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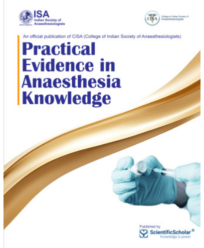

ORIGINAL ARTICLE

Comparison of ease of intubation with Airtraq®, Miller, Macintosh laryngoscope blades in children: A prospective randomised trial

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ABSTRACT

Aims and Objectives: In children, the airway often presents unique anatomical challenges that can make intubation difficult, particularly when attempting to align the line of sight with the laryngeal inlet. However, video laryngoscopes offer several advantages over traditional direct laryngoscopy by eliminating the need for precise alignment, thereby facilitating easier and more successful intubation. The primary objective of the study was to compare the ease of intubation with Airtraq®, Miller, and Macintosh laryngoscope blades. The secondary objectives were to compare the mean intubation time, Cormack-Lehane (CL) grade, percentage of glottis opening (POGO), number of intubation attempts, and haemodynamic response between Airtraq®, Miller, and Macintosh laryngoscope blades of appropriate sizes in children undergoing elective surgeries under general anaesthesia.

Material and Methods: 75 paediatric patients of American Society of Anesthesiologists physical status I and between 2 and 10 years of age were consecutively enroled and randomly allocated to one of the three groups: group A (Airtraq®, n = 25), group B (Miller, n = 25), and group C (Macintosh, n = 25). Patients were intubated with one of the three devices, viz. Airtraq®, Miller, and Macintosh laryngoscope blades, and the ease of intubation, mean intubation time, CL grade, POGO score, number of intubation attempts, and haemodynamic responses were noted.

Results: The ease of intubation was better with Airtraq® compared to Miller and Macintosh laryngoscope blades (p-value = 0.001). The mean intubation time [mean ± standard deviation (SD)] for Airtraq® (41.52 ± 6.63 seconds) [95% confidence interval (CI): 38.78, 44.26] was significantly greater than for Miller and Macintosh laryngoscope blades, 33.12 ± 6.77 seconds (95% CI: 24.78, 31.78) and 28.28 ± 8.48 seconds (95% CI: 30.32, 35.92), respectively, p-value <0.05, though the POGO score was more for Airtraq® [mean ± SD (86% ± 10)] (95% CI 81.87, 90.13) compared to Miller blade (72% ± 12.25) (95% CI 66.94, 77.06) p-value <0.05. The POGO score with Airtraq® was more than with Macintosh blade, though statistically insignificant (95% CI 76.52, 85.08) (p-value = 0.290). The modified CL grading was better with Airtraq® compared with Miller and Macintosh (p-value = 0.020), with no significant difference in the haemodynamic response between the three blades. The number of first and second attempts at intubation was 56% and 44% for Airtraq and 88% and 12% for Miller blade, respectively. Intubation was successful in the first attempt for the Macintosh blade group.

Conclusion: Even though the ease of intubation and glottic visualisation was better with the Airtraq® compared to Miller and Macintosh blades in children, the time taken for intubation was more with the Airtraq® when compared to Miller and Macintosh laryngoscope blades.

Keywords: Airway, blade, children, intubation, laryngoscopes

INTRODUCTION

Tracheal intubation is considered the gold standard for airway management for administering general anaesthesia and in a critical care setting. Paediatric airways have significant anatomical and physiological differences compared to adult airways, which impact the technique and the tool that anaesthesiologists prefer for obtaining safe and effective control of the airway.[1] Conventionally, direct laryngoscopy using the Macintosh or Miller laryngoscope has been used for direct visualisation of the larynx and to facilitate tracheal intubation in children (particularly in children <2 years). Indirect laryngoscopy has inspired the creation of video laryngoscopes, which have become a valuable tool in clinical settings.[2,3]

