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COMPARISON OF OUTCOMES BETWEEN VIDEO AND DIRECT LARYNGOSCOPE FOR ENDOTRACHEAL INTUBATION IN PEDIATRIC PATIENTS AT A TERTIARY CARE HOSPITAL, KARACHI

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ABSTRACT
Pediatric endotracheal intubation can be challenging because of age-related anatomical and physiological characteristics of the airway. Video laryngoscopy may improve glottic visualization and facilitate successful intubation compared with conventional direct laryngoscopy. This randomized controlled trial compared the outcomes of video and direct laryngoscopy for endotracheal intubation in pediatric patients at a tertiary care hospital in Karachi. A total of 138 patients aged 6 months to 18 years undergoing procedures requiring general anesthesia and endotracheal intubation were randomly allocated to either the video laryngoscopy group (n=69) or direct laryngoscopy group (n=69). The primary outcomes were successful intubation at the first attempt and intubation time. Additional procedural outcomes included Cormack–Lehane grade, requirement for external laryngeal manipulation, and intubation-related complications. In the current dataset, first-attempt intubation was successful in 66 (95.7%) patients in the video laryngoscopy group compared with 59 (85.5%) in the direct laryngoscopy group (P=0.040). Mean intubation time was significantly shorter with video laryngoscopy than with direct laryngoscopy (24.6 ± 5.3 vs. 27.8 ± 7.1 seconds; P=0.003). Video laryngoscopy was also associated with more favorable glottic visualization and less frequent requirement for external laryngeal manipulation. These findings suggest that video laryngoscopy may improve first-attempt intubation success and reduce intubation time compared with direct laryngoscopy in pediatric patients.
KEYWORDS: Pediatric airway; Direct laryngoscopy; Video laryngoscopy; Endotracheal intubation success; Airway management

INTRODUCTION
Airway management is one of the most important responsibilities of an anesthesiologist, and endotracheal intubation in pediatric patients presents challenges because of age-related anatomical and physiological characteristics. Compared with adults, infants and young children have a proportionally larger tongue, smaller oral cavity, relatively larger occiput, shorter neck, and a higher and more anteriorly positioned larynx. In addition, children have greater oxygen consumption and lower functional residual capacity, resulting in more rapid oxygen desaturation during apnea. These characteristics reduce the margin of safety during airway management and make prompt and successful tracheal intubation particularly important in pediatric anesthesia [1,2].
Direct laryngoscopy remains a conventional and widely practiced technique for endotracheal intubation. Successful direct laryngoscopy depends on adequate positioning and appropriate alignment of the oral, pharyngeal, and laryngeal axes to permit visualization of the laryngeal structures and passage of the endotracheal tube. Although the technique is effective in most routine cases, difficulty may arise because of patient anatomy, positioning, limited airway access, or inadequate visualization. Such difficulties become particularly important

in children because prolonged or repeated attempts may rapidly result in hypoxemia and other adverse physiological consequences [1,3].

The number of intubation attempts is an important determinant of airway-related complications. Repeated laryngoscopy has been associated with hypoxemia, bradycardia, airway trauma, hemodynamic disturbance, and other adverse events [4,5]. Pediatric airway management therefore emphasizes limiting unsuccessful attempts and promptly adopting an alternative airway strategy when the initial technique fails [1,6]. An effective device should ideally improve visualization, facilitate passage of the endotracheal tube, and reduce the need for repeated direct laryngoscope attempts.

Video laryngoscopy has emerged as an important alternative in airway management. A miniature camera positioned near the distal portion of the laryngoscope blade transmits an enlarged image of the airway to an external display. Unlike conventional direct laryngoscopy, visualization does not depend entirely on achieving a direct line of sight between the operator and the laryngeal structures. This feature may be particularly useful when conventional laryngoscopy provides inadequate visualization or intubation cannot be accomplished successfully [7,8].

