Original Article

Comparison of the C-MAC video laryngoscope size 2 Macintosh blade with size 2 C-MAC D-Blade for laryngoscopy and endotracheal intubation in children with simulated cervical spine injury: A prospective randomized crossover study

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Abstract

Background and Aims: CMAC video laryngoscope size 2 D-Blade has been recently introduced for management of pediatric difficult airway. Our primary outcome was to compare glottic view, intubation time, and ease of intubation with the size 2 Macintosh versus D-Blade of C-MAC video laryngoscope in simulated cervical injury in children.

Material and Methods: This randomized crossover study was conducted in a tertiary care hospital of Northern India. Forty children of 4–14 years of age were enrolled in this study. After induction of anesthesia, video laryngoscopy was performed either with size 2 CMAC Macintosh (group M) or D-Blade (group D) with manual in-line stabilization. After removal of the first blade, second video laryngoscopy was performed with the alternative blade. Endotracheal intubation was done with the second laryngoscopy. Best glottic view, time for best glottic view, and difficulty in blade insertion were recorded during both the video laryngoscopies. During second video laryngoscopy, difficulty of tube insertion and time for intubation were noted.

Results: The glottic view grade was significantly better in group D compared with the group M ($P = 0.0002$). Insertion of D-Blade was more difficult than Macintosh blade ($P = 0.0007$). There was no statistical difference in terms of time for best glottic view in group M and group D (13.40 ± 4.90 vs 13.62 ± 5.60 s) and endotracheal tube insertion time (24.80 ± 7.90 vs 27.90 ± 10.90 s), respectively. Number of intubation attempts was similar in both the groups.

Conclusions: Size 2 D-Blade of C-MAC video laryngoscope provided a better glottic view in children with simulated cervical spine injury as compared with CMAC Macintosh blade. Success of intubation, intubation time, and ease of intubation were comparable with both the blades.

Keywords: Children, CMAC D-Blade, CMAC Macintosh blade, difficult airway, simulated cervical spine injury, video laryngoscope

Introduction

Endotracheal intubation is the gold standard method for securing the airway for surgery under general anesthesia. Several new technologies have been developed to facilitate endotracheal intubation. In children, endotracheal intubation is difficult in comparison to the adults due to anatomic differences, i.e., large head, short neck, large tongue, short jaw, long palate, long epiglottis, and more cephalad larynx.[1]

Video laryngoscopy is a newly available and emerging technology. Several studies have shown that video laryngoscopy

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provides a better laryngeal view than direct laryngoscopy in adult patients as well as in mannequins with either apparently normal or potentially difficult airways.[2,3] Most of the published data related to video laryngoscopy have been obtained from adults. Video laryngoscopy in children is a developing area of research with limited reports of video laryngoscopy in difficult pediatric airways.[4-7]

The CMAC video laryngoscope system (Karl Storz GmbH& Co. KG, Tuttlingen, Germany) is a novel device with camera providing an 80° angle of view and a light source is recessed from the tip of the blade. CMAC system has different sizes Miller and Macintosh laryngoscope blades and a difficult-airway (D-Blade) blade size 4. Many studies showed superiority of D-Blade over Macintosh blade of CMAC in terms of glottic view and intubating conditions due to the highly pronounced curvature in adults.[8,9] Size 4 D-Blade has also been used in simulated and actual cervical spine injury adult patients.[10,11] Recently, size 2 D-Blade has been introduced for difficult intubation in pediatric patients. However advantage of CMAC size 2 D-Blade in pediatric airways has not been evaluated. This is the first study in literature using pediatric CMAC D-blade laryngoscope. This randomized crossover study was designed to evaluate the efficacy of the CMAC size 2 D-Blade with the conventional CMAC size 2 Macintosh blade for ease of intubation in simulated cervical spine injury in children. Primary outcome of this study was to compare glottic view, success of intubation and intubation time with the size 2 Macintosh versus D-Blade of C-MAC video laryngoscope. Secondary outcome was to compare the ease of laryngoscopy and intubation in terms of negotiation of the endotracheal tube (ETT).

