Javaherforooshzadeh and Gharacheh (20) Our study has shown an increase in heart rate and mean arterial pressure in a video-laryngoscopy group compared to the direct group. The force exerted by the laryngoscope at the base of the tongue while lifting the epiglottis was most likely responsible for the circulatory response to laryngoscopy and intubation.

Video laryngoscope has been improvised as an important tool in pediatric airway management. Using a video laryngoscope has improved glottic views and intubation success in pediatric patients with difficult airways. However, more evidence from large randomized clinical trials is required to establish the effectiveness of video laryngoscopes in children in real-world settings. Using a video laryngoscope, the anesthetist will have a clear view of the laryngeal inlet during the intubation process as the camera is near the tip of the blade of the video laryngoscope. As a result, it is easy to visualize relevant airway structures in detail, which is often difficult with direct laryngoscopy. Studies have shown that video laryngoscopy leads to better glottic visualization resulting in a better success rate during the first intubation attempt (17, 19). Thus, video laryngoscopy can be preferred over direct laryngoscopy during intubation and laryngoscopy in pediatric patients. This can lead to early and successful intubation and lower the risk of adverse events.

5.1. Conclusions

According to the results obtained from our study, we conclude that the time taken for intubation in pediatric patients was more in the video laryngoscopy group. However, even if the time was longer, the glottic view was much better, and the requirement for external maneuvers was also less compared to a direct laryngoscope. The clear view of the glottis seen by the instructor and the intubating anesthetist makes it a useful teaching tool.

Footnotes

Authors' Contribution: Shravya K: Acquisition of data, analysis and interpretation; Sunil B V: Study concept, design, drafting manuscript, critical revision of the manuscript for important intellectual content, Administrative and material support; Sonal B: Statistical analysis, Administrative and material support.

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Ethical Approval: The study was approved by the Institutional Ethics Committee (IEC KMC MLR 12-2020/388).

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Informed Consent: Written informed consent was obtained from the parent or legal guardian of the children.

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