Original Article

Comparison between Macintosh, Miller and McCoy laryngoscope blade size 2 in paediatric patients - A randomised controlled trial

Address for correspondence:
Dr. Pratishtha Yadav,
A 308, Shastri Nagar,
Delhi - 110 052, India.
E-mail: pratishthayadav88@gmail.com

Pratishtha Yadav, Sudeshna Bhar Kundu[1], Dhurjoti P Bhattacharjee[1]

Institute of Post-Graduate Medical Education and Research and Seth Sukhlal Karnani Memorial Hospital, [1]Department of Anaesthesiology, Calcutta National Medical College, Kolkata, West Bengal, India

ABSTRACT

Background and Aims: Paediatric airway needs special consideration as it is not a miniature replica of adult airway, rather it has different anatomy with different proportion and angulations. This study was conducted with the aim to find a laryngoscope blade that provides best laryngoscopic and intubation conditions in paediatric patients of age 2–6 years. **Methods:** This trial was conducted in a total of 75 children age 2–6 years, either gender, with American Society of Anesthesiologists grade I or II scheduled for elective surgery under general anaesthesia. They were randomly allocated to groups A, B and C to be intubated with Macintosh, Miller and McCoy blades, respectively. Intubation Difficulty Score (IDS) was considered as primary outcome, and Cormack–Lehane grade and Percentage of Glottic Opening (POGO) score were taken as secondary outcome. Data were compared by ANOVA or Kruskal-Wallis or chi square test using Statistica, SPSS and GraphPad Prism softwares. $P < 0.05$ was considered statistically significant. **Results:** IDS score was significantly lower ($P = 0.002$) in group B (0.6 ± 0.7) as compared to group A (1.4 ± 0.9) and group C (1.3 ± 1.1); majority of patients in group B (48%) had Cormack–Lehane grade I ($P = 0.002$) unlike group A (0%) and group C (20%) and POGO score ($P < 0.001$) was higher in group B (86 ± 23.4) when compared with groups A (68.2 ± 20.5) and C (59.8 ± 28.9). Haemodynamic changes and other intubation parameters were comparable among the groups. **Conclusion:** Miller blade may be considered superior to Macintosh and McCoy blades in terms of glottic visualisation and ease of intubation in paediatric patients.

Key words: IDS score, Macintosh laryngoscope blade, McCoy laryngoscope blade, Miller laryngoscope blade, paediatric

Access this article online
Website: www.ijaweb.org
DOI: 10.4103/ija.IJA_307_18
Quick response code

INTRODUCTION

Paediatric airway is not a miniature replica of adult airway, rather it has different anatomy with different proportion and angulation. In paediatric population, epiglottis is large, floppy and omega-shaped. It makes an angle of 45° with base of tongue. At birth, larynx is situated opposite to the lower border of C4 vertebra, it descends to C4–C5 interspace by the age of 3 years and finally descends to lie opposite to the body of C5.[1] Moreover, the tonsils and adenoids appear in the second year of life and generally reach their largest size by 4–7 years, posing a risk of obstruction.[1]

Previous studies have suggested that there is no significant difference in laryngoscopic view and ease of intubation between Miller and Macintosh laryngoscope blades (1–24 months age group)[2] as well as Miller

How to cite this article: Yadav P, Kundu SB, Bhattacharjee DP. Comparison between Macintosh, Miller and McCoy laryngoscope blade size 2 in paediatric patients – A randomised controlled trial. Indian J Anaesth 2019;63:15-20.

and straight McCoy laryngoscope blade (0–6 months age group).[3] Another study suggested that in infants and children less than 2 years of age, optimal laryngoscopic view may be obtained with either Miller size 1 blade lifting the epiglottis or Miller or Macintosh blade lifting the tongue base.[4] Till date, no reported study has compared Miller, Macintosh and McCoy laryngoscope blades in paediatric patients of age 2–6 years. Thus the trial was conducted with the primary aim to compare glottic visualisation using Intubation Difficulty Score(IDS)[5] and secondary aim to compare ease of intubation using Cormack Lehane grade[6] and Percentage of Glottic Opening (POGO) score[7] with these three blades in paediatric patients of age 2-6 years.