Material and Methods

The study was designed as a prospective randomized controlled crossover trial and registered in the clinical trial registry of India (CTRI/2015/12/006468; http://www.ctri.nic.in). After institutional ethics committee approval, 67 children scheduled for elective ophthalmic surgery requiring general anesthesia were assessed for eligibility in this study. Inclusion criteria were children of 4–14 years of age with American Society of Anesthesiologists (ASA) physical status I and II. Children whose parents refused to participate in the study had difficult airway, mental retardation, severe cardiac or respiratory disease, and reactive airway, and children with metabolic disease were excluded from the study.

Preanesthetic checkup was done a day prior of the proposed day of surgery. All children were kept nil per orally according to standard protocol and did not receive any premedication. An informed written consent from the child's guardian and assent from the child were taken for participation in the study.

In the operating room (OR), children were randomized into two groups (group M and group D) based on computer-generated random number table and sealed envelope technique. Sealed opaque envelope was opened in the OR and laryngoscope blade sequence was decided according to the particular randomized group.

In the preoperative area, after child's consent, intravenous (IV) access was obtained after application of local anesthetic cream. In the OR, standard monitoring [heart rate, electrocardiography, oxygen saturation (SpO_2), and noninvasive blood pressure] were applied and IV anesthesia was induced with 2 μg/kg fentanyl and 3–5 mg/kg propofol. Atracurium 0.5 mg/kg was administered after confirmation of ventilation. Lungs were ventilated manually with 100% O_2 for 3 min with monitoring of vital parameters. Meanwhile, CMAC video laryngoscope was checked and appropriate size ETT with stylet was prepared. In group M, ETT was curved at 60°, and in group D, ETT was curved in the shape of D-Blade.

The procedures were performed by two experienced anesthesiologist, who had >10 years of experience in pediatric anesthesia and >3 years of experience with the use of Macintosh as well as adult D-Blade of CMAC video laryngoscope. Manual inline stabilization (MILS) was applied by the same assistant in all the cases. Assistant was trained for the method of application of MILS for a month before the start of study. MILS was applied by the assistant from the side of the patient by holding the sides of the patient's neck in the palms of his hands and avoiding any movement of the neck on the shoulder, while the fingers grasped the mastoid process on either side preventing any movement at the atlanto-occipital joint.

Depending on the randomization, either CMAC Macintosh or D-Blade was inserted from right angle of the mouth, displacing the tongue toward the left side. Once the tip of the blade reached the vallecula, forward force was applied to lift the epiglottis and to visualize glottis. The best glottic view grade along with time to obtained it and difficulty in blade insertion was noted. Then, blade was removed and the ventilation with 100% O_2 was resumed. The second blade was inserted with same method and best glottic view and time was noted. At the end of second laryngoscopy, endotracheal intubation was done with styletted ETT and the difficulty of ETT insertion and time for intubation was noted.

After successful intubation of trachea, laryngoscope blade was removed; ETT was connected to close circuit and ventilated

with 100% O_2. ETT was secured with adhesive tapes, after checking for bilateral air entry.

Assessment: Following data were recorded in all the patients:

Difficulty of insertion of both blades, time for best glottic view with both blades, difficulty of insertion of ETT, and time for intubation.

Five-point Likert scale was used for grading of ease of insertion of blade and ETT from easy insertion (grade 0), mild difficulty (grade 1), moderate difficulty (grade 2), severe difficulty (grade 3), or impossible insertion (grade 4).[12]

Glottic view was graded according to POGO score,[13] i.e., percentage visibility of the glottis: 0 (no visibility of even interarytenoid notch), 1 (only arytenoid and or epiglottis), 2 (1% to 25%), 3 (>25% to 50%), 4 (>50% to 75%), 5 (>75 to <100%), and 6 (100%).