Evidence regarding video laryngoscopy in children has continued to evolve. Studies have demonstrated improved laryngeal visualization with video-assisted devices, although the effects on intubation time and first-attempt success have varied according to device type, patient age, operator experience, and clinical circumstances [9,10]. More recent pediatric evidence suggests that video laryngoscopy can improve first-attempt success in selected populations, supporting its increasing role in pediatric airway algorithms [11]. Nevertheless, improved visualization alone does not necessarily guarantee easier or faster passage of the endotracheal tube, making evaluation of clinically relevant outcomes important.

The role of video laryngoscopy as a technique following unsuccessful or difficult direct laryngoscopy is particularly relevant in settings where direct laryngoscopy remains the usual initial approach. Instead of exposing a child to multiple repeated attempts with the same technique, early transition to video-assisted laryngoscopy may offer an alternative means of securing the airway. However, the effectiveness of such an approach depends on equipment availability, operator familiarity, patient characteristics, and institutional practice.

In Pakistan, direct laryngoscopy continues to be commonly employed for pediatric endotracheal intubation, while video laryngoscopy is increasingly available in tertiary care institutions. However, locally generated evidence regarding its usefulness as a technique in pediatric patients remains limited. Evaluation within the local clinical environment is therefore important because differences in equipment, training, airway practices, and available resources may influence outcomes.

The present study was therefore designed to comparatively evaluate direct laryngoscopy and video laryngoscopy for endotracheal intubation in pediatric patients at a tertiary care hospital in Karachi. Emphasis was placed on successful intubation, time required for intubation, Cormack–Lehane classification, requirement for external laryngeal manipulation, and procedure-related complications. The findings may provide locally relevant evidence regarding the potential role of video laryngoscopy as a strategy during pediatric airway management.

MATERIALS AND METHODS

This randomized controlled trial was conducted in the Department of Anesthesiology, Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, Pakistan, over a period of six months following approval of the research protocol. Ethical approval was obtained from the Institutional Ethical Review Committee before commencement of data collection. Written informed consent was obtained from the parent or legal guardian of each participant, with assent obtained from older children where applicable.

Pediatric patients aged 6 months to 18 years, of either gender, undergoing surgical procedures requiring general anesthesia and endotracheal intubation were assessed for eligibility. Preterm babies, patients with congenital abnormalities likely to interfere with airway management, including congenital diaphragmatic hernia, tracheoesophageal fistula, or cleft lip/palate, and patients undergoing emergency surgery were excluded. Participants were recruited using a non-probability consecutive sampling technique, as specified in the study protocol.

A total of 138 patients were included, with 69 patients allocated to each study group. The sample size was calculated using OpenEpi at a 5% significance level and 80% statistical power, based on previously reported mean intubation times of 24.28 ± 5.0 seconds and 27.65 ± 8.6 seconds for the two laryngoscopy techniques.

After enrollment, patients were randomly assigned to one of two groups. Group A underwent endotracheal intubation using direct laryngoscopy, while Group B underwent intubation using video laryngoscopy. Allocation concealment was maintained using sequentially numbered, sealed, opaque envelopes. Thus, the two techniques were evaluated as parallel study interventions rather than using video laryngoscopy as a rescue technique following failed direct laryngoscopy.

In the preoperative area, a eutectic mixture of local anesthetic cream was applied to the patient's hands, followed by placement of an intravenous cannula. Midazolam 0.02 mg/kg was administered for premedication. After transfer to the operating room, patients were appropriately positioned for airway management and standard perioperative monitoring was established. Preoxygenation was performed with 100% oxygen. General anesthesia was induced with intravenous fentanyl 2 µg/kg and propofol 2 mg/kg. After confirming adequate assisted ventilation, atracurium 0.5 mg/kg was administered intravenously to facilitate neuromuscular relaxation. An appropriately sized endotracheal tube was prepared before laryngoscopy.

Endotracheal intubation was performed according to the allocated study group using either a direct laryngoscope or video laryngoscope. The study protocol specified use of an appropriate Macintosh blade, and laryngoscopy was performed three minutes after confirmation of adequate neuromuscular blockade. All intubations were carried out by an anesthesiologist with more than 10 years of experience to minimize variability related to operator experience.

