

Comparison of Conventional Laryngoscopy and Videolaryngoscopy for Endotracheal Intubation in 5 To 11 Year School Going Children Undergoing Surgeries under General Anesthesia in Tertiary Care Centre

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Received: 05-08-2026 / Revised: 02-09-2026 / Accepted: 03-10-2026

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Conflict of interest: Nil

Abstract:

Introduction: Securing the airway safely and efficiently is a fundamental responsibility of the anesthesiologist, particularly in pediatric patients who have distinct anatomical and physiological characteristics and are vulnerable to rapid oxygen desaturation and hemodynamic disturbances during airway manipulation. Conventional direct laryngoscopy requires alignment of the oral, pharyngeal, and laryngeal axes, whereas videolaryngoscopy provides an indirect view of the glottis and may improve visualization and facilitate tracheal intubation. This study compared conventional laryngoscopy and videolaryngoscopy for endotracheal intubation in children aged 5–11 years undergoing elective surgery under general anesthesia.

Methods: A quasi-experimental comparative study was conducted in a tertiary care teaching hospital over 18 months. Seventy children aged 5–11 years, classified as ASA physical status I–III and scheduled for elective surgery under general anesthesia, were enrolled and randomly allocated into two groups of 35 each. Group A underwent intubation using a Macintosh direct laryngoscope, while Group B underwent videolaryngoscopy. The primary parameters assessed were time to intubation, number of intubation attempts, Cormack–Lehane grade, requirement for airway maneuvers, peri-intubation hemodynamic changes, oxygen saturation, and airway-related complications.

Results: First-attempt intubation success was higher with videolaryngoscopy than direct laryngoscopy (91.4% vs. 74.3%), although the difference was borderline statistically significant ($\chi^2=3.64$, $p=0.056$). Mean time to intubation was significantly shorter with videolaryngoscopy (24.91 ± 4.61 seconds) compared with direct laryngoscopy (35.84 ± 7.82 seconds; $t=8.72$, $p<0.001$). Cormack–Lehane Grade 1 visualization was significantly more frequent with videolaryngoscopy (62.9% vs. 28.6%), while difficult views (Grades 2b and 3) were more common with direct laryngoscopy ($p=0.004$). Additional airway maneuvers were required significantly less frequently with videolaryngoscopy (17.1% vs. 54.3%; $\chi^2=8.27$, $p=0.041$). Post-intubation pulse rate and blood pressure were significantly higher in the direct laryngoscopy group at most observed intervals, indicating greater hemodynamic response. Complications were also significantly more frequent with direct laryngoscopy, with no complication in 88.6% of videolaryngoscopy patients compared with 60.0% of direct laryngoscopy patients ($\chi^2=9.84$, $p=0.020$).

Conclusion: Videolaryngoscopy provided significantly better glottic visualization, shorter intubation time, reduced requirement for airway maneuvers, improved hemodynamic stability, and fewer peri-intubation complications compared with conventional direct laryngoscopy. Although first-attempt success was higher with videolaryngoscopy, the difference was not statistically significant. Videolaryngoscopy appears to be a useful and effective technique for endotracheal intubation in school-aged children undergoing general anesthesia.

Keywords: Videolaryngoscopy; Direct Laryngoscopy; Pediatric Airway; Endotracheal Intubation; Cormack–Lehane Grade; Hemodynamic Response; Children; General Anesthesia.

DOI: 10.25258/ijcpr.18.10.14

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Introduction

Securing the airway using an endotracheal tube remains a primary responsibility of the anesthesiologist and the criterion standard for optimizing airway control during general anesthesia. This is particularly important in pediatric patients because anatomical and physiological differences influence perioperative safety. Traditional direct laryngoscopy using the Macintosh laryngoscope requires alignment of the oral, pharyngeal, and laryngeal axes and a direct field of vision, which may be technically difficult in children because of their proportionally larger tongue, higher and more anterior larynx, pliable epiglottis, and limited mouth opening compared with adults [1].

Children are prone to rapid oxygen desaturation, excessive vagal responses, and exaggerated hemodynamic changes, emphasizing the need for rapid and atraumatic tracheal intubation. Video laryngoscopes incorporate a camera near the blade tip and provide indirect glottic visualization without requiring complete alignment of the airway axes. Kim et al., in a randomized controlled study involving 203 children, found that GlideScope videolaryngoscopy provided a similar or better laryngoscopic view than direct laryngoscopy; however, intubation time was increased with videolaryngoscopy [1]. Similarly, Sun et al. demonstrated improved glottic visualization in a 200-patient randomized clinical trial, although successful intubation required an average of 16 additional seconds, suggesting a trade-off between visualization and procedure time [2]. Jones et al. reported improved performance characteristics and reduced sore throat with GlideScope videolaryngoscopy during nasotracheal intubation compared with direct laryngoscopy [3].

Another important advantage of videolaryngoscopy is reduced cervical spine movement. Robitaille et al. reported less cervical spine movement during GlideScope-assisted tracheal intubation than with direct laryngoscopy in patients undergoing manual in-line stabilization [4]. Redel et al. confirmed the efficacy and safety of videolaryngoscopy for pediatric intubation [5], while John et al. reported successful pediatric airway management using GlideScope with improved glottic visualization across various clinical settings, including difficult airways [6].