METHODS

After obtaining the Institutional Ethical Committee approval and taking written informed consent from the guardians of the children undergoing study, this prospective, single-blind, parallel group, randomised controlled clinical trial was conducted in 75 children of age group 2–6 years of either gender and American Society of Anesthesiologists physical status I or II scheduled for elective surgery under general anaesthesia. Patients with anticipated difficult airways, planned for oral surgeries, having severe cardiovascular disease such as congenital heart diseases, any abnormal liver and/or renal function, having asthma, pneumothorax, hydrothorax or grossly impaired pulmonary function were excluded from the trial.

Randomisation was carried out using random number generating software [Urbaniak, G. C., & Plous, S. (2013). Research Randomizer (Version 4.0) [Computer software]. Retrieved on June 22, 2013, from http://www.randomizer.org/]. Opaque envelope containing the assigned randomised group was opened by the anaesthesiologist just before starting the procedure. Patients were blinded regarding the group allotted. In the operating room, the anaesthesia machine was checked. All the airway equipment including the emergency cart were kept ready. The patient was brought into the operating room, and standard monitors (ECG, pulse oximeter, non invasive blood pressure, end tidal carbon dioxide concentration, temprature monitoring) were attached. Baseline data were recorded for all the patients. After preoxygenation, inhalational induction was done with oxygen and halothane. While maintaining spontaneous respiration, intravenous (IV) cannulation was performed, and glycopyrrolate 0.01 mg/kg IV and fentanyl 2 μg/kg IV were given. After confirmation of mask ventilation, atracurium 0.5 mg/kg IV was administered, followed by 4 min of positive pressure ventilation. Laryngoscopy and intubation was carried out in sniffing position. Sniffing position was maintained in all the patients. All the blades were inserted into the mouth from the right commissure, sweeping the entire tongue to the left of the blade. In group A, Macintosh blade was introduced till the tip lies in vallecula after which traction force was applied along the handle to lift the base of tongue and epiglottis, exposing the laryngeal inlet. In group B, Miller blade was passed posterior to the epiglottis directly lifting it to expose the glottis. In group C, McCoy blade was introduced till the tip lies in the vallecula, and then the lever was pressed to flex the tip and elevate the epiglottis. All the laryngoscopy and intubations were performed by same operator. They were performed under supervision of an experienced senior consultant, who acted as an alternate operator whenever necessary like patient desaturated below 95% or in case of any complication.

The IDS score is the sum of the following variables:

N1: number of intubation attempts >1

N2: number of operators >1

N3: number of alternative intubation techniques used

N4: glottic exposure (Cormack–Lehane grade minus 1)

N5: lifting force required during laryngoscopy (0 = normal; 1 = increased)

N6: necessity for external laryngeal pressure (0 = not applied; 1 = applied)

N7: position of the vocal cords at intubation (0 = abduction/not visualized; 1 = adduction).

IDS score of 0 indicates easy intubation, whereas higher scores indicate progressively more difficult tracheal intubation.

The duration of the laryngoscopy was defined as the time taken from insertion of the blade between the teeth until the anaesthesiologist had obtained the best possible view of the vocal cords. The duration of the intubation attempt was defined as the time taken from when the anaesthesiologist indicated the best view of laryngoscopy until the endotracheal tube (ETT) was placed through the vocal cords, as evidenced by visual confirmation by the anaesthesiologist. In the circumstances where ETT was not directly visualised passing through the vocal cords, the intubation attempt was not considered complete until the ETT was connected to the anaesthetic circuit and evidence obtained of the presence of carbon dioxide in the exhaled breath. The total time taken to secure the airway was calculated by taking the sum of all laryngoscopy and intubation times over the entire procedure. In cases where Cormack–Lehane grade was found to be more than grade 2, external laryngeal manipulation was applied. An intubation attempt was defined as the total number of passes of the ETT in the direction of the vocal cords. Patients were ventilated with 100% oxygen and halothane in between the attempts of laryngoscopy and intubation; SpO_2 was not allowed to fall below 95%. Only three attempts were permitted with the selected laryngoscope. After three failed attempts with assigned blade, laryngoscopy was performed using alternative blade. A failed intubation attempt was defined as an attempt in which the trachea was not intubated, or where the device was abandoned and another device utilised. Data regarding haemodynamic changes – heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxygen saturation – were noted 1 min after securing the airways.

