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ORIGINAL RESEARCH

Videolaryngoscopy for pediatric intubation compared to classic orotracheal intubation.

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Abstract

Introduction: Airway management is an important aspect of pediatric anesthesia. Anatomical differences in this population make pediatric patients more susceptible to the devices that are designed for their management. Videolaryngoscopy provides an improved panoramic view of the glottis. The aim of the present study was to compare the use of video laryngoscopy to direct laryngoscopy for endotracheal intubation in pediatric patients.

Methods: Using an observational descriptive study design, 276 patients (aged 5 to 17 years) who were undergoing planned surgery with general anesthesia plus orotracheal intubation were enrolled. The specialist determined the handling device that was used. The data were transcribed from the forms and analyzed using SPSS 22.0. Descriptive analysis was based on the median, mode, average, and minimum and maximum values as well as the standard deviation and range. A p value ≤ 0.05 was considered to be statistically significant.

Results: The patients' mean age was 9.83 years. With direct laryngoscopy or videolaryngoscopy, 97.4% or 88.4% of the intubations were performed on the first attempt (P=0.003). In 94.2% of direct laryngoscopy cases and 75.2% of laryngoscope cases, successful intubation was performed in less than 10 seconds (P<0.001). Complications occurred in 6.6% of intubations with video laryngoscopy compared to 2.6% with conventional laryngoscopy (P=0.103). Additionally, 56.2% of specialists preferred direct laryngoscopy compared to videolaryngoscopy to manage a pediatric airway without predictors of difficulty.

Conclusions: Videolaryngoscopy provides additional support for routine airway management, and it requires previous knowledge and skill. However, there is insufficient evidence to support the use of one technique over the other.

Keywords: airway, videolaryngoscopy, intubation time, complications, number of attempts.

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Introduction

A fundamental part of pediatric anesthesia practice is the airway approach. The anatomical characteristics of this population and the structural differences compared to adults make them more susceptible to complications that are caused by video devices that are designed for their airway approach. Airway imaging studies in children identified the glottis as the narrowest part and the larynx as cylindrical rather than conical. These findings generate discrepancies when choosing a handling device [1].

Although complications related to the management of the pediatric airway are not frequent, they can cause morbidity in vulnerable populations such as newborns and young infants. Difficulties such as inadequate ventilation, bronchial obstruction, apnea, or difficult intubation are causes that are related to morbidity and mortality in this population. Determining the advantages and limitations of the different pediatric orotracheal intubation techniques is a starting point to optimize its approach. The videolaryngoscopy is becoming a fundamental support tool for pediatric orotracheal intubation [2].

The American Society of Anesthesiologist Closed Claims project reveals that 34% of the lawsuits against anesthesiologists are related to airway events, and they represent 10% of the complaints that are filed against health professionals in the pediatric setting [3].

This research is relevant to treating physicians and those who are in charge of managing the pediatric airway because it can help with establishing appropriate management protocols, and the ability to anticipate a possible difficult airway or to use an additional support tool if there is an unexpected difficult airway is beneficial. This research also directly benefits the patients who will receive individualized treatment in terms of airway assessment and management. The aim of the present study was to compare the use of video laryngoscopy with direct laryngoscopy for orotracheal intubation in pediatric patients.

Population and methods

Study design

A descriptive, observational, analytical study was performed.

Research setting

This study was conducted at the Vicente Corral Moscoso Hospital, which is part of the Public Health Ministry, Cuenca, Ecuador, from January 1 to December 31, 2018. The study period was considered to include the recruitment and procedure periods. Study follow-up was concluded on March 7, 2019, and data collection was completed on April 7, 2019.

Participants

Patients who were between 5 and 17 years of age were enrolled into this study. There were 980 patients who attended the Vicente Corral Moscoso Hospital during the study period and they included hospitalized patients and outpatients who underwent planned surgery using general anesthesia plus orotracheal intubation.

Variables

The study variables included age, sex, body mass index (BMI), surgeon's laryngoscopy preference, intubation time, number of attempts to perform intubation, and complications (bleeding, edema, dental trauma, technical difficulty, and others).