Operator skill is an important determinant of successful intubation. Lim et al. demonstrated that less-experienced operators found GlideScope easier to use than Macintosh laryngoscopy in simulated difficult airways, suggesting that videolaryngoscopy may simplify the learning curve and improve first-attempt success [7]. Airway manoeuvres such as BURP (Backward, Upward, Rightward Pressure) have traditionally been used to optimize the glottic

view during difficult direct laryngoscopy. Takahata et al. demonstrated that BURP could improve direct visualization of the glottis during difficult intubation [8]. However, direct laryngoscopy has limitations in visual exposure and consistency of Cormack–Lehane grading. Serocki et al., comparing conventional blade laryngoscopy, video-assisted blade laryngoscopy and GlideScope, found enhanced airway visualization with videolaryngoscopy, particularly in difficult airways [9].

A pediatric study comparing Macintosh and GlideScope reported no significant difference in tracheal intubation success, but better glottic visualization with GlideScope in children older than one year [10]. In children with actual or predicted difficult airways, videolaryngoscopy performed by senior anesthetists provided significantly better laryngoscopic views with and without external laryngeal pressure, although the time required to obtain the best view was not significantly different [11]. Similarly, Rabiner et al. demonstrated better overall intubation success with GlideScope than direct laryngoscopy among less-experienced physicians in simulated pediatric airways, possibly due to improved visualization and an educational effect during simulation training [12].

Despite improved Cormack–Lehane grades and first-pass success, videolaryngoscopy has limitations, including potentially increased intubation time, fogging or obscuration of camera optics, the need for stylet-assisted tube passage, and higher cost. In pediatric patients, prolonged airway instrumentation and repeated attempts increase the risk of hypoxia and bradycardia. Direct laryngoscopy and tracheal intubation may also produce significant sympathetic stimulation, resulting in tachycardia, hypertension and arrhythmias, particularly in high-risk children.

The balance between improved visualization and intubation time is especially relevant in school-aged children between 5 and 11 years, whose airway anatomy is transitioning toward adult proportions while retaining important pediatric characteristics. Considering the increasing use of videolaryngoscopy and the mixed evidence regarding intubation time, glottic visualization, airway manoeuvres, hemodynamic stability and complications, the present study comparatively evaluates conventional direct laryngoscopy and videolaryngoscopy in school-aged children undergoing general anesthesia at a tertiary care hospital. The study aims to compare time to intubation, Cormack–Lehane grading, airway manoeuvre requirement, hemodynamic effects and peri-intubation airway-related complications,

thereby generating region-specific evidence to improve pediatric airway management protocols.

The present study was conducted to compare conventional laryngoscopy and videolaryngoscopy for endotracheal intubation in children aged 5–11 years undergoing surgeries under general anaesthesia in a tertiary care centre.

Material and Methods

The present study was conducted as a quasi-experimental comparative study to evaluate the effectiveness of conventional direct laryngoscopy and videolaryngoscopy for endotracheal intubation in pediatric patients. This study was carried out in the Department of Anaesthesiology in a tertiary care teaching hospital. This research was carried out for eighteen months amongst children between the ages of 5 and 11 who qualified for the study and had elective surgical procedures performed under general anesthesia were identified and recruited during this period.

The study period of 18 months provided ample time for recruitment of the necessary number of patients, peri-operative observations and collection of outcome measures. The longer study time also allowed for a more constant number of participants to be recruited, regardless of the time of year.

Inclusion Criteria: Participants included in the study fulfilled the following criteria:

1. Children aged 5 to 11 years undergoing elective surgical procedures under general anesthesia.
2. Children of either gender admitted to the hospital for surgery.
3. Children classified as American Society of Anesthesiologists (ASA) physical status I–III.
4. Parents or legal guardians who provided written informed consent for participation in the study.

Exclusion Criteria: Participants were excluded from the study if they met any of the following criteria:

1. Children younger than 5 years or older than 11 years.
2. Parents or guardians who refused consent for participation.
3. Children with anticipated difficult airway, including craniofacial anomalies or congenital airway malformations.
4. Children at risk of pulmonary aspiration.
5. Patients with cardiovascular disease, respiratory disease, or hemodynamic instability.
6. Patients with conditions that could interfere with airway management or increase anesthesia risk.

These criteria ensured that only suitable participants were included while maintaining patient safety.

Study Sampling: A convenience sampling method was used for selecting the participants in the study. All children (5 to 11 years) who were scheduled for elective surgery under general anesthesia (GA) were screened for inclusion between April 2024 and January 2026. The participants were randomly separated into two study groups.

Study Sample Size: The overall number of children in the study was 70. The sample size was calculated based on the statistics obtained from previous research studies which had reported the mean time for intubation and SD. The calculated minimum sample size was 56 participants (28 in each group). To compensate for possible dropouts or incomplete data, additional participants were included. Therefore, the final sample size was increased to 70 participants, with 35 participants in each study group.

Study Groups: Participants were divided into two groups:

Group A – Conventional Laryngoscopy Group (Control Group): Participants in this group underwent endotracheal intubation using a Macintosh direct laryngoscope.

Group B – Videolaryngoscopy Group (Test Group): Participants in this group underwent endotracheal intubation using a video laryngoscope.

Both groups received identical anesthesia protocols except for the method of laryngoscopy used during intubation.

Study parameters: The following parameters were assessed during the study:

1. **Time taken for intubation (TTI):** Measured from removal of the face mask after ventilation to confirmation of end-tidal CO₂.
2. **Cormack–Lehane grading:** Used to assess the laryngeal view obtained during laryngoscopy.
3. **Requirement of additional airway maneuvers:** Such as external laryngeal manipulation or BURP maneuver.
4. **Hemodynamic parameters:** Including heart rate, blood pressure, oxygen saturation, and respiratory rate before and after intubation.
5. **Complications:** Such as airway trauma, desaturation, or arrhythmia.