The Airtraq® Vygon optical laryngoscope is a marketed video laryngoscope for children. It is available in sizes 0, 1, and 2 and can accommodate an endotracheal tube (ETT) of size 2.5–3.5, 4–5.5, and 6–7.5 mm internal diameter, respectively. The configuration of the optical components within the system, along with the extreme curvature of the blade, improves the glottic view, eliminating the need for alignment of the oropharyngeal and laryngeal axis. The blade of Airtraq® consists of two side-by-side channels; one acts for the distal lens and the other for the placement of the ETT. Airtraq® has a short learning curve in adults, but this is to be extrapolated in children due to differences in airway anatomy, and the requirement of a higher degree of hand-eye coordination. The use of Airtraq® eliminates the need for tongue displacement and forceful epiglottic lift, thereby minimising trauma and reducing the need for assistance compared with conventional laryngoscopy. However, it has been observed that even though video laryngoscope provides a good view of the larynx, it does not guarantee ease of tracheal intubation and may prolong the time required for tracheal intubation.[4–6]

This study aimed to compare intubation with the Airtraq® laryngoscope blade over the conventional Miller laryngoscope blade and Macintosh laryngoscope blade in children. The primary objective was to compare the ease of intubation with Airtraq®, Miller, and Macintosh laryngoscope blades. The secondary objectives were to compare the mean intubation time, Cormack-Lehane (CL) grade, percentage of glottis opening (POGO), number of intubation attempts, and haemodynamic response between Airtraq®, Miller, and Macintosh laryngoscope blades.

MATERIAL AND METHODS

A prospective, randomised, single-blinded study was conducted on 75 children undergoing otolaryngeal, orthopaedic, urological, and general surgeries requiring general anaesthesia. They were recruited for the study after institutional ethics committee approval (KIMS/EC/16/2019–2020) dated 22 November 2019 and registration of the study in the Clinical Trials Registry - India (CTRI/2021/09/036334). The study was performed between October 1, 2021, and October 2, 2022, in a tertiary healthcare institute. Written informed consent was obtained from all parents and legal guardians, who were thoroughly informed about the study's purpose and potential outcomes. The study followed all the principles of the Declaration of Helsinki (2013) and good clinical practice guidelines.

Seventy-five children between 2 and 10 years, of American Society of Anesthesiologists (ASA) physical status I, with a weight between 10 and 35 kg and scheduled for various elective surgical procedures under general anaesthesia were enroled for the study. Children with active upper/lower respiratory tract infections with a risk of aspiration, severe systemic disease, anticipated difficult airway, laryngeal trauma, and coagulopathy were excluded from the study.

Considering the ease of intubation in the three groups (Airtraq®, Miller, and Macintosh) as the primary outcome variable, the sample size was calculated using G*Power software version 3.1.5 1. Based on the results from a previous study by Yadav et al. and considering an effect size of 0.4, an error of 5%, and a power of 80%, the minimum sample size required in each of the three groups (Airtraq®, Miller, and Macintosh) was 22, with a total sample size of 66.[7] The final sample size was rounded to 75 (25 in each group). The children were randomly allocated into three groups by a computer-generated randomisation program by an anaesthesiologist who was not involved in the operating room procedure. In group A, children were intubated using an Airtraq® laryngoscope blade; in group B, using a Miller laryngoscope blade; and in Group C, using a Macintosh laryngoscope blade. The children were unaware of which blade was being used in their mouths. Solid foods were not allowed for 6 hours preoperatively, and clear liquids were permitted up to 2 hours prior to the induction of anaesthesia. An intravenous (IV) line was secured using an appropriate-size IV cannula. The child was premedicated with midazolam 0.05 mg/kg IV 30 minutes before surgery. In the operation theatre (OT), all appropriate-sized paediatric airway equipment and drugs were kept ready. Following premedication, the child was taken to the OT away from the parents. In the OT, the child was placed on a forced-air warming blanket. Warm IV fluid was started as per the requirement. Standard monitors were connected, and the baseline haemodynamic data was recorded. The child was premedicated with glycopyrrolate 0.004 mg/kg IV, preoxygenated with 100% oxygen for 3 minutes, and induced with IV fentanyl 2 μg/kg and IV propofol 2 mg/kg. When eyelash reflexes disappeared, check ventilation was done. After adequate muscle relaxation with IV atracurium 0.5 mg/kg along with sevoflurane 3%, laryngoscopy was done as per the randomisation group.