Data sources

After successful intubation, we collected data, and subsequently performed statistical analysis. A form was used to transcribe patient data including intubation time in seconds, number of attempts, surgeon's preference, and complications in the pediatric patients between 5 and 17 years of age who underwent planned surgery plus orotracheal intubation at the study's institution. The anesthesiologists' intubation preference was used to divide the data, and the control group comprised patients who were intubated using laryngoscopy, while the comparator group comprised patients who were intubated using videolaryngoscopy.

Procedures for collecting information and instruments

The intubation time was calculated in seconds, and the timer was started when the physician in charge of the airway completed 3 minutes of assisted ventilation and began the intubation procedure.

Data on the number of attempts showed how many times the anesthesiologist or resident under their supervision tried to remove the tube to redirect it and achieve adequate intubation.

Complications were observed during direct or indirect laryngoscopy, and these included dental trauma, bleeding, technical difficulty, and edema.

The age in years was calculated bases on the patient's medical history.

The weight was measured using a mechanical scale (SECA, Hamburg, Deutschland) with a capacity of 400 kg. With the support of the patient's representative, the children were weighed, wearing the least amount of clothing that was possible, using the scale. The weight was recorded in kg. The height was measured using a mechanical ruler, which was attached to the mechanical scale, which was described above, and it had a height measurement of between 50 and 200 cm, which provided the exact data in cm.

The patient's BMI was calculated according to the percentiles that were provided by the World Health Organization.

The type of instrument that was used for intubation was determined by the specialist who was in charge of the intubation, based on their familiarity with the device and their skills.

Controlling sources of bias

Medical records with incomplete data were excluded, and missing or excluded data were not imputed. This study protocol was approved by the Institutional Teaching Committee and the Bioethics Committee of the University of Cuenca. This was not an experimental study because normal procedures that were used in the anesthesia department and specialist physician intubation preferences were used.

Study size

The sample size was calculated from a total of 980 randomly selected patients, with a 95% confidence interval (95% CI) of 1.96, a 5% margin of error 0.05, 0.5 probability of event occurrence, and 0.5 probability of event nonoccurrence. EPI-Info 7.0 (Clifton Road, Atlanta, USA) was used to perform the sample size calculation. There were 276 patients required for this study.

Management of quantitative variables

Categorical variables were presented as the frequency and percentage (%), and a summary of the statistical data are presented in tables according to each variable. The following descriptive statistics were used: median, mode, average, minimum value, maximum value, and measures of dispersion such as the range and standard deviation. A value of $P \leq 0.05$ was considered to be statistically significant.

Statistical methods

The data that were collected using the form were introduced into the statistical program SPSS v.22.0. (IBM, Amonk, New York, USA).

Results

Sociodemographic characterization of the study population

The patients' average age was 9.83 years (median, 9 years; mode, 5 years; range, 12 years; minimum, 5 years; and maximum, 17 years). The most frequent age group was 5 to 10 years, which accounted for 61.2% of the patients.

The patients were predominantly male (58.3%). The normal BMI was the most frequent, accounting for 56.9% of patients. Direct laryngoscopy was the most common method for orotracheal intubation (56.2%) compared to videolaryngoscopy (43.8%) (see Table 1).

Table 1 Description of the studied population

	Variable	n	%
Age (years)	5–10	169	61.2%
	11–17	107	38.8%
Sex	Male	161	58.3%
	Female	115	41.7%
Body mass index (kg/m^2)	Low weight <5th percentile	35	12.7%
	Normal 5th-85th percentile	157	56.9%
	Overweight 86th-95th percentile	35	12.7%
	Obesity>95th percentile	49	17.8%
Intubation preference by the anesthesiologist	Laryngoscopy	155	56.2%
	Video laryngoscopy	121	43.8%

Intubation instrument and its relationship with the number of attempts

For direct laryngoscopy, intubation was performed on the first attempt in 97.4% of the patients. For video laryngoscopy, intubation was performed on the first attempt in 88.4% of the patients. For video laryngoscopy, 11.6% of intubations required more than one attempt, while for laryngoscopy, 2.6% required more than one attempt, which was a significant difference (*P*=0.003; see Table 2).