Study Procedure: Pre-anesthetic evaluation was performed one day prior to surgery. Baseline demographic data and medical history were recorded. After obtaining written informed consent from parents or guardians, eligible participants were enrolled in the study.

On the day of surgery, in the operating room, standard monitoring devices were attached,

including ECG, non-invasive blood pressure monitor, pulse oximeter, and capnography.

Pre-medication was administered including ondansetron (0.1 mg/kg), glycopyrrolate (0.004 mg/kg), midazolam (0.02 mg/kg), and fentanyl (2 µg/kg). Patients were pre-oxygenated with 100% oxygen for 3-5 minutes. Anesthesia was induced using propofol (2 mg/kg) followed by succinylcholine (2 mg/kg) to facilitate endotracheal intubation. Laryngoscopy was then performed according to the assigned study group.

The initial laryngoscopic view was graded according to the modified Cormack–Lehane classification. The appropriate size endotracheal tube was selected using the formula $\text{Age}/4 + 4$. The time taken for intubation was recorded and confirmation of successful intubation was done by detecting end-tidal $\text{CO}_2 \geq 30$ mmHg on capnography. Atracurium

0.5 mg/kg was used as muscle relaxant. Intraoperatively, patient was maintained on O_2 + air + sevoflurane. Vital parameters were monitored in both groups after intubation, 1 minute, 5 minute and 10 minutes after intubation. Intraoperative hemodynamic parameters were monitored in both groups. At the end of surgery, sevoflurane was stopped. Patient was extubated after adequate reversal with inj neostigmine (0.05 mg/kg) and glycopyrrolate (0.008 mg/kg). Patients were monitored at PACU after surgery. Patients were evaluated for any complications during evening rounds in the ward.

Data Collection: Data was entered electronically and analysed using standard statistical methods.

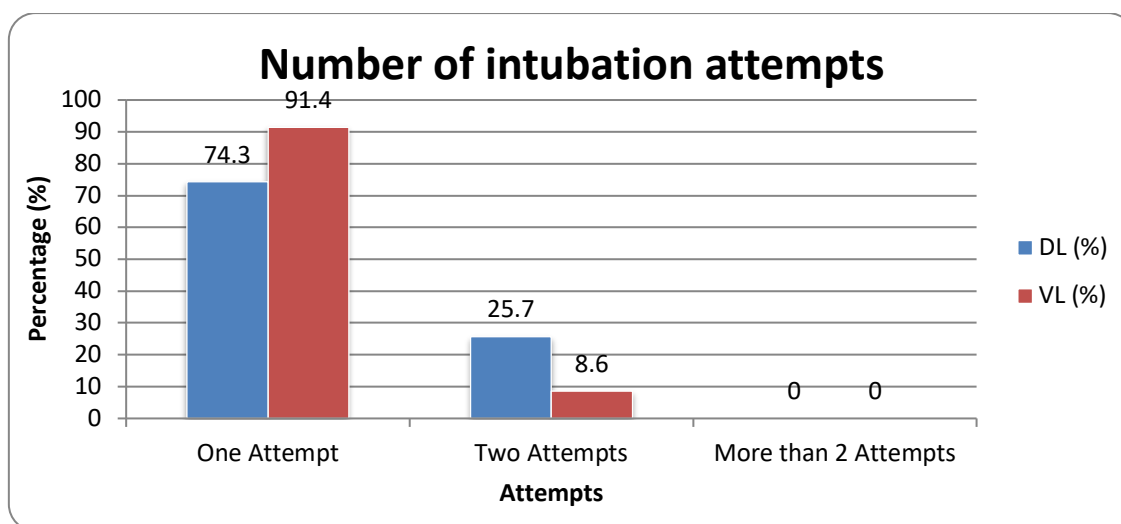
Results

Table 1: Comparison of number of intubation attempts between study groups

Number of intubation attempts	Direct Laryngoscopy n (%)	Video Laryngoscopy n (%)	Chi-square value	p value
One attempt	26 (74.3%)	32 (91.4%)	3.64	0.056
Two attempts	9 (25.7%)	3 (8.6%)		
More than 2 attempts	0 (0.0%)	0 (0.0%)		

Interpretation: Most patients in both groups were successfully intubated on the first attempt. First-attempt success was higher in the Video Laryngoscopy group (91.4%) compared to the Direct Laryngoscopy group (74.3%). Two intubation attempts were more frequently required in the Direct Laryngoscopy group, whereas no patient

in either group required more than two intubation attempts. Chi-square analysis showed borderline statistical significance ($\chi^2 = 3.64$, $p = 0.056$), suggesting that video laryngoscopy may improve first-attempt intubation success compared to direct laryngoscopy.



Graph 1: Number of intubation attempts.

Table 2: Comparison of time to intubate between study groups

Variable	Direct laryngoscopy (n=35) (in seconds)	Video laryngoscopy (n=35) (in seconds)	t value	p value
Mean time to intubate (Seconds)	35.84	24.91	8.72	<0.001*
Standard deviation	7.82	4.61		
Minimum time	20.3	16.8		
Maximum time	50.6	35.2		

Interpretation: The mean time required for intubation was significantly higher in the direct laryngoscopy group (35.84 ± 7.82 seconds) compared to the video laryngoscopy group (24.91 ± 4.61 seconds). independent sample t-test demonstrated a highly statistically significant difference between the groups ($t = 8.72$, $p < 0.001$).