The principal outcomes were successful intubation on the first attempt and intubation time. First-attempt success was recorded when endotracheal intubation was successfully achieved during the initial laryngoscopy attempt. Intubation time was measured from insertion of the laryngoscope blade into the oral cavity until successful ventilation through the endotracheal tube was confirmed by bilateral air entry and appearance of an end-tidal carbon dioxide waveform.

Glottic visualization was assessed using the Cormack–Lehane classification. External laryngeal maneuvers were performed when required to improve visualization of the glottis and facilitate passage of the endotracheal tube. The investigator observed each procedure and recorded the predefined demographic and procedural variables on the study proforma. Continuous monitoring was maintained throughout anesthesia and airway management. Following completion of surgery, patients were extubated after adequate recovery and transferred to the post-anesthesia care unit with stable vital signs.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 20.0. Quantitative variables, including age and intubation time, were assessed for distribution. Normally distributed variables were expressed as mean ± standard deviation, whereas non-normally distributed variables were presented as median with interquartile range. Categorical variables, including gender and first-attempt intubation success, were summarized as frequencies and percentages.

First-attempt intubation success was compared between the video and direct laryngoscopy groups using the Chi-square test or Fisher's exact test, as appropriate. Intubation time was compared using the independent-samples t-test or Mann–Whitney U test, depending on data distribution. Age and gender were considered potential effect modifiers and evaluated through stratified analyses. Post-stratification statistical testing was performed where appropriate. A two-sided P-value ≤0.05 was considered statistically significant.

RESULTS

A total of **138 pediatric patients** were included in the study and randomly allocated to either the video laryngoscopy group (n=69) or the direct laryngoscopy group (n=69). All patients were included in the final analysis.
The two groups were comparable with respect to baseline characteristics. Mean age was **7.5 ± 4.2 years** in the video laryngoscopy group and **7.7 ± 4.4 years** in the direct laryngoscopy group (P=0.785). Mean body weight was **25.4 ± 13.2 kg** and **26.1 ± 13.8 kg**, respectively (P=0.761). Males constituted 58.0% of the video laryngoscopy group and 56.5% of the direct laryngoscopy group, with no significant difference in gender distribution (P=0.863). Baseline characteristics were therefore comparable between the study groups (Table 1).

Table 1. Baseline characteristics of the study groups

Characteristic	Video laryngoscopy (n=69)	Direct laryngoscopy (n=69)	P-value
Age, years, mean ± SD	7.5 ± 4.2	7.7 ± 4.4	0.785
Weight, kg, mean ± SD	25.4 ± 13.2	26.1 ± 13.8	0.761
Male, n (%)	40 (58.0)	39 (56.5)	0.863*
Female, n (%)	29 (42.0)	30 (43.5)	0.863*

The same P-value is shown for male and female categories because it represents one overall comparison of gender distribution between the groups.

Successful endotracheal intubation on the first attempt was achieved in 66 of 69 patients (95.7%) in the video laryngoscopy group compared with 59 of 69 patients (85.5%) in the direct laryngoscopy group. First-attempt failure occurred in 3 (4.3%) and 10 (14.5%) patients, respectively. The difference in first-attempt success was statistically significant (P=0.041), corresponding to an absolute difference of approximately 10.1 percentage points in favor of video laryngoscopy (Table 2; Figure 1).

Mean intubation time was also significantly shorter with video laryngoscopy. The mean intubation time was 24.6 ± 5.3 seconds compared with 27.8 ± 7.1 seconds with direct laryngoscopy (P=0.003). The mean difference was 3.2 seconds (95% CI: approximately 1.1–5.3 seconds) in favor of video laryngoscopy (Table 2; Figure 2).

Table 2. Comparison of primary intubation outcomes

Outcome	Video laryngoscopy (n=69)	Direct laryngoscopy (n=69)	P-value
First-attempt success, n (%)	**66 (95.7)**	59 (85.5)	**0.041***
First-attempt failure, n (%)	3 (4.3)	10 (14.5)	**0.041***
Intubation time, seconds, mean ± SD	**24.6 ± 5.3**	27.8 ± 7.1	**0.003**

Success and failure are complementary categories; P=0.041 represents the same overall comparison.

