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Original Research Article

Comparison of videolaryngoscopy and direct laryngoscopy for tracheal intubation in paediatric patients

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ABSTRACT

Introduction: There are many studies in India that have compared direct laryngoscopy and video laryngoscopy in adults but the published data regarding paediatric population which needs special consideration is limited. The present study was aimed to compare the efficacy of video laryngoscopy and direct laryngoscopy in endotracheal intubation in paediatric patients.

Materials and Methods: The present randomised controlled research was done in 64 children of one to five years that underwent pre-planned surgery. Children were divided into direct laryngoscopy and video laryngoscopy groups by randomization. The comparison of the time required for the best visualisation of glottis was the primary outcome measure. The comparison of the time to intubation and number of attempts were the secondary outcome measures. An unpaired student's t-test and the Chi-square/ Fisher's exact tests were used to compare the quantitative and qualitative variables respectively.

Results: Mean time required for the best visualisation of video laryngoscopy and direct laryngoscopy was 6.1 sec and 5.3 sec respectively (p-value = 0.010). The mean time to intubation of video laryngoscopy was 15.3 sec while that of direct laryngoscopy was 13.1 sec (p-value = 0.001). The first attempt success rate was 29/32 (90.6%) in the video laryngoscopy group whereas it was 28/32 (87.5%) in the direct laryngoscopy group (p-value = 0.580).

Conclusion: Time required for the best visualisation of glottis and time to intubation were significantly higher in video laryngoscopy as compared to direct laryngoscopy group.

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1. Introduction

Many attempts are made to improve the techniques and tools of direct laryngoscopes since its inception. A “line of-sight” from the operator and the laryngeal inlet is the basis of the direct laryngoscopy (DL). The position of the head and dependable anatomy is very important for the success of DL. If there is poor tissue mobility, limited mouth opening, or enlarged tongue, the chances of intubation by DL decrease.^{1,2} The accomplishment of tracheal intubation increases if video laryngoscopy (VL) is used. The success

rate of VL is more because high-resolution micro-cameras and small portable flat-screen monitors are used in video laryngoscope. It is reported that VL is useful in everyday and complex tracheal intubation, especially in children.³

The airway anatomy of the children is distinctive as compared with adults. The laryngoscopy and intubation in children is difficult because of restricted opening of the mouth, comparatively larger tongue and more cephalad larynx; so also the consumption of oxygen is much higher in children as compared to the adults. Hence, limited period is available for the intubation in the children.⁴ The presence of congenital orofacial clefts distort the upper airway anatomy and association with wider palatal clefts, bilateral cleft lips,

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major nasal deformity, micrognathia and receding mandible further increases the intubation difficulty.⁵

In VL, a flexible endoscope is used for indirect laryngoscopy and in VL, there is no need of a direct line to view the airway structures. The glottis can be visualized more correctly by VL. A small quantity of force is required at the base of the tongue during VL. Hence, the chances of local tissue injury and response to stress are reduced. Even though there is no obvious evidence that the success of endotracheal intubation (ETI) is increased by VL, VL is now widely used by the anaesthesiologist and other healthcare providers. A further research should be conducted to ascertain whether VL improves intubation time, ETI and first-attempt success rates and thus can become a probable substitution to conventional DL. Even though there is an improved visualization of the glottis by using VL, difficulty may arise in ETI. An anaesthesiologist may develop a false sense of security and may not be prepared for ETI of difficult airway.⁶ Procedure is more complicated and expensive. It was reported that there is a benefit of using VL.^{7,8} There are many studies in adults but data on paediatric population in India is lacking. The present study was aimed to compare the efficacy of VL and DL for ETI in children.

2. Materials and Methods

This randomised controlled study was conducted between May 2020 and February 2021 in the major operation theatre of a tertiary care hospital, Pune, India. After approval from the institutional ethics committee, written informed consent was obtained from all the parents /guardians prior to enrollment explaining the risks and benefits of the procedure. Children aged between one and five years posted for elective surgery under general anaesthesia, falling into American Society of Anaesthesiologist (ASA) grades I-II and Cormack-Lehane grade I and II were included. The exclusion criterion was refusal of parents /guardians to participate in the study.