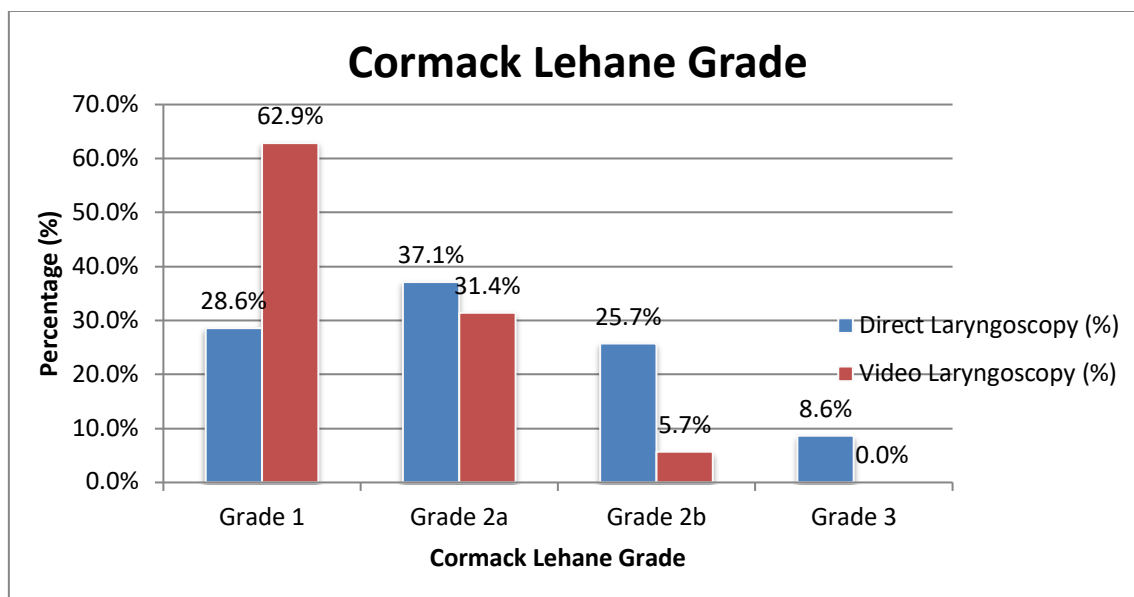
These findings indicate that video laryngoscopy facilitates faster endotracheal intubation in pediatric patients. Prolonged intubation time observed with direct laryngoscopy may contribute to increased sympathetic hemodynamic response, which can occasionally persist for up to 10 minutes following airway instrumentation.

Table 3: Distribution of Cormack Lehane grade between study groups

Cormack Lehane grade	Direct laryngoscopy n (%)	Video laryngoscopy n (%)	Chi-square value	p value
Grade 1	10 (28.6%)	22 (62.9%)	10.82	0.004*
Grade 2a	13 (37.1%)	11 (31.4%)		
Grade 2b	9 (25.7%)	2 (5.7%)		
Grade 3	3 (8.6%)	0 (0.0%)		

Interpretation: Cormack Lehane Grade 1 view was observed more frequently in the Video Laryngoscopy group compared to the Direct Laryngoscopy group. Difficult glottic views such as Grade 2b and Grade 3 were more common in the Direct Laryngoscopy group. Chi-square analysis

demonstrated a statistically significant difference between the groups ($\chi^2 = 10.82$, $p = 0.004$). These findings suggest that video laryngoscopy provides superior glottic visualization compared to direct laryngoscopy.



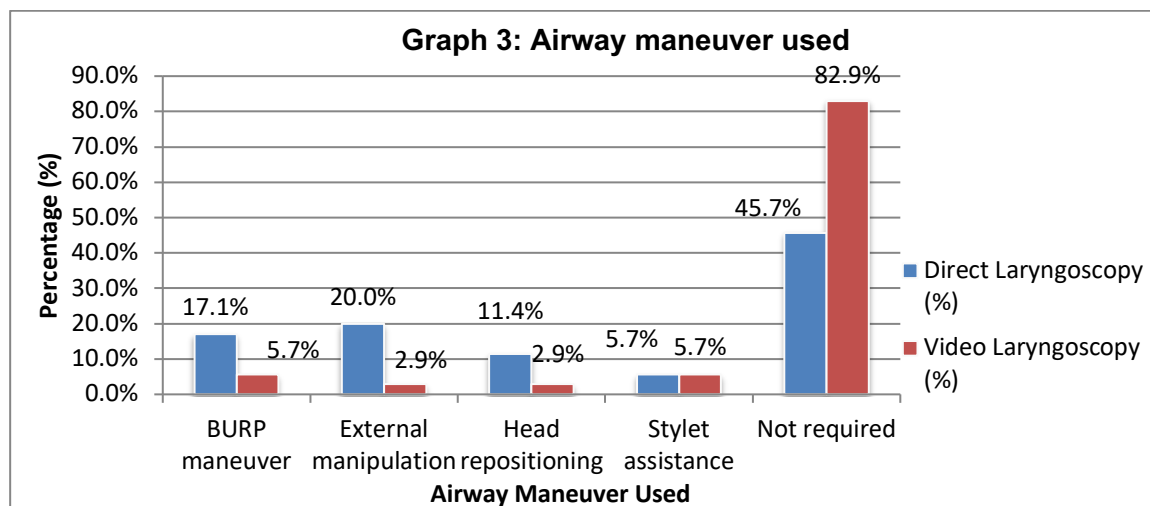
Graph 2: Cormack Lehane Grade

Table 4: Distribution of airway maneuver used between study groups

Airway maneuver used	Direct laryngoscopy (n=35)	Video laryngoscopy (n=35)	Chi-square value	p value
BURP maneuver	6 (17.1%)	2 (5.7%)	8.27	0.041*
External laryngeal manipulation	7 (20.0%)	1 (2.9%)		
Head repositioning	4 (11.4%)	1 (2.9%)		
Stylet assistance	2 (5.7%)	2 (5.7%)		
Not required	16 (45.7%)	29 (82.9%)		