An anesthesiologist not involved in the study did the glottic view grading subjectively by analyzing the recorded video clips of the video laryngoscopy.

Time for intubation was defined as the time from the touching of blade tip to lip, till passage of ETT through the glottis under direct vision on CMAC monitor.

Any extra manipulation of the blade or ETT, if required, was noted. Anytime during the procedure if there was a fall in SpO_2 to <94%, positive pressure ventilated with 100% oxygen was resumed till the improvement of SpO_2.

If intubation was unsuccessful even after two attempts with the second blade, it was considered as failure with that blade. Again mask ventilation was resumed and a third attempt was done with the other blade, i.e., in group M with D-Blade or vice versa. If intubation was unsuccessful even with the use of the alternative blade, then intubation was done without MILS using conventional laryngoscope blade. An independent anesthesiologist (not involved in the study) monitored vital parameters during the procedure. Rest of the anesthesia technique was at the discretion of the attending anesthesiologist.

As there were no similar studies mentioned in the literature, this study was conducted as a pilot project. A minimum sample of 40 patients was enrolled to have a normal distribution. The primary outcome of this study was to evaluate the ease (success and number of attempts) of laryngoscopy and endotracheal intubation in both the groups. The secondary outcomes were to find out the video laryngoscope blade and ETT insertion difficulty and time for best glottic view/ETT insertion.

Statistical analysis

Data were recorded using a standardized data collection sheet and analyzed using Microsoft Excel Spreadsheet and the statistical software STATA. The data were presented as number (%) and mean ± standard deviation (SD) as appropriate. The baseline categorical and continuous characteristics were analyzed between the groups using Chi-square test/Fisher's exact test and Student's "*t*"-test for independent samples, respectively. A P value of <0.05 was considered significant.

Results

In total, 67 patients assessed for eligibility during preanesthesia checkup and 40 patients were finally included in the study (27 patients were excluded: 4 refused to participate and 23 patients did not meet inclusion criteria [Figure 1]. Demographic data are given in Table 1.

Video laryngoscopy was possible in all the children with both blades. Second attempt was required for proper laryngoscopy in five children in group D; however, successful laryngoscopy was possible in the first attempt in all children in group M. The difficulty of the blade insertion during laryngoscopy was statistically significant between the groups (P = 0.0007) [Table 2].

About 75%–100% glottic view (POGO 5,6) during laryngoscopy was found in 19 (47.5%) children in group M and 34 (85%) children in group D. However, five (12.5%) children in group M had poor glottic view (POGO 1 and 2, 0%–25%) in comparison to one (2.5%) child in group D. Glottic view grading (POGO score) was statistically significant between the

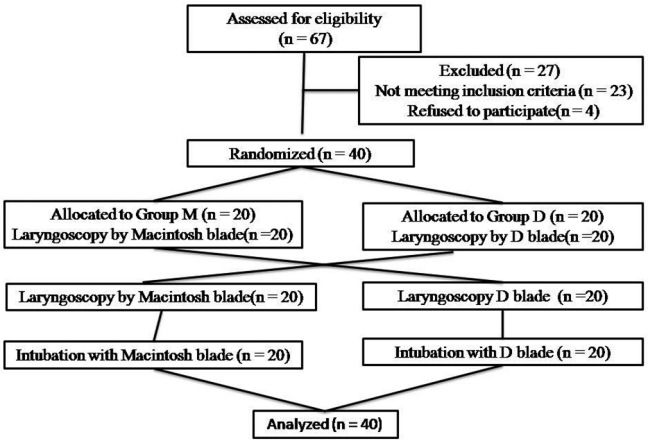

Figure 1: Consort flow diagram

groups ($P = 0.0002$). Time required for obtaining the best glottic view was comparable between the groups [Table 2]. Intubation was performed successfully in all children using either of the blades in first attempt. Intubation success and difficulty in intubation were found to be statistically nonsignificant between the groups. The time for intubation was comparable between the groups [Table 3].