Table 2 Comparison between techniques

	DL n=155	VL n=121	*P*
Success on the first attempt	151 (97.4%)	107 (88.4%)	0.003
Complications	4 (2.6%)	8 (6.6%)	0.103
Dental trauma	3 (1.9%)	5 (4.1%)	0.103
Bleeding	1 (0.6%)	0 (0%)	0.103
Difficulty of the technique	3 (1.9%)	21 (17.4%)	0.01
IT of 5 to 10 seconds	146 (94.2%)	91 (75.2%)	<0.0001
IT of 11 to 30 seconds	8 (5.2%)	30 (24.8%)	

*IT: Intubation time. DL: direct laryngoscopy; VL: video laryngoscopy

Intubation instrument and its relationship to complications

For videolaryngoscopy and direct laryngoscopy, 93.4% and 97.4% of intubations were performed without complications, respectively, which was not significantly different (*P*=0.103). The videolaryngoscopy intubation technique was more difficult than direct laryngoscopy (17.4% vs. 1.9%; see Table 2).

Intubation instrument and its relationship to intubation times

For direct laryngoscopy, intubation was performed between 5 and 10 seconds in 94.2% of patients compared to 75.2% with videolaryngoscopy. For videolaryngoscopy, 24.8% of the intubations were performed between 11 and 30 seconds compared to 5.2% with direct laryngoscopy. One intubation that required more than 30 seconds occurred with conventional laryngoscopy. This result was statistically significant (*P*<0.0001).

Discussion

There are few comparative studies between direct laryngoscopy and videolaryngoscopy in the pediatric population, and most researchers based their studies on adults or mannequins. To perform a comparative study and to determine the impact of pediatric intubation techniques in our environment, videolaryngoscopy for pediatric intubation was compared to classic orotracheal intubation. On the one hand, the conventional laryngoscope is the most widely used method during surgery due to its simplicity of use, lower cost, and durability. On the other hand, VividTrac is a videolaryngoscopy method. There is little evidence for routine use of both devices in children 4–6 years of age. Our study was novel because it was performed in a pediatric population without predictors of a difficult airway. Most of the studies are based on pediatric patients with a recognized difficult airway, including oropharyngeal malformations or characteristic syndromes that compromise the airway, and this may denote alterations in the resulting statistical values because the methods do not have the same level of difficulty.

The average age of the study group was 9.83 years (median, 9 years; mode, 5 years; range, 12 years; minimum age, 5 years; maximum age, 17 years). The most frequent age group was 5 to 10 years with 61.2% of patients in this age group. There was a predominance of males (58.3%), and most patients (56.9%) had a normal BMI followed by a BMI indicating "obese" (17.8%).

Intubation on the first attempt was achieved in 97.4% of patients using direct laryngoscopy and in 88.4% of patients using videolaryngoscopy. This means that 11.6% of the intubations that were performed using videolaryngoscopy required at least two attempts compared to direct laryngoscopy (2.6%; *P*=0.003). Generally, these differences would be largely explained by the anatomical and physiological characteristics of the study population, the size of the device compared to the oral diameter, and the tongue prominence, which limits the operator's maneuverability. Some anatomical structures are outside the video laryngoscope's field of vision, which makes it difficult for the endotracheal tube to slide correctly from the mouth towards the trachea, requiring it to be redirected for satisfactory intubation. Despite having experience performing intubation using a video laryngoscope in adults, some specialists and postgraduate

physicians who participated in this study had some difficulty with the pediatric population. The success or failure rates depend on both the skill of the anesthesiologist and the characteristics of each patient and their age group [7-10].