Interpretation: The most commonly used airway maneuver in the Direct Laryngoscopy group was external laryngeal manipulation followed by BURP maneuver. In contrast, the majority of patients in the Video Laryngoscopy group did not require any additional airway maneuver. Requirement of airway maneuver was significantly higher in the Direct

Laryngoscopy group compared to the Video Laryngoscopy group. Chi-square analysis demonstrated a statistically significant difference between the two groups ($\chi^2 = 8.27$, $p = 0.041$), indicating that video laryngoscopy provided improved glottic visualization with reduced need for adjunct airway maneuvers.



Graph 3: Airway maneuver used

Table 5: Comparison of vital parameters before intubation between study groups (baseline)

Variable	Direct laryngoscopy (Mean $\pm$ SD)	Video laryngoscopy (Mean $\pm$ SD)	t value	p value
Pulse rate before intubation (beats/min)	94.28 $\pm$ 8.12	93.11 $\pm$ 8.44	0.58	0.564
Systolic BP before intubation (mmHg)	101.37 $\pm$ 5.64	100.82 $\pm$ 5.91	0.31	0.758
Diastolic BP before intubation (mmHg)	61.14 $\pm$ 4.82	60.51 $\pm$ 5.11	0.49	0.624
SpO ₂ before intubation (%)	98.88 $\pm$ 0.71	99.02 $\pm$ 0.68	-0.61	0.543

Interpretation: The baseline vital parameters before intubation were comparable between the Direct and Video Laryngoscopy groups. Mean pulse rate, systolic blood pressure, diastolic blood pressure, and oxygen saturation showed no

statistically significant difference between the two groups. Independent sample t-test revealed p values greater than 0.05 for all baseline variables. Hence, both groups were hemodynamically stable and comparable prior to intubation.

Table 6: Comparison of vital parameters at different time intervals between study groups

Timeline	Variable	Direct laryngoscopy (Mean $\pm$ SD)	Video laryngoscopy (Mean $\pm$ SD)	t value	p value
After intubation	Pulse rate (beats/min)	110 $\pm$ 10	99 $\pm$ 7	6.84	<0.001*
	Systolic BP (mmHg)	118 $\pm$ 7	107 $\pm$ 6	7.21	<0.001*
	Diastolic BP (mmHg)	72 $\pm$ 6	65 $\pm$ 5	5.96	<0.001*
	SpO ₂ (%)	97 $\pm$ 1	99 $\pm$ 1	-4.63	<0.001*
1 minute after intubation	Pulse rate (beats/min)	107 $\pm$ 9	97 $\pm$ 6	6.12	<0.001*
	Systolic BP (mmHg)	114 $\pm$ 6	103 $\pm$ 5	6.88	<0.001*
	Diastolic BP (mmHg)	70 $\pm$ 5	63 $\pm$ 4	5.44	<0.001*
	SpO ₂ (%)	98 $\pm$ 1	99 $\pm$ 1	-3.91	<0.001*
5 minutes after intubation	Pulse rate (beats/min)	101 $\pm$ 7	95 $\pm$ 5	4.82	<0.001*
	Systolic BP (mmHg)	108 $\pm$ 5	101 $\pm$ 4	5.76	<0.001*
	Diastolic BP (mmHg)	65 $\pm$ 4	61 $\pm$ 3	4.29	<0.001*
	SpO ₂ (%)	99 $\pm$ 1	99 $\pm$ 1	-1.82	0.072
10 minutes after intubation	Pulse rate (beats/min)	97 $\pm$ 5	93 $\pm$ 4	2.94	0.004*
	Systolic BP (mmHg)	103 $\pm$ 4	100 $\pm$ 3	3.18	0.002*
	Diastolic BP (mmHg)	62 $\pm$ 3	60 $\pm$ 2	2.76	0.007*
	SpO ₂ (%)	99 $\pm$ 1	99 $\pm$ 1	-0.84	0.403

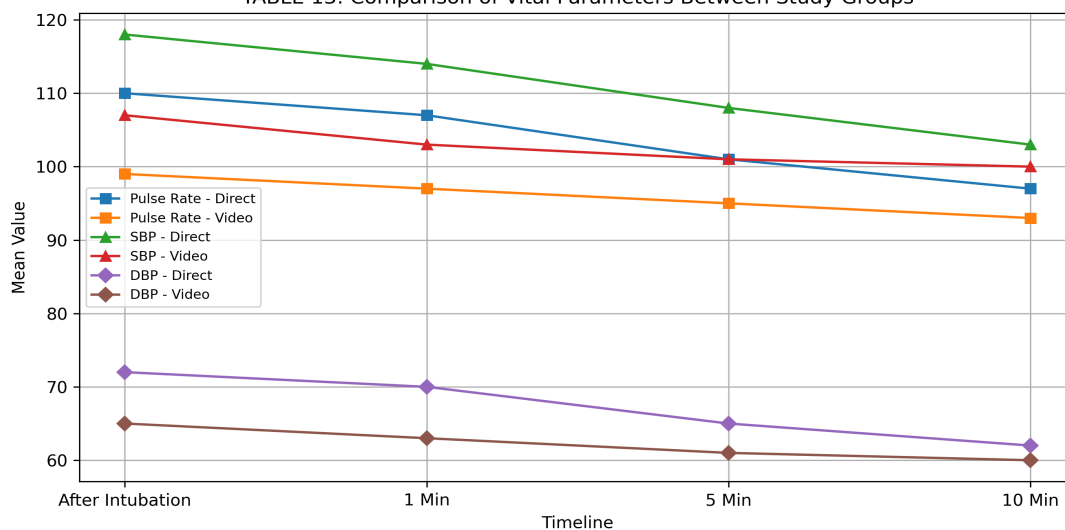
Interpretation: Following intubation, pulse rate and blood pressure increased significantly in the direct laryngoscopy group compared to the video laryngoscopy group. At 1 minute and 5 minutes after intubation, gradual normalization of hemodynamic