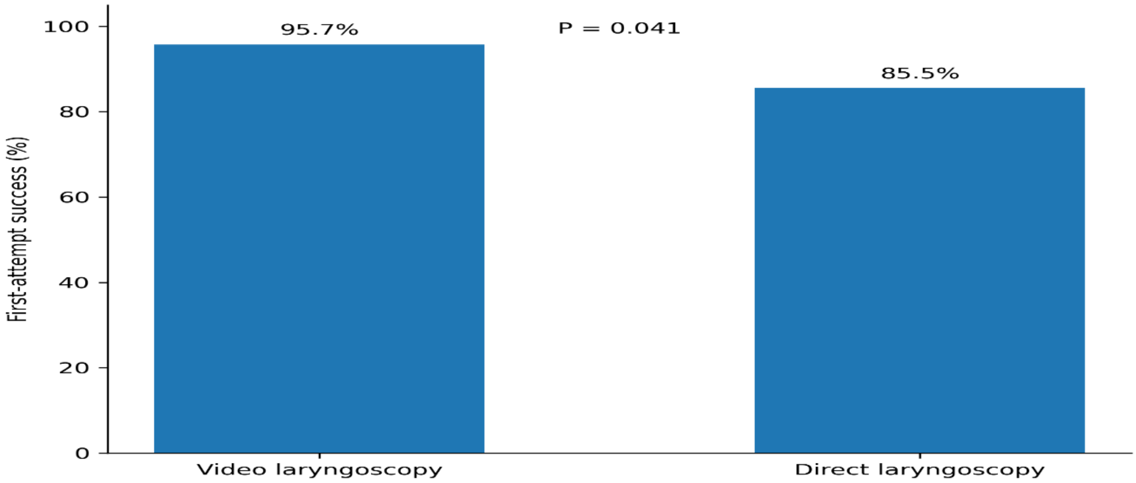

Figure 1. Comparison of first-attempt endotracheal intubation success between the video and direct laryngoscopy groups. First-attempt success was achieved in **95.7%** of patients undergoing video laryngoscopy compared with **85.5%** undergoing direct laryngoscopy (**P=0.041**).

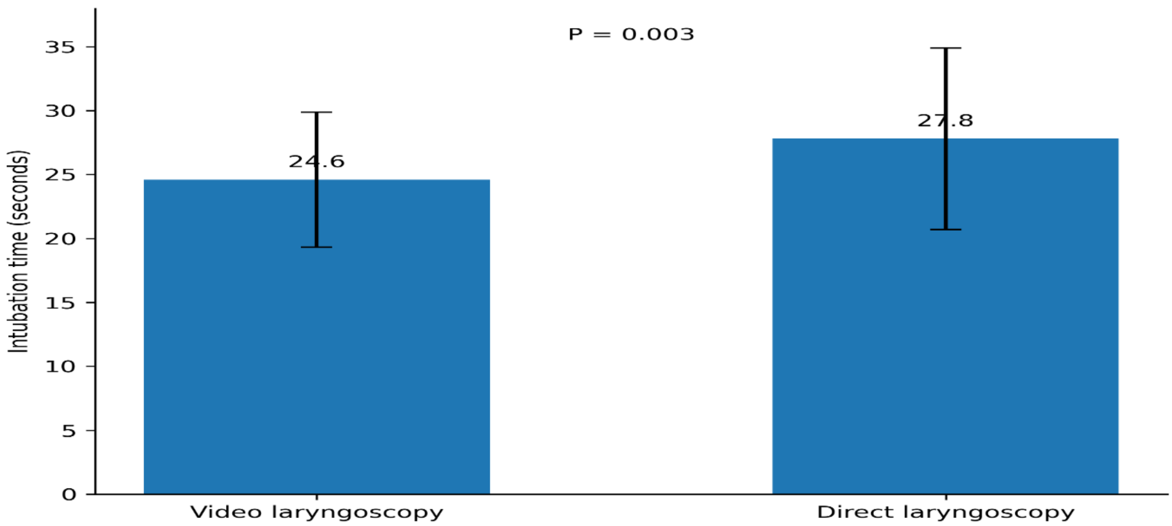

Figure 2. Comparison of mean intubation time between the video and direct laryngoscopy groups. Mean intubation time was 24.6 ± 5.3 seconds with video laryngoscopy and 27.8 ± 7.1 seconds with direct laryngoscopy (P=0.003).