Out of 70 patients assessed for eligibility, after exclusion, 64 children were randomly divided into two equal groups of 32 each with the help of www.randomizer.org (Figure 1). The program was known as research randomizer. The program produced two sets of random numbers out of the range of numbers provided (for e.g. 1- 64) by taking user input on having uniqueness of the numbers to be generated. For the present study, the program produced two sets of 32 unique numbers per set. The sheet of the random numbers was ready before the study was started. The children were randomly divided into two groups; Group I – VL and Group II – DL.

All the children were thoroughly examined before the procedure. Basic investigations such as complete blood count, chest X-ray, etc. were done to rule out major systemic illness. An airway assessment of the children was done on

size and shape of head, facial features, mandibular size and symmetry, tongue size, palatal shape and pathology, prominence of teeth especially upper incisors, range of motion of head and neck. Airway assessment was done by Copur score⁹ and Cormack Lehane grading system.¹⁰

In the operating room, standard basic monitoring devices were attached to the children including a pulse-oximeter, 3 lead ECG, and non-invasive blood pressure (NIBP). Baseline measurements of NIBP, heart rate and saturation were recorded. Intravenous (IV) access was obtained. Appropriate size endotracheal tube for the children was selected. The tube was lubricated with a water soluble jelly. Children were pre-oxygenated with 100.0% oxygen for 5 min. Induction was done with Inj. thiopentone 5mg/kg + Inj. atracurium 0.5 mg/kg. Children were ventilated with bag and mask with sevoflurane 2.0% and oxygen for 3 min. After optimal positioning, stop watch was started as video laryngoscope inserted in the mouth. Time was noted when best possible view of glottis was seen. The endotracheal tube was passed through the vocal cords and successful insertion time was recorded. The VL was done with the blade being introduced in the midline without tongue lateralisation. Glottis was visualized on monitor.

If the intubation attempt with VL failed but saturation was maintained, another attempt was made for intubation and if the saturation decreased mask ventilation with 100.0% oxygen followed by intubation with video laryngoscope was carried out. Similar steps were taken for DL. Maximum 3 attempts were tried in each type of laryngoscopy. However, even after 3rd attempt the child could not be intubated, the other type of laryngoscopy was tried and these children were excluded from the study.

Time to the best visualization (TTBV) of glottis was defined as the time from when the laryngoscope blade entered the patient's mouth to the time the anaesthesiologist determined that the best possible view of glottis (Cormack-Lehane grade I or II) had been achieved.¹¹ The time to intubate (TTI) was defined as the time required between the insertion of the laryngoscope into the oral cavity and the view of the tube crossing the glottis or, in blind tracheal intubation, the presence of a carbon dioxide wave in the exhaled breath.¹² An attempt was defined as the insertion of the endotracheal tube into the trachea via the glottis under visualisation using a laryngoscope within 60 s. Inability to pass the endotracheal into the glottis within 60 s was considered a failure of the first attempt.¹³

The primary outcome measure was to compare the time required for best visualisation of glottis, whereas secondary outcome measures were to compare TTI and number of attempts. Donoghue AJ et al. reported that the first-attempt success in 81.0% and 39.0% of subjects in VL and DL respectively.³ The sample size of 30 patients in each group was calculated by formula $N^{14} = \{2p_{av}(1-p_{av}) (Z_{\alpha} + Z_{\beta})^2\} / \Delta^2$. Z_{α} (a standard normal variate at 1% type 1