parameters was observed in both groups; however, the video laryngoscopy group demonstrated better cardiovascular stability and oxygen saturation maintenance. Even at 10 minutes after intubation, the direct laryngoscopy group continued to show

mildly elevated pulse rate and blood pressure values, indicating prolonged sympathetic hemodynamic response associated with conventional

laryngoscopy. Oxygen saturation remained adequately maintained in both groups throughout the observation period.

TABLE 13: Comparison of Vital Parameters Between Study Groups



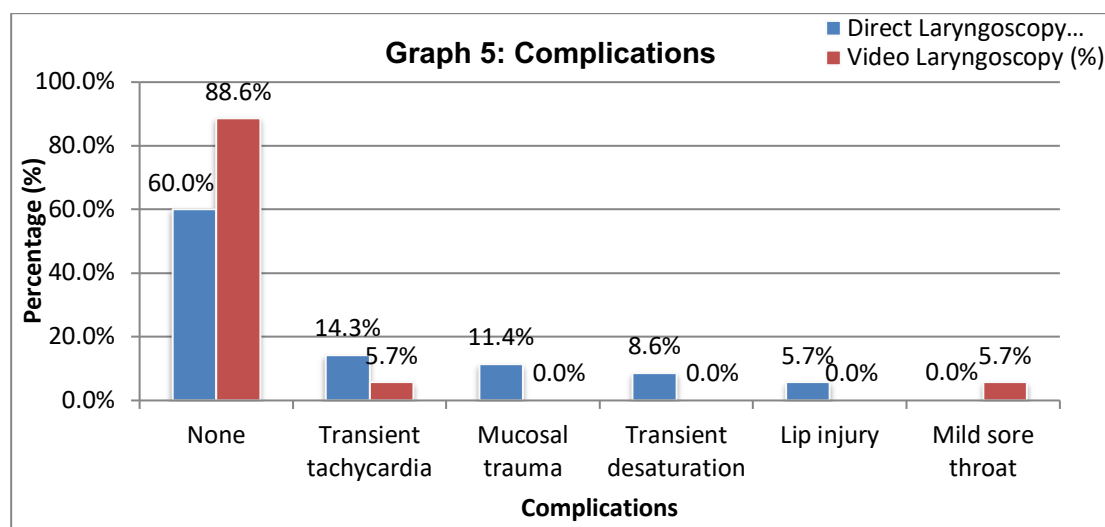
Graph 4: Comparison of Vital Parameters

Table 7: Distribution of complication details between study groups

Complication details	Direct laryngoscopy n (%)	Video laryngoscopy n (%)	Chi-square value	p value
None	21 (60.0%)	31 (88.6%)	9.84	0.020*
Transient tachycardia	5 (14.3%)	2 (5.7%)		
Mild mucosal trauma	4 (11.4%)	0 (0.0%)		
Transient desaturation	3 (8.6%)	0 (0.0%)		
Lip injury	2 (5.7%)	0 (0.0%)		
Mild sore throat	0 (0.0%)	2 (5.7%)		

Interpretation: The most common finding in both groups was absence of complications; however, complications such as transient tachycardia, mucosal trauma, desaturation, and lip injury were more common in the Direct Laryngoscopy group. Mild sore throat was infrequently observed in the

Video Laryngoscopy group. Chi-square analysis demonstrated a statistically significant difference in complication profile between the two groups ($\chi^2 = 9.84$, $p = 0.020$). These findings support the safer airway profile associated with video laryngoscopy.



Graph 5: Complications

Discussion

The paediatric airway presents unique challenges because of its smaller airway diameter, relatively large tongue, increased oxygen consumption and reduced functional residual capacity. Children can therefore develop rapid oxygen desaturation and physiological instability during prolonged or difficult airway instrumentation. Conventional DL requires alignment of the oral, pharyngeal and laryngeal axes and may necessitate considerable airway manipulation. VL provides an indirect, magnified view of the glottis and may facilitate intubation with less alignment and reduced mechanical manipulation. These characteristics are particularly relevant in children, in whom even brief periods of difficult or repeated intubation can result in hypoxaemia and haemodynamic stress.

Demographic and Clinical Comparability: The two groups were comparable with respect to age, gender, ASA physical status, Mallampati grade, type of surgery and surgical specialty. The mean age was 7.43 ± 1.75 years in the DL group and 7.69 ± 2.13 years in the VL group, with no statistically significant difference ($p=0.583$). Similarly, gender distribution was comparable ($p=0.630$), with females comprising 60.0% of the DL group and 51.4% of the VL group. ASA physical status was also similar, with most children belonging to ASA I or II, and no significant difference between groups ($p=0.856$). These findings are important because baseline physiological and airway characteristics could otherwise influence intubation outcomes.