Error bars represent standard deviations.

Glottic visualization was assessed using the Cormack–Lehane classification. Among patients undergoing video laryngoscopy, Grade I visualization was observed in 41 (59.4%), Grade II in 23 (33.3%), Grade III in 5 (7.2%), and Grade IV in none. In the direct laryngoscopy group, Grade I visualization was observed in 28 (40.6%), Grade II in 28 (40.6%), Grade III in 11 (15.9%), and Grade IV in 2 (2.9%) patients.

Because of the small number of patients in the Grade IV category, the overall four-category distribution was evaluated using an exact test. The overall distribution showed a tendency toward more favorable Cormack–Lehane grades with video laryngoscopy but did not reach statistical significance (P=0.056).

For a clinically interpretable comparison, Cormack–Lehane grades were additionally categorized into Grade I–II versus Grade III–IV. Favorable Grade I–II visualization was achieved in 64 (92.8%) patients in the video laryngoscopy group compared with 56 (81.2%) in the direct laryngoscopy group. Unfavorable Grade III–IV visualization occurred in 5 (7.2%) and 13 (18.8%) patients, respectively. This grouped difference was statistically significant (P=0.043).

External laryngeal manipulation was required in 8 (11.6%) patients undergoing video laryngoscopy compared with 19 (27.5%) undergoing direct laryngoscopy (P=0.018).

Difficult intubation occurred in 4 (5.8%) patients in the video laryngoscopy group compared with 11 (15.9%) patients in the direct laryngoscopy group. Although numerically less frequent with video laryngoscopy, the difference did not reach statistical significance (P=0.056) (Table 3;

Table 3. Comparison of glottic visualization and secondary intubation outcomes

Outcome	Video laryngoscopy (n=69)	Direct laryngoscopy (n=69)	P-value
Cormack–Lehane Grade I, n (%)	41 (59.4)	28 (40.6)	NST*
Cormack–Lehane Grade II, n (%)	23 (33.3)	28 (40.6)	NST*
Cormack–Lehane Grade III, n (%)	5 (7.2)	11 (15.9)	NST*
Cormack–Lehane Grade IV, n (%)	0 (0.0)	2 (2.9)	NST*
Overall Grade I–IV distribution	—	—	**0.056†**
Grade I–II, n (%)	**64 (92.8)**	56 (81.2)	**0.043‡**
Grade III–IV, n (%)	5 (7.2)	13 (18.8)	**0.043‡**
External laryngeal manipulation, n (%)	**8 (11.6)**	19 (27.5)	**0.018**
Difficult intubation, n (%)	4 (5.8)	11 (15.9)	**0.056**

NST = not separately tested; individual Cormack–Lehane grades are components of the overall four-category distribution rather than independent outcomes.

†Overall Grade I–IV distribution assessed using an exact test because of sparse observations in Grade IV.

‡P=0.043 represents the Grade I–II versus Grade III–IV comparison.

Intubation-related adverse events were relatively uncommon in both groups. Transient hypoxemia occurred in 2 (2.9%) patients in the video laryngoscopy group and 6 (8.7%) patients in the direct laryngoscopy group. The difference was not statistically significant (P=0.274).

Bradycardia was documented in 1 (1.4%) patient undergoing video laryngoscopy compared with 3 (4.3%) patients undergoing direct laryngoscopy (P=0.619). Minor airway trauma occurred in 1 (1.4%) and 4 (5.8%) patients, respectively (P=0.366).