After the airway was secured, anaesthesia was maintained and analgesics were given. At the end of the surgery, neuromascular blockade was antagonised. After adequate reversal, the patient was extubated and shifted to post anaesthesia care unit.

For the purpose of sample size calculation, the IDS score was taken as the primary outcome measure. It is estimated that 25 subjects would be required per group to detect a difference of 2.0 in this parameter between the groups with 90% power and 5% probability of type I error. This calculation assumes that IDS score will have a standard deviation (SD) of 2.25.[8] So assuming equal distribution of patients in all the groups, 75 patients in total were taken for the study ($N = 75$), with 25 patients in each group ($n = 25$). Patients were randomly allocated into three groups A, B and C to be intubated using Macintosh blade size 2, Miller blade size 2 and McCoy blade size 2, respectively.

Data were summarised by descriptive statistics, namely, mean and SD for numerical variables that are normally distributed and median and interquartile range for those that are skewed. Categorical variables were summarised as counts and percentages. Numerical variables were compared between groups by one-way analysis of variance and Kruskal–Wallis test; each device was compared with the other two using Dunn's multiple comparison test. *P* value of less than 0.05 was considered as statistically significant.

RESULTS

A total of 75 patients were included in the trial. There was no significant difference ($P > 0.05$) in patient characteristics between the groups [Table 1]. IDS score [Table 2] was found to be significantly lower with Miller blade (mean = 0.6 ± 0.7) when compared with Macintosh (mean = 1.4 ± 0.0.9) and McCoy (mean = 1.3 ± 1.1) blades ($P = 0.002$). No difference was found between Macintosh and McCoy blades. Thus, intubating conditions provided by Miller blade were better when compared with the other two.

Glottic visualisation was assessed by Cormack–Lehane grade and POGO score. Miller blade (mean = 86 ± 23%) provided significantly better POGO scores [Figure 1] when compared with Macintosh blade (mean = 68.2 ± 20%) and McCoy blade (mean = 59.8 ± 29%). An significantly better Cormack–Lehane view ($P = 0.002$) was obtained with Miller blade when compared with the other two blades [Table 3]. Glottic view was found to be similar between Macintosh and McCoy blades.

There was no difference between the groups with regard to the duration of laryngoscopy, and/or intubation, or in the total time to intubate the trachea successfully in each group [Table 4]. Five patients needed a second attempt for intubation with a different size ETT, three with Macintosh and one each with Miller and McCoy

Table 1: Demographic profile

Parameter	Gr A (*n*=25)	Gr B (*n*=25)	Gr C (*n*=25)
Age (years) (mean, SD)	3.4 (1.2)	3.3 (1.2)	3.4 (1.5)
Sex (male/female)	18/7	16/9	17/8
ASA status (I/II)	18/7	17/8	19/6
Body weight (kg) (mean, SD)	13.8 (3.7)	11.5 (3.1)	12.32 (3.7)
Height (cm) (mean, SD)	90.7 (9.7)	93.8 (7.9)	93.6 (8.4)

SD – Standard deviation; ASA – American Society of Anesthesiologists; Gr A – Macintosh blade, Gr B – Miller blade, Gr C – McCoy blade

Table 2: IDS score

	0	1	2	IDS 3	Score 4	5	6	7	Mean±SD
Gr A (*n*=25)	0	19	3	2	0	1	0	0	1.4±0.9
Gr B (*n*=25)	12	10	3	0	0	0	0	0	0.6±0.7
Gr C (*n*=25)	4	15	4	0	1	1	0	0	1.3±1.1

Gr A – Macintosh blade, Gr B – Miller blade, Gr C – McCoy blade; IDS – Intubation Difficulty Score; SD – Standard deviation; ANOVA – Analysis of variance. This table shows IDS scores with each device. IDS scores were significantly lower with Miller when compared with Macintosh and McCoy blade. *P*=0.002 between groups, Kruskal-Wallis ANOVA on ranks. Gr A vs Gr B, *P*=0.01; Gr A vs. Gr C, *P*=0.001; Gr B vs. Gr C, *P*=0.001

blades. The incidence of complications such as soft tissue trauma and blood tinge on the tip of the blade was minor and found to be similar among the groups. Arterial oxygen saturation was maintained well in all the groups.