Previous paediatric airway studies have used similar comparative designs. Manirajan et al. studied 78 children and compared King Vision VL with Macintosh DL, assessing intubation time, first-attempt success, glottic view and intubation difficulty score [13]. Klabusayová et al. evaluated 501 paediatric patients and compared first-attempt success, intubation time, number of attempts and complications [14]. Kamal et al. included 70 children aged 4–12 years, with 35 patients in each group [15], while Yavuz et al. evaluated 100 children equally divided between VL and DL [16]. Ray et al. studied younger children aged 3 months to 6 years [17]. The present study specifically focuses on school-going children aged 5–11 years, thereby providing evidence within a relatively homogeneous paediatric age group.

Mallampati grading was also statistically comparable ($p=0.087$). Although the DL group had a somewhat higher proportion of Grade II and III airways, this difference was not significant. Thus, the superior glottic visualization observed with VL is unlikely to be explained by a major baseline difference in airway assessment.

The distribution of surgical procedures and specialties was also comparable. ENT procedures accounted for 42.9% of cases in each group, while general surgery and orthopaedic procedures were similarly distributed. This is relevant because ENT surgery may itself influence airway management. The balanced surgical profile therefore strengthens the interpretation that differences in intubation outcomes were predominantly associated with the airway device rather than surgical category. Mutlak et al. similarly assessed children undergoing elective surgery using C-MAC VL, TruView infant EVO2 VL and Macintosh DL [18].

First-Attempt Success and Intubation Attempts: First-attempt success was higher with VL. In the present study, 91.4% of children in the VL group were intubated successfully on the first attempt compared with 74.3% in the DL group. Although the difference was borderline statistically significant ($\chi^2=3.64$, $p=0.056$), the clinical importance is considerable. Repeated intubation attempts can increase airway trauma, oxygen desaturation and haemodynamic stimulation, particularly in children.

These findings are consistent with the systematic review and meta-analysis by Lingappan et al., which included 467 paediatric intubation attempts and demonstrated improved first-attempt success with VL (relative risk 1.44; absolute risk difference 0.19) [19]. Warinton and Ahmed also reported improved first-pass success with VL in 10 observational studies involving 5,586 paediatric intubations (OR 1.64, 95% CI 1.21–2.21; $p=0.001$) [20]. However, evidence is not completely uniform. Klabusayová et al. reported first-attempt success of 86.8% with VL versus 92.6% with DL ($p=0.046$) [84]. These differences may reflect variations in device type, operator experience, patient characteristics and clinical setting. Nevertheless, the higher first-attempt success observed in the present study favours VL.

Intubation Time: A major finding was the significantly shorter intubation time with VL. Mean intubation time was 24.91 ± 4.61 seconds with VL compared with 35.84 ± 7.82 seconds with DL ($t=8.72$; $p<0.001$). The maximum recorded time was also lower with VL. Reduced intubation time is particularly important in paediatric patients because of their limited oxygen reserve and rapid progression to desaturation during airway instrumentation.

Smereka et al. similarly demonstrated shorter median intubation time with VL in difficult paediatric airway simulation, 15 seconds compared with 27 seconds with Miller DL [21]. However, other studies have reported longer intubation times with VL. Rabiner et al. found that VL required 61.4 seconds compared with 67.4 seconds with DL in normal airway simulation, whereas in difficult

airway simulation VL took longer [22]. Klabusayová et al. reported 39.0 ± 36.7 seconds with VL versus 23.6 ± 24.7 seconds with DL ($p < 0.001$) [84], while Yavuz et al. reported 29.1 ± 5.7 seconds versus 20.7 ± 5.1 seconds, respectively ($p = 0.001$) [16]. These contrasting results indicate that intubation time is influenced by operator familiarity, device design, stylet requirements, airway anatomy and clinical environment. The shorter time in the present study may reflect improved visualization and operator familiarity with the VL device.

Cormack–Lehane Grade and Glottic Visualization: VL produced significantly better glottic visualization. Grade I views were obtained in 62.9% of VL cases compared with only 28.6% of DL cases. Grade 3 views occurred in 8.6% of DL cases but were absent in the VL group ($\chi^2 = 10.82$; $p = 0.004$). This represents one of the strongest advantages of VL demonstrated in the present study.

The findings are consistent with Kamal et al., who reported Grade I views in 32 of 35 children using VL compared with 23 of 35 using DL ($p = 0.002$) [15]. Yavuz et al. also reported Grade I visualization in 78% of children with VL compared with 66% with DL [16]. Manirajan et al. demonstrated improved glottic visualization and reduced intubation difficulty with VL [13]. The improved view achieved with VL may explain several other favourable outcomes observed in the present study, including shorter intubation time, fewer manoeuvres and higher first-attempt success.

Airway Manoeuvres: The requirement for additional airway manoeuvres was significantly lower with VL. No manoeuvre was required in 82.9% of VL cases compared with 45.7% of DL cases ($\chi^2 = 8.27$; $p = 0.041$). BURP, external laryngeal manipulation and head repositioning were considerably less frequent with VL, although stylet assistance was similar between groups.

These findings agree with Manirajan et al., who reported a significant reduction in additional manoeuvres with VL ($p < 0.01$) [13]. Yavuz et al. found that anterior laryngeal pressure was required in 32% of VL cases compared with 78% of DL cases ($p = 0.01$) [16]. Kamal et al. also demonstrated a shorter time to obtain the best glottic view with VL [15]. Reduced manoeuvre requirements suggest that VL allows the operator to visualize the glottis more effectively without excessive external manipulation, potentially decreasing airway trauma and sympathetic stimulation.