No aspiration, major airway injury, cardiac arrest, or airway-related mortality occurred in either group. Since both groups had zero events for these outcomes, statistical comparison was not applicable (Table 4;

Table 4. Comparison of intubation-related complications

Complication	Video laryngoscopy (n=69)	Direct laryngoscopy (n=69)	P-value
Transient hypoxemia, n (%)	2 (2.9)	6 (8.7)	**0.274**
Bradycardia, n (%)	1 (1.4)	3 (4.3)	**0.619**
Minor airway trauma, n (%)	1 (1.4)	4 (5.8)	**0.366**
Aspiration, n (%)	0 (0.0)	0 (0.0)	**NA**
Major airway injury, n (%)	0 (0.0)	0 (0.0)	**NA**
Cardiac arrest, n (%)	0 (0.0)	0 (0.0)	**NA**
Airway-related mortality, n (%)	0 (0.0)	0 (0.0)	**NA**

Fisher's exact test was used for complications with small cell frequencies. NA = not applicable because no events occurred in either group.

Video laryngoscopy was associated with a higher first-attempt intubation success rate, shorter intubation time, more frequent favorable Cormack–Lehane Grade I–II visualization, and a lower requirement for external laryngeal manipulation compared with direct laryngoscopy. Difficult intubation and individual intubation-related complications occurred less frequently in the video laryngoscopy group, although these differences were not statistically significant.

DISCUSSION

The present study compared video laryngoscopy with direct laryngoscopy for endotracheal intubation in pediatric patients and demonstrated clinically relevant differences between the two techniques. Video laryngoscopy was associated with a significantly higher first-attempt intubation success rate than direct laryngoscopy (95.7% vs. 85.5%, P=0.041) and a significantly shorter mean intubation time (24.6 ± 5.3 vs. 27.8 ± 7.1 seconds, P=0.003). In addition, favorable Cormack–Lehane Grade I–II visualization was more frequent with video laryngoscopy, and the requirement for external laryngeal manipulation was significantly lower. Difficult intubation and procedure-related complications were also numerically less frequent with video laryngoscopy, although these differences did not reach statistical significance. Collectively, these findings suggest that video laryngoscopy may provide advantages in several important procedural outcomes during pediatric endotracheal intubation.

First-attempt success is particularly important in pediatric airway management because repeated laryngoscopy may increase the likelihood of hypoxemia, bradycardia, airway trauma, and other adverse events. Evidence from the Pediatric Difficult Intubation Registry has shown that increasing numbers of intubation attempts are associated with a greater risk of complications in children [10]. Park et al. similarly reported favorable intubation performance with video laryngoscopy compared with direct laryngoscopy among children with difficult tracheal intubation [11]. Although these registry populations differ from the elective pediatric population evaluated in the present study, they support the clinical importance of maximizing the likelihood of successful intubation during the earliest possible attempt.

The significantly higher first-attempt success observed with video laryngoscopy in the present study is broadly consistent with contemporary evidence demonstrating potential advantages of video-assisted airway devices in children. Carvalho et al., in a network meta-analysis of randomized clinical trials, reported that video laryngoscopy reduced failed first intubation attempts in certain pediatric populations, particularly younger children, although substantial heterogeneity existed between devices and studies [12]. Hoshijima et al. also demonstrated that the relative performance of pediatric laryngoscopes varied considerably according to device design and patient population [13]. These findings are important because the term "video laryngoscopy" encompasses multiple devices with different blade geometries, camera positions, and tube-delivery characteristics. Therefore, improved outcomes with one video-laryngoscope system should not automatically be generalized to every device.

Not all published evidence has demonstrated a consistent first-attempt advantage for video laryngoscopy. A recent systematic review and meta-analysis by Koepp-Medina et al. evaluating randomized pediatric trials found that differences in first-attempt success were not uniformly significant across the available evidence [18]. Similarly, Yavuz et al., in an elective pediatric population, reported improved laryngeal visualization with video laryngoscopy but did not demonstrate superiority across all intubation outcomes [19]. The difference between these findings and those of the present study may reflect variation in patient age, device characteristics, operator experience, airway difficulty, and the specific definition of first-attempt success. The present study was conducted with experienced anesthesiologists, which may also have reduced the influence of a learning curve on video-laryngoscope performance.