In one child, grade 5 glottic view was seen with both Macintosh blade and D-Blade. However, in four children, poor glottic view with CMAC Macintosh blade was improved to more than one grade with the D-Blade. One child in each group required manipulation of the blade or ETT during intubation. One child had desaturation (SPO_2 up to 90%) after the first laryngoscopy requiring ventilation with 100% oxygen before attempting second laryngoscopy. However, the second laryngoscopy and intubation was uneventful. There was no trauma, aspiration, bronchospasm, laryngospasm, or postextubation stridor in any of the children.

Table 1: Demographic data of the children

Variables	Number of children (*n*=40)
Age (years)	7.9±2.9 (3-14)
Sex (male:female)	18:22
Weight (kg)	21.7±8.2 (10-40)

Data are in mean±SD (range), number of patients

Discussion

CMAC size 2 D-Blade has been introduced recently for management of difficult intubation in pediatric patients. This is the first study in children comparing it with CMAC size 2 Macintosh blade. In this study, we found a better glottic visualization with the CMAC size 2 D-Blade in comparison to size 2 CMAC Macintosh blade. Better view of the laryngeal structures with D-Blade can be explained by the highly pronounced curvature of the D-Blade than curvature of Macintosh blade [Figure 2].

Table 2: Comparison of laryngoscopic conditions and glottic view between group M and group D

	Group M (*n*=40) %, mean±SD	Group D (*n*=40) %, mean±SD	*P*
Success of laryngoscopy	100%	100%	
No. of attempt (1st/2nd)	40/0	35/5	0.025
Difficulty in blade insertion			
Easy	18 (45%)	7 (17.5%)	0.0007*
Mild	20 (50%)	19 (47.5%)	
Moderate	2 (5%)	11 (27.5%)	
Severe	0	3 (7.5%)	
Impossible	0	0	
POGO score			
0 (no visibility of even interarytenoid notch)	0	0	0.0002*
1 (only arytenoid and/or epiglottis)	2 (5%)	1 (2.5%)	
2 (1% to 25%)	3 (7.5%)	0	
3 (25% to 50%)	7 (17.5%)	3 (7.5%)	
4 (>50% to 75%)	9 (22.5%)	2 (5%)	
5 (>75% to<100%)	13 (32.5%)	5 (12.5%)	
6 (100%)	6 (15%)	29 (72.5%)	
Time for best glottic view (seconds)	13.40±4.90	13.62±5.60	0.38

**P<0.05 statistically significant*

Table 3: Comparison of intubation success and difficulty in intubation between group M and group D

	Group M (*n*=40) %, mean±SD	Group D (*n*=40) %, mean±SD	*P*
Success of intubation	100%	100%	
No. of attempts (1st/2nd)	20/0	20/0	
Difficulty in ETT insertion			
Easy	10 (50%)	8 (40%)	0.58
Mild	7 (35%)	7 (35%)	
Moderate	2 (10%)	5 (25%)	
Severe	1 (5%)	0	
Impossible	0	0	
ETT insertion time (seconds)	24.80±7.90	27.90±10.90	0.15
Manipulation required	1	1	