Table 1: Comparison of demographic data and comparison of time taken for intubation, number of intubation attempts, POGO score, and CL grade

Variables	Group A (Airtraq®) n = 25	Group B (Miller) n = 25	Group C (Macintosh) n = 25	p-value
Age (years), mean, [SD]	6.16 [2.014]	7.12 [1.943]	6.68 [2.529]	0.302
Weight (kg), mean, [SD]	24.64 [6.311]	27.52 [5.084]	22.80 [6.449]	0.052
POGO score (%) (mean) (SD), [95% CI]	86, (10) [81.87, 90.13]	72, (12.25) [66.94, 77.06]	80, (10.38) [76.52–85.08]	0.000
CL grade 1/II	16/9	7/18	15/10	0.020
Time taken for intubation (s) (mean), (SD), [95% CI]	41.52, (6.63) [38.78, 44.26]	33.12, (6.77) [30.32, 35.92]	28.28, (8.48) [24.78, 31.78]	0.000
Number of attempts for intubation (1/2)	14/11	25/0	22/3	0.000

CI: Confidence interval; CL: Cormack-Lehane; kg: Kilogram; SD: Standard deviation; POGO: Percentage of glottic opening

In group A, an appropriate size ETT was lubricated and pre-mounted into the tube channel of Airtraq. The child's head was positioned neutrally to ease insertion. Airtraq® was inserted in the middle of the mouth and then slid over the tongue till the vallecula. Side-to-side movement or gentle vertical lift was done to obtain the best view of the glottis in the centre of the field. The ETT was then gently inserted and guided into the trachea. In group B, with the patient's head in the sniffing position, the Miller blade was passed posterior to the epiglottis, directly lifting it to expose the glottis. In group C, with the patient's head in the sniffing position, the Macintosh blade was advanced until its tip was positioned in the vallecula, and subsequent gentle traction on the handle elevated the tongue base and epiglottis, revealing the laryngeal inlet. Following successful intubation, the correct placement of the tracheal tube was confirmed by capnography. The investigator, who received comprehensive training on all laryngoscope blades (20 intubations with all three blades in children), gaining sufficient expertise and comfort with their use, performed all the intubations. External laryngeal manipulation was done if CL grade surpassed grade 2 to facilitate intubation. In the event of desaturation [peripheral oxygen saturation (SPO_2 < 95%)], the device was removed, and the patient was ventilated using a face mask. A maximum of two attempts was permitted, after which the anaesthesiologist would use a Macintosh laryngoscope with which she was more familiar. Any patient with airway management needing more than two attempts was excluded from the study. In the current study, successful intubation was possible either in the first or second attempt from the same group by changing the size or redirecting the scope. After the airway was secured, general anaesthesia was maintained with a mixture of 66% nitrous oxide, 33% oxygen, and 1.5%–2% sevoflurane. The surgical procedure commenced after the last haemodynamic data point was recorded, five minutes post-intubation. Haemodynamic data like heart rate, systolic blood pressure, diastolic blood pressure, and SPO_2 were collected at the following intervals: pre-induction, immediately after intubation, and 3 and 5 minutes after intubation. Adequate analgesia was given with IV paracetamol according to body weight (15 mg/kg). Neuromuscular blockade was maintained with IV vecuronium as and when required. The child was extubated and shifted to recovery with stable vitals after the surgery.