The effects of laryngoscopy and intubation on the heart rate and blood pressure were modest. Heart rate, SBP and DBP increased significantly in all the groups 1 min after intubation [Table 5]. Changes in haemodynamic parameters, from preintubation to 1 min postintubation, were found to be similar in all the groups.

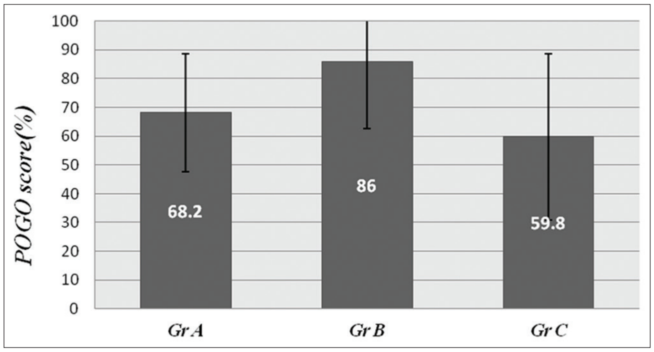

Figure 1: POGO score. Box plot representing POGO scores with each device. The POGO scores were highest with group B compared with groups A and C. *P* =0.001 between groups (*P* value A vs B 0.01, B vs C 0.001, C vs A 0.0001). Gr A: Macintosh blade, Gr B: Miller blade, Gr C: McCoy blade

Table 3: Cormack-Lehane grade (Kruskal-Wallis test; *P*=0.00126)

Cormack-Lehane grade	Gr A (*n*=25)	Gr B (*n*=25)	Gr C (*n*=25)
I	0	12 (48%)	5 (20%)
II	24 (96%)	12 (48%)	19 (76%)
III	1 (4%)	1 (4%)	1 (4%)
IV	0	0	0

Gr A – Macintosh blade, Gr B – Miller blade, Gr C – McCoy blade

DISCUSSION

In our study, Miller blade was found to be better than Macintosh and McCoy laryngoscope blades in terms of ease of laryngoscopy and intubation. Other parameters such as duration of laryngoscopy, and/or intubation, total time to intubate the trachea successfully and changes in haemodynamic parameters were found to be similar.

The purpose of laryngoscope is to provide an unobstructed glottic view by displacing the tongue and lifting the epiglottis, allowing easy passage of ETT. The success and ease of procedure depend on the design and technique of using the blade, individual's anatomy and the skill of the operator.

The anatomical differences are more evident in the infants and children; as they grow anatomy becomes more like that of an adult. The age group of 2–6 years is a transition phase where anatomy is somewhat like infants and adults. Some practitioners use a straight blade for infant laryngoscopy, whereas in older children a curved blade (small Macintosh blade) is sufficient.[9] Curved blade is preferred by many anaesthesiogists due to familiarity of its use in adults. Till date, no reported study has compared Macintosh, Miller and McCoy laryngoscope blades in paediatric patients, specifically of age 2–6 years. Thus, we conducted this study using size 2 blade as recommended in this age

Table 4: Intubation parameters (one-way ANOVA test)

Intubation parameters	Gr A (*n*=25)	Gr B (*n*=25)	Gr C (*n*=25)	*P*
Duration of laryngoscopy (s) (mean, SD)	10.4 (3.2)	10.8 (3.3)	9.9 (2.8)	0.6
Duration of intubation (s) (mean, SD)	11.1 (4.1)	9.9 (5.9)	11.6 (3.6)	0.5
Total duration to secure airway (s) (mean, SD)	21.5 (4.8)	20.8 (8.5)	21.6 (4.5)	0.5