ETT=Endotracheal tube, P<0.05 statistically significant

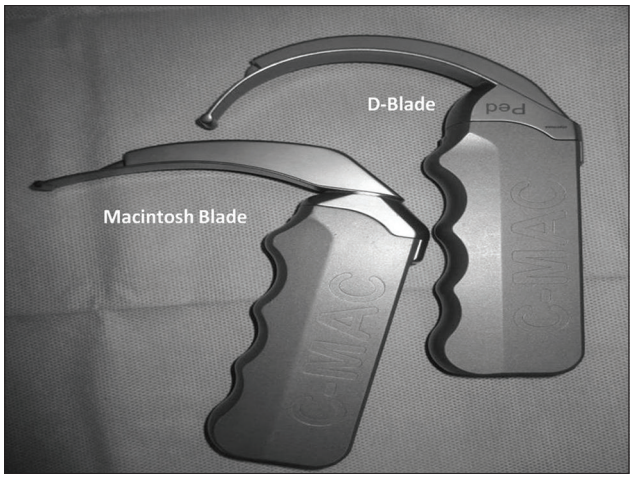

Figure 2: CMAC size 2 D-Blade and Macintosh Blade

Jain and co-workers also found better glottic view with the adult D-Blade in comparison to Macintosh blade of CMAC in a manikin study.[10] Manikin studies have their inherent disadvantages and cannot be generalized to normal population. We selected children with normal airway for evaluation of the newer CMAC D-Blade and also due to crossover design, we were able to exclude patient bias and we found better efficacy of D-Blade for glottic visualization in same child in comparison to Macintosh blade.

In this study, insertion of D-Blade was more difficult than Macintosh blade. None of the children had severe difficulty in Macintosh blade insertion during laryngoscopy in comparison to three children who had severe difficulty in D-Blade insertion. The relatively bulky handle of the C-MAC Macintosh blade abutting the patient's chest and preventing full insertion of the blade has been reported in pediatric age group.[14] This problem is amplified with D-Blade due to the increased angulation. In our experience, lateral angulation of the laryngoscope handle during insertion is helpful to decrease this difficulty. Difficulty in blade insertion during laryngoscopy explains the requirement of second attempt for laryngoscopy in five children with the D-Blade. Whether angulated blade video laryngoscopes require more skill and practice needs to be evaluated. However, we suggest that anesthesiologist should gain experience of pediatric CMAC size 2 D-Blade use in normal airway before using it in actual difficult airway scenarios. Although blade insertion was difficult with D-Blade, the time required to obtain the best glottic view was not significantly different between both the groups. This may be due to the fact that laryngoscopy was performed by experienced anesthesiologists who were familiar with the use of D-Blade.

In this study, successful intubation was possible in all the children in first attempt. Difficulty in negotiating the ETT through the cords, between the groups, was comparable. Similar to other angulated video laryngoscopes, D-Blade of CMAC is angled more to obtain a better glottic view. This increased angulation leads to change in direction of tip of ETT toward the anterior wall of the trachea instead of right angle to the larynx and hence leads to difficulty in the advancement of ETT further in to the trachea. In this study, use of stylet shaped ETT as per the curvature of the D-Blade reduced this problem.

Time for intubation was not found to be statistically different between the groups. Similar results are found in a previous trial while comparing difference between the duration of intubations with the D-Blade and Macintosh blade in the cervical spine immobilization scenario.[11] However, intubation time was found to be prolonged with D-Blade in comparison to Macintosh blade of C-MAC in the manikin study by Jain and coworkers.[10] In their study, intubation was done in manikin and by residents, who are not experienced and have difficulty in negotiation of the ETT while using the D-Blade.

None of the children had any complication in this study.

Limitations of the study are as follows: first, children with normal airway who were simulated to difficult airway were included in the study. Hence, as with all simulation studies involving psychomotor performance of a technical skill, generalizing results to real difficult airway children may be difficult. Second, our difficult scenario might be debated, in that it was not difficult enough, and could not provide rare situations in which efficacy of D-Blade could actually be tested. However, this scenario has been used in prior studies. Third, our investigators were not blinded to the type of blade that is being used due to inherent study design. However, our primary endpoints were objective measurements, and there is no possibility of an effect of bias of the observer. Fourth limitation in our study is the subjective measurement of difficulty scores.

In conclusion, CMAC size 2 D-Blade provided a better glottic view compared with CMAC size 2 Macintosh blades in simulated pediatric difficult airway in this study. Though insertion of D-Blade was more difficult than CMAC Macintosh blade, it resulted in equal success rate and similar time for intubation.

Ethical approval

This clinical study has been approved from the institute ethics committee and has been registered in central government registry of India.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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