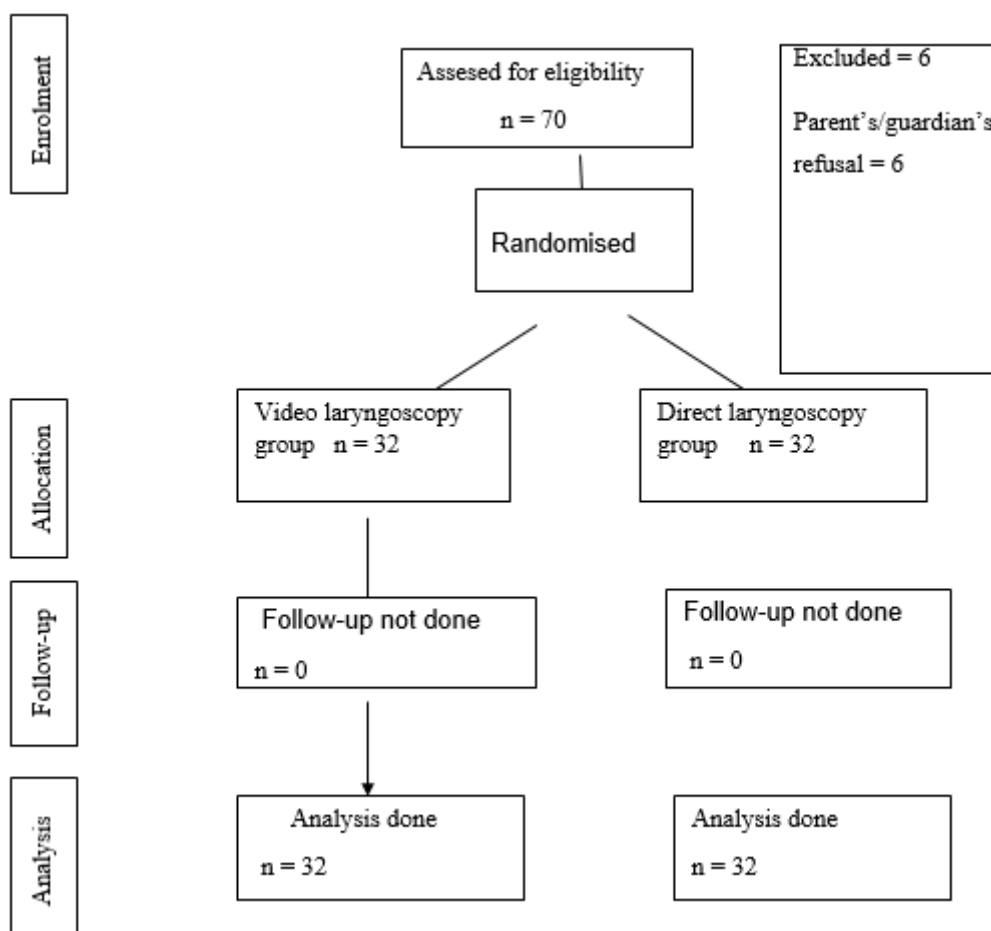


Fig. 1: Consort diagram

error) was taken as 2.58, whereas Z_{β} (a standard normal deviate for β power at 80% type II error) was taken as 0.842. We included 32 children to validate the results.

2.1. Statistical analysis

Data were collected and was analysed by using Statistical Package for Social Sciences for Windows, Version 20.0 from IBM Corporation Armonk, NY, USA. The data on categorical and continuous variables are presented as n (% of cases) and mean \pm standard deviation (SD) respectively. The Chi-square/Fisher's exact test and unpaired student's t-test were used to compare the qualitative and quantitative variables respectively. A p-value < 0.05 was considered as a significant.

3. Results

Out of 70 children, 64 children were included in the study as shown in Figure 1. They were divided into two groups (VL and DL) by randomization. As depicted in Table 1, the two groups were comparable in terms of the mean age,

gender and ASA grades. The mean Copur score was 6.1 ± 1.5 and 6.4 ± 2.2 in VL and DL groups respectively (p-value = 0.430). As shown in Table 2, the percentage of children in Cormack-Lehane grade I and grade II in VL group were 29/32 (90.6%) and 3/32 (9.4%) respectively, whereas the percentage of children in Cormack-Lehane grade I and grade II in DL group were 22/32 (68.7%) and 10/32 (31.3%) respectively (p-value = 0.007). It can be seen from Table 3 that mean TTBV (in seconds) was 6.1 ± 1.2 and 5.3 ± 1.1 in VL and DL groups respectively (p-value = 0.010), whereas mean TTI (in seconds) was 15.3 ± 1.9 and 13.1 ± 2.2 in VL and DL groups respectively (p-value = 0.001). The number of items required for intubation were comparable between VL and DL groups (p-value = 0.580).