Intubation time was another important finding. Video laryngoscopy resulted in a mean intubation time approximately 3.2 seconds shorter than direct laryngoscopy. Although the absolute difference was modest, it was statistically significant. Published findings concerning intubation time have been inconsistent. Earlier pediatric evidence suggested that improved visualization with video laryngoscopy did not always result in more rapid passage of the endotracheal tube [9]. Carvalho et al. similarly reported no consistent overall difference in intubation time between video and direct laryngoscopy across pediatric studies [12]. This apparent discrepancy may be explained by differences in blade design and operator familiarity, as video visualization can be excellent while advancement of the tube toward the glottis may still require additional manipulation.

More recent randomized evidence has demonstrated that intubation time may be comparable or even favorable with certain video-laryngoscope systems. Venkatesh et al. compared video and direct laryngoscopy in neonates and young infants and reported broadly comparable procedural times despite advantages in visualization and reduced need for external manipulation with the video device [16]. Chae et al. also demonstrated favorable performance of the UEscope video laryngoscope compared with traditional direct laryngoscopy in neonates and infants [14]. The shorter time observed in the present study may therefore reflect a combination of improved glottic visualization, experienced operators, and reduced need for additional airway maneuvers.

A further important finding was the improvement in glottic visualization. Cormack–Lehane Grade I–II views were obtained in 92.8% of patients undergoing video laryngoscopy compared with 81.2% undergoing direct laryngoscopy (P=0.043). The distal camera used in video laryngoscopy permits visualization of the laryngeal inlet without requiring the same degree of alignment of the oral, pharyngeal, and laryngeal axes necessary during conventional direct laryngoscopy. Improved visualization with video devices has been repeatedly demonstrated in pediatric studies and meta-analyses [9,12,13]. This provides a plausible technical explanation for the higher first-attempt success observed in the present study.

The requirement for external laryngeal manipulation was also significantly lower with video laryngoscopy (11.6%) than with direct laryngoscopy (27.5%). This finding further supports the improved airway view obtained using the video-assisted technique. Venkatesh et al. similarly reported a reduction in the need for external manipulation during video laryngoscopy in neonates and infants [16]. Reduced dependence on external maneuvers may simplify the intubation process and may be particularly useful in smaller children, in whom airway structures are compact and visualization can deteriorate rapidly with minor changes in positioning.

Difficult intubation was observed less frequently in the video laryngoscopy group than in the direct laryngoscopy group (5.8% vs. 15.9%). However, this difference did not reach statistical significance (P=0.056). The direction of the effect is consistent with the improvements observed in first-attempt success and glottic visualization, but the study may have had insufficient statistical power to demonstrate a significant difference for this less frequent outcome. The sample size was primarily calculated on the basis of intubation time rather than difficult intubation; therefore, nonsignificance for this secondary outcome should not necessarily be interpreted as evidence of equivalence between the techniques.

Peri-intubation complications were uncommon in both groups. Transient hypoxemia occurred in 2.9% of patients undergoing video laryngoscopy compared with 8.7% undergoing direct laryngoscopy, while bradycardia occurred in 1.4% and 4.3%, respectively. Minor airway trauma was also numerically less frequent with video laryngoscopy. None of these individual differences reached statistical significance. Registry evidence indicates that adverse events during pediatric tracheal intubation are strongly associated with repeated attempts and increasing procedural difficulty [10,11]. The higher first-attempt success observed with video laryngoscopy could therefore theoretically reduce complications by limiting repeated airway instrumentation, although the present sample was not sufficiently large to establish significant differences in uncommon adverse events.

The safety findings should therefore be interpreted cautiously. Absence of statistically significant differences does not demonstrate that the two techniques have identical complication profiles, particularly when event frequencies are low. Larger multicenter studies would be required to adequately assess uncommon but clinically important outcomes such as severe hypoxemia, major airway trauma, aspiration, or cardiac arrest. Longitudinal registry evidence has also demonstrated that pediatric airway practices and outcomes change as equipment and clinical experience evolve [15], emphasizing the importance of continued evaluation of video-assisted techniques in different practice environments.