The following parameters were recorded and analysed: ease of intubation, time taken for intubation, POGO score, CL grade, number of attempts for successful intubation, and haemodynamic changes. The investigator measured the ease of intubation, POGO score, and CL grade. Other data were measured by another anaesthesiologist assigned for the same. The time taken for intubation was defined as the interval between inserting the laryngoscope blade into the oral cavity and confirmation of tracheal intubation by capnography. Ease of intubation included: grade 1—no need for extrinsic manipulation; grade 2—extrinsic manipulation of larynx required; grade 3—intubation not possible even with extrinsic manipulation of the larynx. POGO scoring included 100%—entire glottic structures visible, 33%—only the lower third of vocal cord and arytenoid visible, and 0%—no glottic structure visible.

The data were entered in a Microsoft Excel spreadsheet, and statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) statistics software version 20 for Windows (International Business Machines, New York, United States of America). All the continuous variables, like age, size of the tube used, and the number of attempts for intubation, were described using mean and standard deviation. Categorical variables like gender and ASA physical status were expressed as frequencies and percentages. Data for ease of intubation, POGO score, and CL grade were analysed with Fisher's exact test. Haemodynamic parameters were analysed using analysis of variance (ANOVA), Fisher's test, and Bonferroni post hoc analysis. A p-value less than 0.05 was deemed statistically reliable.