Haemodynamic Response: Baseline pulse rate, systolic and diastolic blood pressure and SpO_2 were comparable between groups, confirming similar physiological status before intubation. Following intubation, however, VL was associated with significantly lower pulse rate and blood pressure at

all measured time points. Immediately after intubation, pulse rate was 110 ± 10 beats/min with DL compared with 99 ± 7 beats/min with VL ($p < 0.001$). Similarly, systolic BP was 118 ± 7 mmHg with DL versus 107 ± 6 mmHg with VL, while diastolic BP was 72 ± 6 mmHg versus 65 ± 5 mmHg, respectively (both $p < 0.001$).

The difference persisted at 1, 5 and 10 minutes, indicating a more prolonged sympathetic response following DL. Overall, a stable haemodynamic response was observed in 68.6% of VL cases compared with only 17.1% of DL cases, whereas marked sympathetic response occurred in 2.9% and 31.4%, respectively ($\chi^2 = 18.92$; $p < 0.001$). Javaherforooshzadeh and Gharacheh emphasized the risk of rapid haemodynamic instability during paediatric induction, particularly in children undergoing congenital heart surgery [23]. The lower cardiovascular response observed with VL in the present study may be related to its shorter intubation time, improved visualization and reduced airway manipulation.

Oxygen Saturation: Although baseline oxygen saturation was comparable, early post-intubation SpO_2 was significantly better with VL. Immediately after intubation, SpO_2 was $97 \pm 1\%$ with DL compared with $99 \pm 1\%$ with VL ($p < 0.001$). At 1 minute, the corresponding values were $98 \pm 1\%$ and $99 \pm 1\%$ ($p < 0.001$). By 5 and 10 minutes, SpO_2 was $99 \pm 1\%$ in both groups, indicating recovery in both techniques.

Mutlak et al. found no significant difference in post-intubation oxygen saturation among different VL devices and Macintosh DL [18]. Lingappan et al. similarly reported comparable desaturation episodes between VL and DL [19]. The better early oxygenation in the present study may be associated with shorter intubation time and higher first-attempt success with VL.

Airway-Related Complications: Complications were significantly less frequent with VL. No complication occurred in 88.6% of VL cases compared with 60.0% of DL cases ($\chi^2 = 9.84$; $p = 0.020$). Transient tachycardia, mucosal trauma, transient desaturation and lip injury occurred more frequently with DL, whereas VL was associated mainly with transient tachycardia and mild sore throat. These results differ somewhat from previous literature. Lingappan et al. reported improved first-attempt success without increased complications and found comparable desaturation between techniques [19]. Warinton and Ahmed found no significant difference in adverse events (OR 0.79, 95% CI 0.52–1.20) [20]. Kamal et al. reported no airway complications in either group [15], while Yavuz et al. found no significant airway trauma or hypoxaemia [16]. The lower complication rate in the present study may be attributable to better glottic

visualization, fewer attempts, shorter intubation time and reduced airway manipulation.

Association of Glottic View with Intubation Outcomes: An important finding was the significant association between CL grade and intubation attempts ($\chi^2=16.42$; $p<0.001$). Among children with Grade I views, 93.8% were intubated in one attempt, whereas only 33.3% of Grade III cases achieved first-attempt success. Similarly, worsening CL grade was strongly associated with increasing need for airway manoeuvres ($\chi^2=28.74$; $p<0.001$). Only 15.6% of Grade I cases required a manoeuvre compared with 100% of Grade III cases. These findings demonstrate that improved visualization is not merely a descriptive advantage of VL but is clinically relevant to successful and atraumatic intubation. Lingappan et al. reported improved first-attempt success with VL [19], while Smereka et al. demonstrated first-attempt success of 87.1% with VL compared with 48.4% with DL in difficult paediatric airway scenarios [21]. Warinton and Ahmed similarly reported improved first-pass success with VL [20]. Thus, the superior CL view achieved by VL in the present study provides a plausible mechanism for its improved intubation performance.

Overall Interpretation: The findings of the present study indicate that VL offers several clinically relevant advantages over conventional DL in school-going children aged 5–11 years. VL significantly improved glottic visualization, reduced intubation time and airway manoeuvres, and was associated with a higher first-attempt success rate. It also produced a substantially lower sympathetic response and better early oxygenation, with fewer airway-related complications.

Although some previous studies have reported longer intubation times or no significant difference in complications with VL [14,20], the overall evidence supports its usefulness, particularly where airway visualization and minimization of repeated attempts are important. The results suggest that VL may be especially beneficial in anticipated difficult airways, teaching environments and situations where reduction of airway manipulation is desirable.

The study has practical implications for paediatric anaesthesia. Incorporating VL into routine paediatric airway protocols may improve airway visualization and reduce peri-intubation morbidity. However, successful use depends on appropriate device selection, availability of suitable paediatric blades, operator training and familiarity with the technique. VL should therefore complement rather than completely replace DL, as proficiency in conventional laryngoscopy remains essential for airway rescue and situations where VL is unavailable or unsuitable.

Conclusion

The study comparing conventional laryngoscopy and videolaryngoscopy in 5 to 11 year school going children who underwent surgery under general anaesthesia showed that videolaryngoscopy has better visualisation, less intubation time requirement, less number of intubation attempts, lesser hemodynamic responses and fewer complications after intubation. Hence, we conclude that videolaryngoscope is better in endotracheal intubation in 5 to 11 year school going children than conventional laryngoscope.

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