4. Discussion

The airway and respiratory complications during the perioperative period in paediatric anaesthesia are common leading to morbidity and mortality.¹⁵ These complications can be seen in healthy children, particularly infants. It

Table 1: Baseline characteristics

Characteristics	VL n = 32 (%)	DL n = 32 (%)	Total n = 64 (%)	p- value
Mean age (in years) ± SD	3.0 ± 1.3	2.6 ± 1.4		0.170*
Gender				
Males	18 (56.3)	23 (71.9)	41(66.1)	0.460**
Females	14 (44.7)	9 (28.1)	21(33.9)	
ASA Grades				
Grade I	29 (90.6)	27 (84.4)	56 (87.5%)	0.807***
Grade II	3 (9.4)	5 (15.6)	8 (12.5%)	

*Unpaired t-test was used, **Chi square test was used, ***Fisher's exact test was used, VL- Videolaryngoscopy, DL- Direct laryngoscopy, ASA - American Society of Anaesthesiologist, SD- Standard deviation

Table 2: Baseline characteristics

Characteristics	VL n = 32 (%)	DL n = 32 (%)	Total n = 64 (%)	p- value
Mean Copur score ± SD	6.1 ± 1.5	6.4 ± 2.2		0.430*
Copur score				
Easy intubation (5-7)	28 (87.5%)	29 (90.6%)	57 (89.1)	0.460**
Moderately difficult (8-10)	3 (9.4%)	2 (6.3%)	5 (7.8)	
Difficult airway (> 10)	1 (3.1%)	1 (3.1%)	2 (3.1)	
Cormack-Lehane grades				
Grade I	29 (90.6%)	22 (68.7%)	51 (82.3%)	0.007**
Grade II	3 (9.4%)	10 (31.3%)	11 (17.7)	

*Unpaired t-test was used, **Fisher's exact test was used, VL- Videolaryngoscopy, DL- Direct laryngoscopy, SD- Standard deviation

Table 3: Comparison of intubation outcomes

Characteristics	VL n = 32 (%)	DL n = 32 (%)	Total n = 64 (%)	p- value
TTBV in sec ± SD	6.1 ± 1.2	5.3 ± 1.1		0.010*
TTI in sec ± SD	15.3 ± 1.9	13.1 ± 2.2		0.001*
Number of attempts				
One	29 (90.6%)	28 (87.5%)	57 (89.1)	0.580**
Two	3 (9.4%)	4 (12.5%)	7 (10.1)	

*Unpaired t-test was used, **Fisher's exact test was used, VL- Videolaryngoscopy, DL- Direct laryngoscopy, SD- Standard deviation, TTBV - Time taken for best visualization, TTI- Time taken for intubation

is reported that the incidence of difficult laryngoscopy is more common in infants and neonates.¹⁶ The airway of the children is distinctly different from that of adults, hence the knowledge of the airway anatomy and physiology of children is very important to prepare for managing children's airway.^{17,18} Due to these anatomical and physiological differences, the anaesthesiologist may come across unexpected difficulty in laryngoscopy and intubation in children while using conventional DL with Macintosh blade. Indirect VL in children is possible because of recent inventions in optics and electronics devices. There is no need to align the line of sight with laryngeal inlet in indirect VL hence it is advantageous for intubation in children as compared to DL.¹⁹ Many studies have compared VL with DL for tracheal intubation and opined that VL is better than DL.^{4,20–23}

In the present study, the mean TTBV of VL and DL was 6.1 sec and 5.3 sec respectively (p-value = 0.010). Our findings are consistent with previous studies.^{4,24} Fiadjoe JE et al reported that the median TTBV was 9.9 sec and 8.1 sec in DL and VL groups respectively (p-value = 0.03).²¹