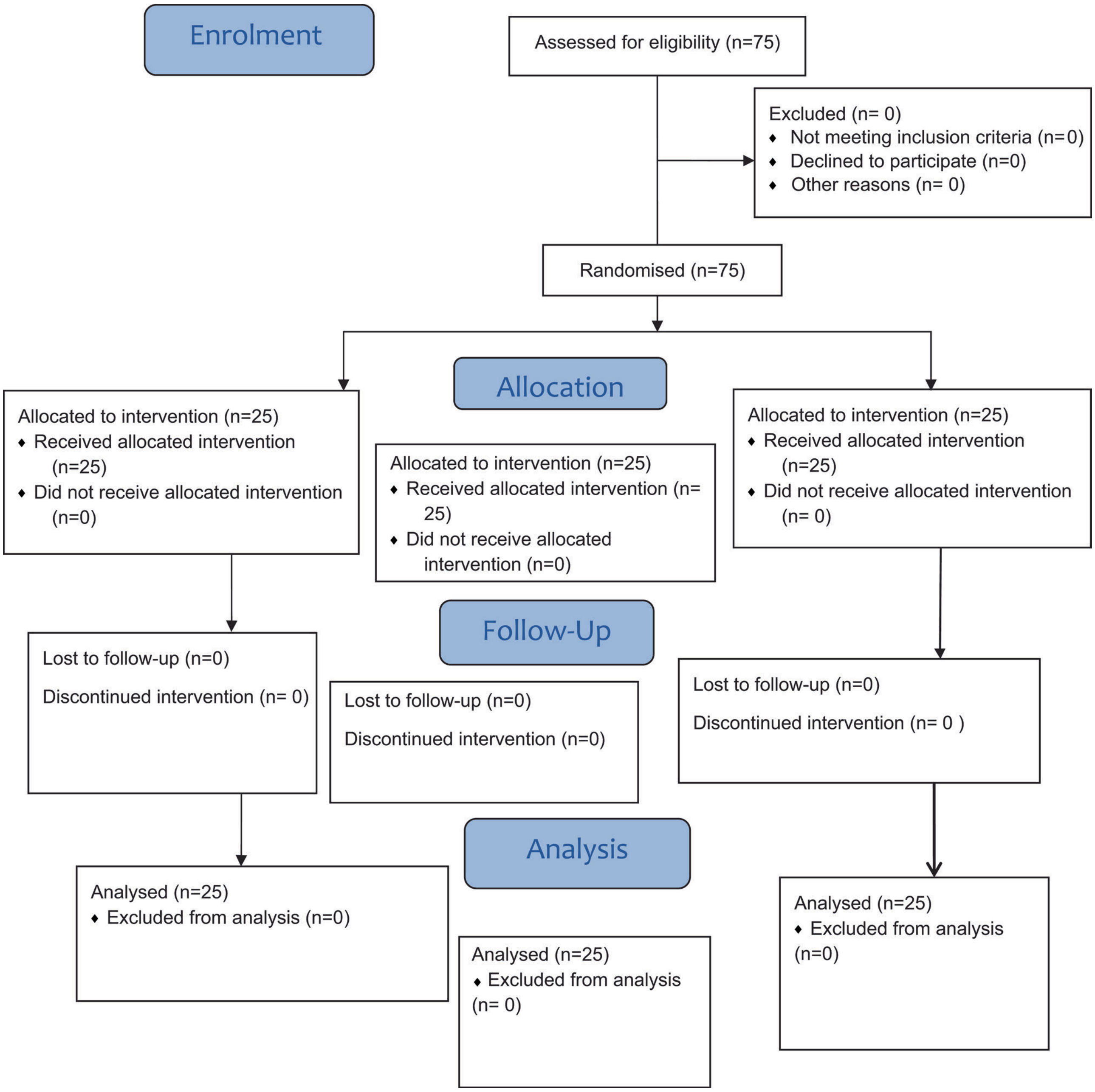

Figure 1: Consolidated Standards of Reporting Trials flow diagram

Table 2: Intubation difficulty score

IDS	Group A	Group B	Group C
1.00 (count/% within the group)	22/88%	16/64%	18/74.6%
2.00 (count/% within the group)	3/12%	9/36%	7/28%

Data are represented in percentages. IDS: Intubation difficulty score
Group A: Airtraq®, Group B: Miller, Group C: Macintosh

RESULTS

A total of 75 consecutive patients were enroled in the study as per the inclusion criteria. Demographic characteristics were comparable in all three groups [Table 1]. All 75 patients completed the study and could be evaluated [Figure 1]. The primary objective of our study was to compare the ease of intubation with the three laryngoscope blades. Ease of intubation was better with Airtraq® compared to Miller or Macintosh blades, with a p-value = 0.001 when

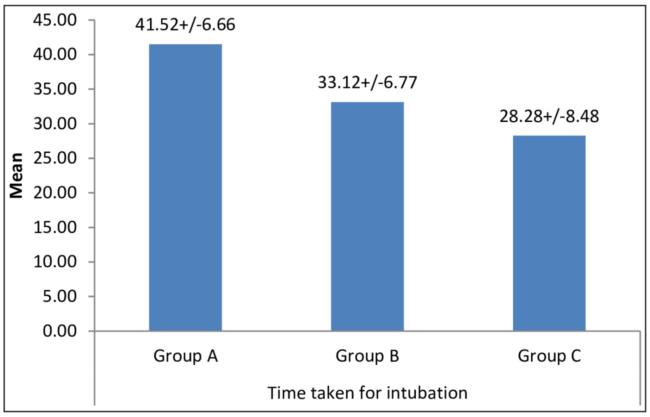

Figure 2: Comparison of time taken for intubation (in seconds) in study participants (Group A: Airtraq®, Group B: Miller, and Group C: Macintosh). Test used: Analysis of variance (p-value = 0.000)

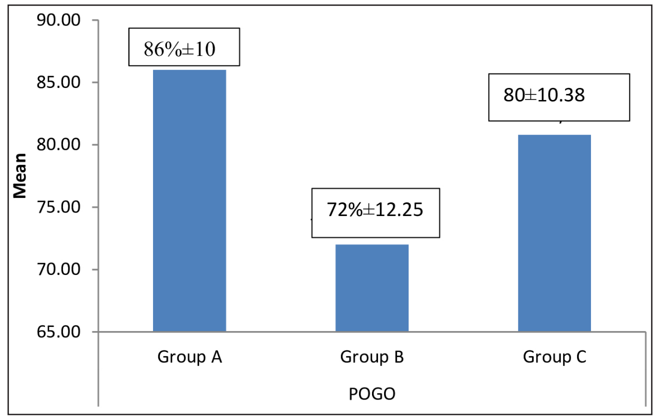

Figure 3: Comparison of percentage of glottic opening (POGO) in study participants (Group A: Airtraq®, Group B: Miller, and Group C: Macintosh). Test used: Analysis of variance (p-value = 0.00)