Ramirez-Hernandez et al. found that with videolaryngoscopy, 33.3% of patients needed more than one intubation attempt. This was higher than in our study, which showed 11.6% [11]. Lingappan et al., in a 2017 systematic review on videolaryngoscopy compared to direct laryngoscopy for tracheal intubation in children, stated that videolaryngoscopy did not reduce the number of intubation attempts compared to direct laryngoscopy (mean difference [MD] −0.05; 95% CI: −0.18–0.07; two studies, 427 intubations). Their results are consistent with the results from our study, which showed that 2.5% of intubations with direct laryngoscopy needed two or more attempts compared to 11.6% with videolaryngoscopy (P=0.003). Another study reported that videolaryngoscopy increased the success of intubation on the first attempt compared to direct laryngoscopy, which differs from our study, where 88.4% of intubations with videolaryngoscopy were performed in one attempt compared to 97.4% with direct laryngoscopy [12].

The rate of complications during intubation based on each instrument was not different (93.4% of intubations were performed without complications using videolaryngoscopy compared to 97.4% with direct laryngoscopy; P=0.103). This suggests that despite the difference in laryngoscopy techniques, the VividTrac and most video methods have some structural similarity to the laryngoscope, which creates a greater familiarity for its use by the anesthesiologist, thereby avoiding possible injuries to the patients and reducing the complications that could appear from new video devices that have different techniques such as fibrobronchoscope. However, an adequate direct laryngoscope technique does not guarantee success in videolaryngoscopy [13]. Lingappan et al. showed no differences in the incidence of trauma or complications due to airway intubation attempts (P=0.10, 213 intubations), which is consistent with our study where there was no statistically significant difference (P=0.103) [12].

For intubation time, we observed that with direct videolaryngoscopy, 94.2% of intubations were performed in less than 10 seconds compared to 75.2% with videolaryngoscopy (P<0.0001). An important factor was the difficulty of the intubation technique using videolaryngoscopy; the present study showed a complexity percentage of 17.4% compared to 1.9% for direct videolaryngoscopy. The difference in these results compared to the presented article could represent a bias in the study because the present investigation was performed by both experienced anesthesiologists and postgraduate training physicians, which suggests that there were different intubation skill levels. The results demonstrate the usefulness of videolaryngoscopy as a teaching and learning tool [14].

In addition to the operator's experience, the high cost of video equipment for individuals or institutions is an important consideration, which could lead to health personnel prioritizing their expertise in using the conventional laryngoscope because it readily accessible. Lingappan et al. referring to the intubation time, which showed similar results between videolaryngoscopy and direct laryngoscopy (MD −0.62, 95% CI: 6.50–5.26), which is in contrast to our study where the shortest times were observed with direct laryngoscopy. This could be partly explained by the reasons that were mentioned above.

The results demonstrated the preference for direct laryngoscopy to approach a pediatric airway if there are predictors of difficulty in 56.2% of patients, and this result is relatively low for the laryngoscopy trend that is observed in operating rooms and in the literature. An important factor was the commitment of the anesthesiologists to participate in this study and gain experience with using the video methods, which affected their decision to use videolaryngoscopy. This was another limitation of the study, which was significantly higher for direct laryngoscopy. Well-designed studies with adequate statistical power are needed to determine the real benefit and to consider the safety of using video laryngoscopes for routine pediatric airway management, and more video instruments should be included in studies to provide results that are closer to reality, where the anesthesiologist has more options to choose from that are adapted to their abilities and skills.

Additionally, there was one patient with a difficult airway among the 276 patients who were included, which represents 0.36% of patients. This is consistent

with Pérez Lara et al.'s review article, which reports an incidence of 0.3% for difficult airway in the children [2].

Because technology was required (VividTrac - video screen), data collection was a limitation of the study. This is because it was an intubation instrument with a relatively short lifespan, and it required that new units were acquired in short periods of time. However, this was not a main concern during data collection. Despite these limitations of the research, it is considered to be an important sample size to describe the intubation technique for the following two reasons: 1) the skill and experience of the anesthesiologist in the procedure have an important effect on the results, and the learning curve with indirect visualization methods suggests that there may be greater challenges; and 2) technology is constantly changing the world in which we live, and medicine is not excluded from these advances. Adapting to these new advances will improve the range of options where the patient and the specialist will obtain a significant benefit. There is bias that occurred at the time of intubation due to the differences in the skill level between an anesthesiologist and a training physician.