SD – Standard deviation; Gr A – Macintosh blade, Gr B – Miller blade, Gr C – McCoy blade

Table 5: Haemodynamic parameters (one-way ANOVA test)

Parameter	Gr A (*n*=25)	Gr B (*n*=25)	Gr C (*n*=25)	*P*
Heart rate (min^{-1}) (mean, SD)				
Preintubation	127.8 (4.5)	129.7 (4.7)	128.4 (5.0)	0.36
1 min postintubation	139.3 (4.7)	139.4 (4.0)	138.7 (4.2)	0.97
SBP (mm of Hg) (mean, SD)				
Preintubation	95 (9.4)	88.7 (13.1)	93.1 (12.3)	0.17
1 min postintubation	116.7 (15.9)	112 (16.9)	120.2 (16.9)	0.21
DBP (mm of Hg) (mean, SD)				
Preintubation	52.5 (13.1)	46.2 (12.2)	47.8 (10.4)	0.16
1 min postintubation	72.6 (20.2)	65.4 (18.5)	73.7 (18.3)	0.29

ANOVA – Analysis of variance; SD – Standard deviation; SBP – Systolic blood pressure; DBP – Diastolic blood pressure; Gr A – Macintosh blade, Gr B – Miller blade, Gr C – McCoy blade group.[10] Another important factor influencing the glottic view is the technique of using the blade. Blade can be introduced directly from the midline or from the right gutter of the mouth sweeping the tongue to the left. But Magill suggested that introducing the blade from midline can obscure the view due to bulging of tongue on the blade.[11] Thus, in our trial paraglossal approach was used. Once the blade is introduced in the mouth, it can be used to either lift the epiglottis directly or by placing the tip in vallecula and then lifting the tongue base to expose the glottis. Passi *et al.* reported in their study that the POGO scores for Miller blade lifting the epiglottis and the tongue base are similar. In contrast, the POGO scores for Macintosh blade lifting the tongue base are usually greater than the scores lifting the epiglottis.[4] A study by Achen *et al.* found superior glottic view with Miller blade directly lifting the epiglottis and paraglossal approach when compared with Macintosh blade with the tip in the vallecula.[12] Therefore, we followed the standard laryngoscope blade insertion technique, that is, directly lifting the epiglottis with Miller blade and placing the tip in vallecula with Macintosh blade.

In our study, we found that Miller blade directly lifting the epiglottis gives better laryngoscopic view and ease of intubation when compared with Macintosh blade. This can be explained by the fact that Miller blade directly lifts the epiglottis which is obstructing the glottic view. Moreover, it displaces the tongue into the submandibular space more efficiently when compared with Macintosh blade. The greater vertical profile of Macintosh blade when compared with Miller also comes in line of vision.[4] The curved blade of Macintosh and McCoy blade provides better intubating conditions in adults[13] as they provide more space for ETT manipulation, but this is not so in paediatric patients as they have a smaller oral cavity with relative macroglossia. Moreover, Miller blade has a small curved tip that gives some room for ETT manipulation.

Passi *et al.* found the POGO scores for Miller size 1 blade lifting the epiglottis and Macintosh size 1 blade lifting the tongue base to be similar.[4] This does not corroborate with our study, and the possible reason can be the differences in the age group. Moreover, they determined the POGO scores from digital photograph taken during the laryngoscopy, but the picture of the larynx can be close to but not always identical with the view obtained by the anaesthesiologist thus altering the result. A study by Varghese *et al.* also concluded that Miller and Macintosh blades provided similar laryngoscopic view and intubating conditions in age group less than 2 years.[2] But this may not be true because first, in this study the Miller blade was inserted from the midline, and second, the tip of both the blades was placed in the vallecula and then lifted to expose the glottis.