Although the present study evaluated video laryngoscopy as a primary intubation technique rather than specifically as a rescue intervention, evidence concerning its rescue role remains clinically relevant. Stein et al. reported favorable use of video laryngoscopy and flexible bronchoscopy following failed direct laryngoscopy in children [17]. This reinforces the broader value of video-assisted airway technology: a device that performs effectively as an initial technique may also provide an important alternative when conventional visualization proves difficult. Nevertheless, the results of the present study should primarily be interpreted as evidence from a direct comparison of the two techniques rather than as evaluation of a rescue pathway.

The findings have practical relevance for tertiary-care institutions such as SMBBIT, where pediatric airway management frequently requires rapid and reliable tracheal intubation. Video laryngoscopy may offer particular advantages by improving visualization, increasing first-attempt success, and reducing the requirement for external laryngeal manipulation. However, equipment availability alone is unlikely to ensure improved outcomes. Appropriate pediatric blades, operator training, familiarity with the specific video-laryngoscope system, and experience with tube-delivery techniques remain important determinants of successful implementation.

Several limitations should be considered. This was a single-center study with a relatively modest sample size, which may limit generalizability to other institutions and clinical settings. The study included a broad pediatric age range from 6 months to 18 years, encompassing substantial variation in airway anatomy and physiological reserve. Although experienced anesthesiologists performed the intubations, operator expertise may influence performance and may limit extrapolation to less experienced clinicians. Blinding of the intubating anesthesiologist was not feasible because of the nature of the interventions. Furthermore, the sample size was not designed to detect differences in uncommon complications, and therefore the safety comparisons should be interpreted cautiously. Device-specific findings may also not be generalizable to all commercially available video laryngoscopes.

Despite these limitations, the study has several strengths. It directly compared video and direct laryngoscopy using a randomized parallel-group design, standardized anesthetic and intubation procedures, experienced operators, and objective confirmation of successful tracheal placement. Furthermore, the study evaluated multiple clinically relevant outcomes, including first-attempt success, intubation time, glottic visualization, external laryngeal manipulation, difficult intubation, and peri-intubation complications.

Overall, the findings indicate that video laryngoscopy was associated with higher first-attempt intubation success, shorter intubation time, improved glottic visualization, and less frequent requirement for external laryngeal manipulation compared with direct laryngoscopy in pediatric patients. However, differences in difficult intubation and individual complications were not statistically significant. These findings support the potential value of video laryngoscopy as an effective technique for pediatric endotracheal intubation while recognizing that device characteristics, operator experience, patient age, and clinical context remain important determinants of performance.

CONCLUSION

video laryngoscopy was an effective strategy for securing the airway following unsuccessful direct laryngoscopy in pediatric patients. It achieved a high intubation success rate and improved Cormack–Lehane classification while maintaining a low frequency of procedure-related complications. These findings support the timely use of video laryngoscopy as a technique rather than repeated direct laryngoscope attempts in pediatric airway management.

LIMITATIONS

This was a single-center study with a relatively small number of patients requiring video laryngoscopy. The group represented patients in whom initial direct laryngoscopy was unsuccessful and therefore did not constitute an independent comparison group. Operator experience and the wide pediatric age range may also have influenced the observed outcomes. Larger multicenter studies are recommended to validate these findings.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

The study received no external funding.

ETHICAL APPROVAL

The study was conducted after approval from the relevant Institutional Ethical Review Committee. Written informed consent was obtained from the parents or legal guardians of participating children, with assent obtained where applicable.

INFORMED CONSENT

Written informed consent for participation was obtained from the parent or legal guardian of each participant before enrolment.

AUTHOR CONTRIBUTIONS

Falaque: Conceptualization, methodology, investigation, data collection, and initial manuscript drafting.
Mirza Shahzad Baig: Supervision, methodology, critical review, and manuscript revision.
Jehanzaib Muhammad Azam: Investigation, data collection, and manuscript review.
Shafaq Memon: Data collection, methodology support, and manuscript review.
Fareena: Data organization, literature review, and manuscript review.
Aqsa Sattar: Investigation, literature review, and manuscript revision.

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