Finally, the use of videolaryngoscopy for the management of a routine airway is currently low, and direct laryngoscopy will continue to be used as the preferred technique. This means that if the conventional laryngoscope is used to approach an airway, additional support tools such as video methods must be located nearby in case of unpredictable complications. This information should be present in future airway management protocols when there are no predictors of difficulty. From the beginning of medical training and until specialization, some concepts that persist over time have become routine. This is the case for the laryngoscope, which has been the traditional instrument to approach the airway since 1941 during its prime in the field of anesthesia, until recently when the advancement of technology and video methods showed important variations in orotracheal intubation. In addition to prioritizing the specialist's comfort, it is important to keep in mind the short-term and long-term repercussions that may occur in the patients [16, 17].

Conclusions

In this study, patients were between 5 and 17 years of age (average age, 9.83 years). The most frequent age group was 5 to 10 years (61.2% of patients). Males were predominant (58.3%), and a normal BMI was the most frequent in this study (56.9%).

Videolaryngoscopy provides better visualization of the glottis and improves intubation conditions, although in the present study, successful intubation on the first attempt was not increased and the number of required attempts was not decreased. Thus, its usefulness over direct laryngoscopy warrants further investigation.

A similar percentage of complications occurred for both techniques, and the technique for video laryngoscopy requires a longer learning curve.

Videolaryngoscopy did not decrease the time to successful intubation, which depends on many factors.

The laryngoscope continues to be the gold standard for routine airway management, and video laryngoscopes have limited use in cases of difficult airway.

Abbreviations

DL, direct laryngoscopy. DA, difficult airway. VL, video laryngoscopy.

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Authors' contributions

JPPA: Research idea, data collection, article writing, editorial corrections
JPP: Research idea, critical analysis, research direction
All the authors read and approved the final version of the manuscript.

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Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due participant confidentiality but are available from the corresponding author on reasonable request.

Ethical statements

Protection of persons

The authors declare that the procedures followed were in accordance with the ethical standards of the responsible human experimentation committee

and in accordance with the World Medical Association and the Declaration of Helsinki.

Confidentiality of the data

The authors declare that they have followed the protocols of their work center on the publication of patient data.

Consent for publication

The authors have obtained the informed consent from the guardians of the patient referred to in the article. This document is in the possession of the corresponding author. The parents have signed the authorization for publication of this case.

Competing interests

The authors have no competing interests to declare

References

1. Ríos Medina Á, Gómez LM, Aguirre Ospina O, Ocampo F. La vía aérea pediátrica: algunos conceptos para tener en cuenta en el manejo anestésico. Rev Colomb Anestesiol. 2012;40(3):199-202. **SU**: Scielo.co/4.n3

2. Pérez Lara J, Acosta Menoya A., Díaz Gener E., González Martínez Á. Vía aérea difícil en pediatría: signos predictores. Artículo de revisión. Revista de Ciencias Médicas de Pinar del Río, 2012;11(1):72-82. **SU**: scielo.cu/S1561

3. Nørskov AK, Rosenstock CV, Wetterslev J, Astrup G, Afshari A, Lundstrøm LH. Diagnostic accuracy of anaesthesiologists' prediction of difficult airway management in daily clinical practice: a cohort study of 188 064 patients registered in the Danish Anaesthesia Database. Anaesthesia. 2015;70(3):272-81. **DOI**: 10.1111/anae.12955. Epub 2014 Dec 16. **PMID**: 25511370.

4. Chaparro-Mendoza K, Luna-Montúfar CA, Gómez JM. Videolaringoscopios: ¿la solución para el manejo de la vía aérea difícil o una estrategia más? Revisión no sistemática. Revista Colombiana de Anestesiología. 1 de julio de 2015;43(3):225-33. **SU**: redalyc/195140440009

5. Ramírez-Acosta J, Torrico-Lara G, Encinas-Pórcel C. Índices predictores de vía aérea en pacientes obesos. Rev. Mex. Anestesiologia 2013;36(3):193-201. **SU**: medigraphic/133

6. Salinas Rojas J, Granados Barrientos J, Valderrábano López A, Kume M, Ramírez Gorostiza A. Uso de videolaringoscopio Glidescope para manejo de vía aérea difícil en paciente con tumor de cuerdas vocales. Acta médica Grupo Ángeles 2017;15(3):234-238.