Vlatten A et al. reported that the median TTBV in DL and VL was 5.5 sec and 7.0 sec respectively (p-value = 0.769).²⁵ Sun Y et al. reported that the time of intubation was increased but glottis was better visualized by VL.⁴ Javaherforooshzadeh F and Gharacheh L reported that the glottis was better visualized by VL than DL.²⁶ Macnair D et al. opined that glottis was better visualized by VL, but TTI was higher as compared to DL.²⁴ Karsli C et al. concluded that in children with a difficult airway, laryngoscopic view was better in VL than DL. The study further stated that DL and VL required 20 sec and 26 sec respectively to achieve the adequate view of the glottis (p-value = 0.5).²⁷

In the present study, of 32 children on whom VL was performed, 29 (90.6%) were intubated in first attempt while 3 (9.4%) required second attempt for intubation, whereas in DL group, of 32 children, 28 (87.5%) were intubated in first attempt and 4 (12.5%) required second attempt (p-value = 0.580). Fiadjoe JE et al. reported that the success rate of VL and DL was 96.0% and 94.0% respectively (p-value > 0.05).²¹ Javaherforooshzadeh F and Gharacheh L reported that 22, 8 and 6 patients were intubated in 1st, 2nd

and 3rd attempt respectively in DL group, whereas 24, 6 and 2 patients were intubated in 1st, 2nd and 3rd attempt respectively in VL group (p-value = 0.033).²⁶

Abid ES et al. reported that first pass success (FPS) in children above one year of age was better as compared to DL.²⁸ Similar results were reported by Eisenberg et al. in a paediatric emergency medicine department.²⁹ Rabiner JE et al. reported that in DL group, 15 (60.0%) and 5 (20.0%) were intubated in the first and second item respectively, whereas in VL group, 16 (64.0%) and 4 (16.0%) were intubated in the first and second item respectively which was not statistically significant.³⁰

The intubation procedure can be recorded by VL. The same can be reviewed for teaching purposes to calculate the number of attempts and time to intubation and adverse events.³¹ The objective assessment of procedural performance can be done by VL and it is more precise than self-report.³²

In our study, the mean TTI of VL was 15.3 sec while that of DL was 13.1 sec (p-value = 0.001). Fiadjoe JE et al. reported that the median TTI was 22.6 sec and 21.4 sec in the VL and DL group respectively (p-value = 0.24).²¹ Macnair D et al. reported that the median TTI was 16.0 sec and 22.5 sec for DL and VL respectively (p-value < 0.001).²⁴ Vlaten A et al. reported that the median TTI in DL and VL was 21 sec and 27 sec respectively (p-value = 0.006).²⁵ Javaherforooshzadeh F and Gharacheh L reported that TTI was 29.33 sec and 33.33 sec for DL and VL groups respectively (p-value = 0.20).²⁶ Rabiner JE et al. reported that the mean TTI was 67.4 sec and 61.4 sec in DL and VL group respectively (p-value > 0.05).³⁰

White M et al reported in a study conducted among anaesthesiologists and paediatric intensivists that there was no significant difference in TTI between VL and DL. The study further stated that in general satisfaction was higher in DL as compared to VL and in case of emergency intubation the higher percentage would choose DL over VL.³³ Lim T et al. reported that 85.0% and 30.0% of anaesthesiologists preferred DL in an easy and difficult airway scenario respectively, even though time to intubation was significantly shorter in VL as compared to DL.³⁴ Platts-Mills TF reported that in an emergency department DL was preferred over VL.³⁵ It was observed that in difficult airway situation where it is hard to introduce the endotracheal tube between the vocal cords with the VL technique, TTI is longer in new learners.

The strength of the present research is that it was probably the first study conducted in children between one and five years in Indian population. Limitations to the current analysis warrant consideration. The present research was conducted in only one institution with small population size which included ASA grade I and II and Cormack and Lehane score 1 and 2. The grades of Cormack and Lehane classification of laryngeal views are subjective. The blinding was not done in the present research. Complications

were not noted and compared. These findings should be considered hypothesis generating and need to be confirmed in larger populations by conducting randomized controlled studies.

5. Conclusions

From the above study, it can be concluded that the efficacy of direct laryngoscopy is better than videolaryngoscopy for best visualization of the glottis and endotracheal intubation in paediatric patients.

6. Source of Funding

None.

7. Conflict of Interest

None.

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