McCoy blade was introduced in 1900s to aid in difficult intubation in adult population. There are very few studies evaluating the efficacy of McCoy blade in already existing difficult airways of paediatric population. Iohom *et al.* in 2002 conducted a study to compare straight McCoy and Miller blades in infants below 6 months of age; they found that McCoy blade has no advantage over the conventional paediatric Miller blade in normal infants.[3] But in our study, we found Miller blade to be better than McCoy blade. First, this difference can be due to the different techniques used by Iohom *et al.* They used both the blades to directly lift the epiglottis, unlike the conventional method of using McCoy blade, which is by placing the tip in vallecula and then activating the lever. Second, they used no muscle relaxant, and as per our knowledge inadequate muscle relaxation can adversely affect the glottic view and hinder the intubation. Some studies say that McCoy blade may not always improve the laryngeal view in paediatric patients with normal airway, and this may be due to its bulky design, difficult biomechanics and complex construction.[14]

There were some limitations to our study, like a cross-over study would have been a more appropriate method of comparing the blades. All the patients were successfully intubated in our study, but to demonstrate significant difference in the rate of failed intubation with these blades we would need a larger sample size. The smaller sample size and single operator limit the external validity of the results to the entire paediatric population. Finally, our study lacked the use of Train of four (TOF) monitoring and Bispectral index (BIS) monitoring for analysing sufficient muscle relaxation and appropriate depth of anaesthesia due to unavailability in paediatric operating room.

Further studies need to be conducted to see the efficacy of these three blades in difficult airway scenario.

CONCLUSION

Miller blade may be considered superior to Macintosh and McCoy blades in terms of glottis visualisation and ease of intubation in paediatric patients with normal airways.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Westhorpe RN. The position of the larynx in children and its relationship to the ease of intubation. Anaesth Intense Care 1987;15:384-8.
2. Varghese E, Kundu R. Does the Miller blade truly provide a better laryngoscopic view and intubating conditions than the Macintosh blade in small children? Pediatr Anesth 2014;24:825-9.
3. Iohom G, Robert F, William C, Barry L. The McCoy straight blade does not improve laryngoscopy and intubation in normal infants. Can J Anaesth 2004;51:155-9.
4. Passi Y, Sathyamoorthy M, Lerman J, Heard C, Marino M. Comparison of the laryngoscopy views with the size 1 Miller and Macintosh laryngoscopy blades lifting the epiglottis or the base of the tongue in infants and children <2yr of age. Br J Anaesth 2014;113:869-74.
5. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, *et al*. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology 1997;87:1290-7.
6. Gal TJ, Miller DM, Fleisher LA, Johns RA, Savarese JJ, Winer-Kronish JP, *et al*. Airway management. In: Miller's Anaesthesia. Philadelphia, PA: Elsevier; 2005. p. 1617-52.
7. Ochroch AE, Kush S, Stuart S, Hollander JE, Levitan RM. Assessment of laryngeal view in direct laryngoscopy: The Percentage of Glottic Opening (POGO) score compared to Cormack and Lehane grading. Can J Anesth 1999;46:987-90.
8. Maharaj CH, Buckley E, Harte BH, Laffey JG. Endotracheal intubation in patients with cervical spine immobilization: A comparison of Macintosh and Airtraq laryngoscopes. Anesthesiology 2007;107:53-9.
9. Davey AJ, Dina A. Equipment for pediatric. In: Wards Anesthetic equipment. 6th ed. China: Saunders Elsevier; 2012. p. 289-310.
10. Davis PJ, Caldis FP, Motoyama EK. Equipment. In: Smith's Anesthesia for infants and children. 8th ed. Philadelphia, PA: Mosby Elsevier; 2011. p. 293-321.
11. Scott J, Baker PA. How did the Macintosh laryngoscope become so popular. Pediatr Anesth 2009;19:24-9.
12. Achen B, Terblanche OC, Finucane BT. View of the larynx obtained using the Miller blade and paraglossal approach compared to that with the Macintosh blade. Anaesth Intensive Care 2008;36:717-21.
13. Kulkarni AP, Tirmanwar AS. Comparison of glottis visualisation and ease of intubation with different laryngoscope blades. Indian J Anaesth 2014,57:170-4.
14. McCoy E. The McCoy laryngoscope in infants and children. Can J Anaesth 2004;51:101-5.