7. Alarcón-Almanza JM, Cano-Gálvez MA. Asociación de los grados de movilidad de la articulación atlanto-occipital con la clasificación de Cormack-Lehane como predictores de una vía aérea pediátrica difícil. Rev Mex Anest. 2016;39(1):15-1. **SU**: medigraphic/63739

8. Echeverry Marín P, Engelhardt T. Algoritmo para el manejo de la vía aérea difícil en pediatría. Revista Colombiana de Anestesiología, 2014;42(4):325-334. ISSN: 0120-3347. **SU**: redalyc/195132030013

9. Healy DW, Maties O, Hovord D, Kheterpal S. A systematic review of the role of videolaryngoscopy in successful orotracheal intubation. BMC Anesthesiol. 2012;12:32. **DOI**: 10.1186/1471-2253-12-32. **PMID**: 23241277; PMCID: PMC3562270.

10. Law JA, Broemling N, Cooper RM, Drolet P, Duggan LV, Griesdale DE, et al. Canadian Airway Focus Group. The difficult airway with recommendations for management–part 1–difficult tracheal intubation encountered in an unconscious/induced patient. Can J Anaesth. 2013;60(11):1089-118. **DOI**: 10.1007/s12630-013-0019-3. **PMID**: 24132407 Epub 2013 Oct 17. (PubMed).

11. Lema FE, Medina H, González C, Hoyos CE, Tafur BLA. Guía para la intubación con fibrobroncoscopio en un Hospital Universitario. Revista Colombiana de Anestesiología 2012;40(1):60-66. **SU**: elsevier/S0120334712700114

12. Lingappan K, Arnold JL, Fernandes CJ, Pammi M. Videolaryngoscopy versus direct laryngoscopy for tracheal intubation in neonates. Cochrane Database Syst Rev. 2018 Jun 4;6(6):CD009975. **DOI**: 10.1002/14651858.CD009975.pub3. **PMID**: 29862490; PMCID: PMC6513507.

13. Ramírez-Hernández ME, Hernández-Gutiérrez D, Sánchez-Hernández E, et al. Videolaringoscopio Airtraq versus fibroscopio Bonfils para intubación orotraqueal electiva en paciente pediátrico con vía aérea normal. Rev Mex Anest. 2018;41(1):24-31. **SU**: medigraphic/77272

14. Healy DW, Picton P, Morris M, Turner C. Comparison of the glidescope, CMAC, storz DCI with the Macintosh laryngoscope during simulated difficult laryngoscopy: a manikin study. BMC Anesthesiol. 2012 Jun 21;12:11. **DOI**: 10.1186/1471-2253-12-11. **PMID**: 22720884; PMCID: PMC3519500.

15. Velázquez-Murillo G. Videolaringoscopio Artesanal Macintosh. Anestesia en México 2016;28(1):40-45. SU: scielo.mx/87712016000100040

16. Burkle CM, Zepeda FA, Bacon DR, Rose SH. A historical perspective on use of the laryngoscope as a tool in anesthesiology. Anesthesiology. 2004;100(4):1003-6. **DOI**: 10.1097/00000542-200404000-00034. **PMID**: 15087639.

17. Burjek NE, Nishisaki A, Fiadjoe JE, Adams HD, Peeples KN, Raman VT, et al. PeDI Collaborative Investigators. Videolaryngoscopy versus Fiber-optic Intubation through a Supraglottic Airway in Children with a Difficult Airway: An Analysis from the Multicenter Pediatric Difficult Intubation Registry. Anesthesiology. 2017;127(3):432-440. **DOI**: 10.1097/ALN.0000000000001758. **PMID**: 28650415.

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