analysed by Fisher's exact test [Table 2]. According to our observations, the mean intubation time ± standard deviation (SD) taken by Airtraq® was 41.52 ± 6.66 seconds [95% CI: 38.78, 44.26], 33.12 ± 6.77 seconds [95% confidence interval (CI): 30.32, 35.92] for Miller, and 28.28 ± 8.48 seconds [95% CI: 24.78, 31.78] for Macintosh in group C. ANOVA test detected a significant difference in the time taken for intubation across the three groups (p-value = 0.00). Airtraq® demonstrated a marked increase in the intubation time compared to Miller and Macintosh [Figure 2]. On comparison of POGO scores, the scores were better in Airtraq® [mean ± SD (86% ± 10)] (95% CI: 81.87, 90.13), compared with Miller, 72% ± 12.25 (95% CI: 66.94, 77.06), and Macintosh 80% ± 10.38 (95% CI: 76.52, 85.08), with a p-value of <0.05 by Fisher's exact test [Figure 3]. On comparing CL grades in the study participants, the grade was class 1 in 64% of patients in Airtraq®, 28% of patients in Miller, and 60% of patients in Macintosh. CL grade was class II in 36% of patients in Airtraq®, 72% of patients in Miller, and 40% of patients in Macintosh blade groups. On analysis with Fisher's exact test, the p-value obtained was 0.020, which is statistically significant [Table 1]. The heart rate and blood pressure in the patients were measured before induction, immediately after intubation, 3 and 5 minutes, and 1 and 2 hours, and the values were compared by ANOVA test, and it was found that the haemodynamic responses were comparable between all three groups [Figure 4]. The number of first and second attempts at intubation was 56% and 44% for Airtraq® and 88% and 12% for Miller, respectively. Intubation was successful in the first attempt for Macintosh group cases.

DISCUSSION

Good glottic visualisation during intubation is necessary for the correct placement of the ETT. Direct vision avoids trauma

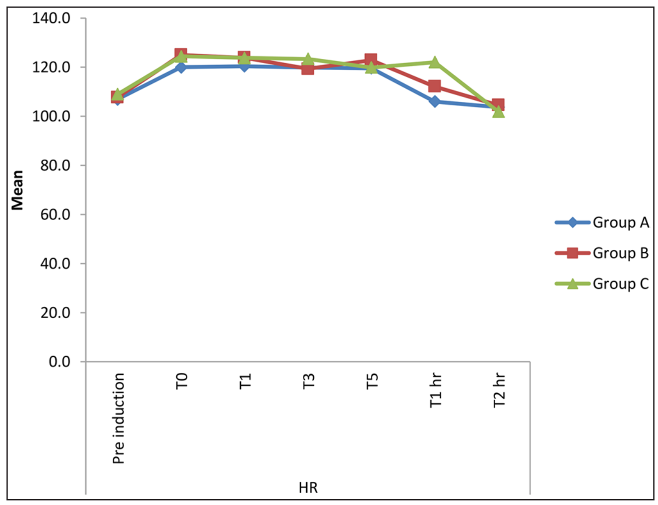

Figure 4: Comparison of heart rate (beats/min) at different time-points. Group A: Airtraq®, Group B: Miller, Group C: Macintosh. Test used: Analysis of Variance. HR: Heart rate; hr:Hours

while negotiating the tube into the trachea. Repeated attempts increase morbidity related to airway management. This study found that the ease of intubation was better for Airtraq® when compared to Miller and Macintosh laryngoscope blades in children. Waleed et al. and Dwivedi et al. demonstrated the same when comparing ease of intubation with Airtraq® and Macintosh blades in children.[4,8] Das et al. also reported the same results when comparing Airtraq® and Miller.[9] This extrapolates good glottic visualisation by Airtraq® compared to Macintosh or Miller, which requires lesser external manipulation. The present study found that mean intubation time was significantly longer with Airtraq® compared to Miller and Macintosh laryngoscope blades. Similar results have been obtained in other studies where the authors have stated that, although the glottic view was superior using Airtraq®, the time for tracheal intubation was more prolonged compared to Macintosh laryngoscope blade. The authors of these studies have also reported that the increased time for intubation may be because, in comparison with adults, the full view of the larynx occupies a much smaller portion of the eyepiece view in the paediatric Airtraq®.[10,11] Although the laryngeal view provided with Airtraq® is good, guiding the paediatric ETT through the vocal cords may not always be straightforward. This could be a result of the tube hinging on the posterior arytenoid while passing the tube or the Airtraq® blade hitting the vallecula while passing. A meta-analysis has reviewed 14 randomised controlled trials that compared video laryngoscopes with direct laryngoscopes in children.[12] The authors of this meta-analysis demonstrated that although video laryngoscopes improved glottic visualisation in children, this was at the expense of prolonged time needed for intubation and increased failures. In contrast to this, some other studies found that the median orotracheal intubation time with the Airtraq® laryngoscope was lower than with the Miller laryngoscope blade or Macintosh laryngoscope blade.[4,8] In the present study, the POGO score with Airtraq® was significantly higher than with the Miller blade. The POGO with Airtraq® was more than with the Macintosh blade, though statistically insignificant. Various other studies have also demonstrated an improved POGO score with Airtraq®.[11,13] In the present study, the modified CL grading was better with Airtraq® compared with Miller and Macintosh. Similar results have been reciprocated in a study with Airtraq®.[14] However, it was observed in another study that the CL grading is better with the Miller blade in younger children when compared with Macintosh.[7] In the present study, the haemodynamic parameters were comparable in all three groups. Nevertheless, the researchers of some studies have demonstrated that Airtraq results in a lesser stimulation of heart rate and mean arterial pressure because of lesser manipulation and direct visualisation.[9,15] The haemodynamic parameters were not compared in other studies.[10–12]

The basic difference between direct and indirect laryngoscopy lies in the fact that the glottic view is better with indirect laryngoscopes, as they have a more focused field of vision, though they require good hand-eye coordination. This may render intubation relatively more challenging compared to direct laryngoscopes. Despite being designed to follow the natural anatomical curve, requiring minimal positioning, many anaesthesiologists have found it difficult to use. Further studies are needed to clarify the efficacy and safety of video laryngoscopes in the hands of non-experts and those with difficult airways. Although some trials have compared the efficacy between video laryngoscopes and direct laryngoscopes in children, most of the trials have been limited to a small sample size. The utility of the Airtraq® in difficult airway situations may be limited by the presence of blood, vomitus, or secretions in the oropharynx, which obstruct the indirect view and hinder intubation. Macintosh and Miller laryngoscope blades are widely used in children. The Airtraq® blade is relatively new, and so we decided to compare the three blades with regard to ease of intubation and other parameters. To the best of our knowledge, to date, no study has comprehensively compared the performance of all three laryngoscope blades together in a single research investigation. The present study has certain limitations that should be taken into account. Blinding the operator to the laryngoscope used was not feasible, potentially introducing bias into the assessment of intubation ease. Also, the POGO scoring is subjective. All the intubations were done on patients with ASA grades I and II posted for elective procedures. Further studies are needed with larger sample sizes to clarify the use of these instruments in difficult airways and emergencies.

CONCLUSION

This study concludes that in children, the ease of intubation and glottic visualisation as per POGO scoring and CL grading is better with the Airtraq® compared to Miller and Macintosh blades. However, the Airtraq® blade is associated with a longer intubation time compared to Miller and Macintosh laryngoscope blades.

Declaration of Patient Consent: The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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