Original Article

Comparative effectiveness of McCoy laryngoscope and CMAC® videolaryngoscope in simulated cervical spine injuries

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Abstract

Background: Videolaryngoscopes are increasingly being used in potentially difficult airway. McCoy laryngoscope provides definitive advantage over conventional laryngoscopes in cervical spine patients. The aim of this study was to compare the performance of the CMAC® videolaryngoscope with the McCoy Laryngoscope in patients with a cervical collar.

Material and Methods: Sample size of at least 22 patients in each group was calculated using Intubation Difficulty Scale (IDS) score as the primary outcome. 60 American Society of Anesthesiologists I and II patients requiring tracheal intubation for elective surgery were randomly allocated into the McCoy group (n = 30) and the CMAC® videolaryngoscope group (n = 30). Anesthesia was induced with fentanyl 2 mcg/kg, propofol 2-3 mg/kg and rocuronium 0.6 mg/kg. A rigid collar was applied to immobilize the cervical spine. Comparative data on the IDS scale, Cormack-Lehane (CL) laryngoscopic view, time taken for glottis visualization, time taken to pass endotracheal tube, total time to intubate, number of optimizing maneuvers and hemodynamic variables were recorded in the two groups.

Results: IDS score was significantly less in the CMAC® group compared to the McCoy group (median [interquartile range (IQR)], 1 [0-1] vs. 4 [3-6], $P < 0.05$). CMAC® videolaryngoscope required significantly less time for glottic visualization with median (IQR), 5 (5-7) versus 14 (8-15), $P = 0.000$ in McCoy laryngoscope, 29 (96.7%) patients in the CMAC® group had Modified CL Grade I compared with 16 (53.3%) patients in McCoy group. The hemodynamic variables, number of optimizing maneuvers and incidence of side effects were comparable in the two groups.

Conclusion: CMAC® videolaryngoscope forms an effective tool for the airway management of cervical spine patients with a cervical collar.

Key words: CMAC® videolaryngoscope, McCoy laryngoscope, simulated cervical spine injury

Introduction

Airway management in patients with cervical spine injury can result in exacerbation of the neurological injury.[1] Advanced Trauma life support guidelines recommend use of a rigid collar or manual in line stabilization.[2] The presence of a cervical collar undoubtedly decreases the impact of neurological trauma during airway management, but can worsen the laryngoscopic view.[3] Various devices have been used to overcome this deterioration of laryngoscopic view.

McCoy laryngoscope has a hinged tip that aids in improving the Cormack and Lehane (CL) laryngoscopic view by 1 grade in comparison to the Macintosh blade in patients with cervical spine injury.[4-6]

Fiber-optic bronchoscopy is regarded as the gold standard for intubation in patients with cervical spine injury.[7] However, its use is restricted by availability, lack of expertise and additional time required to perform bronchoscopy. The recently introduced videolaryngoscopes combine the advantages of conventional laryngoscopes and fiber-optic bronchoscopes CMAC® video laryngoscope (Karl Storz, Tuttligen, Germany) is one such indirect laryngoscope meant for videoscope guided intubation. This portable videolaryngoscope comes with the original Macintosh blade and an angulated D blade along with the CMOS digital camera and high power light emitting diode. In our study, we have used the conventional Macintosh blade of the CMAC®.[8]

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Although both the devices in the study have been independently evaluated and compared with the gold standard Macintosh laryngoscope in simulated difficult airway,[5,9] there are no published reports comparing the McCoy laryngoscope with the CMAC® video laryngoscope in simulated cervical spine injury patients. We designed a prospective randomized study to compare the efficacy of CMAC® video laryngoscope with the McCoy laryngoscope in simulated cervical spine injury patients with neck stabilization with rigid cervical collar (Philedelphia Cervical Collar, Philedelphia Cervical Collar Co., Thorofare, NJ, USA).

Material and Methods

The study was conducted at our institute from November 2011 to March 2013, after being approved by the Institutional Ethics Review Committee. The trial was registered with Clinical Trial Registry-India (CTRI/2014/08/004861). Sixty five patients of American Society of Anesthesiologists (ASA) classification I and II, in the age group of 18-60 years presenting for elective surgery requiring endotracheal intubation were enrolled in the study and written informed consent was taken. Patients with hemodynamic or respiratory compromise and anticipated difficult airway having modified Mallampati grading (MMP)[10] of IV or thyromental distance[10] (TMD) <6 cm were excluded from the study.

Preoperative airway assessment was performed by an anesthetist blinded to the group allocation. All patients were kept fasting for 8 h prior to surgery. Oral alprazolam 0.25 mg was given the night before and on the day of surgery. Baseline pulse rate, electrocardiogram, pulse oximetry and noninvasive blood pressure were recorded.

After exclusion of 5 patients from the study, 60 patients were randomized to undergo tracheal intubation with CMAC® videolaryngoscope or McCoy laryngoscope using online randomization software (http://www.randomisation.com). The allocation was concealed in opaque envelopes opened just before the start of the anesthesia.

Intubations were performed by an anesthetist with experience of more than 50 successful intubations using McCoy laryngoscope and 20 intubations using CMAC® videolaryngoscope.

Anesthesia was induced with intravenous fentanyl 2 mcg/kg and propofol 2-3 mg/kg. Following induction the pillow was removed and an appropriately sized Philadelphia collar was applied. After assessing the ability to ventilate, rocuronium 0.6 mg/kg was given intravenously to facilitate endotracheal intubation. All patients received a standardized general anesthesia. After 3 min of manual ventilation with O_2, the initial assessment of laryngoscopic view was performed with Macintosh laryngoscope (without external laryngeal manipulation) using Modified CL grading (MCL).[11] Patients with MCL IV were excluded from the study. Tracheal intubation was performed without the collar in the normal with the device of choice of the anesthetist.

Once the response to the train of four stimulation was abolished, tracheal intubation was performed using the allocated airway device. External laryngeal manipulation was provided if required through the 4 cm × 4 cm window of the anterior collar.

The anesthetist securing the airway graded the laryngoscopic view according to MCL grading. All the demographic and perioperative data with regards to intubation parameters and the hemodynamic changes were collected by an independent, unblinded observer. Mouth opening (MO) was taken as inter incisor distance (from the lower border of the upper incisor to the upper border of the lower incisor).

Cuffed polyvinyl chloride endotracheal tube (ETT) (Portex, Kent, UK) of internal diameter of 7 mm for females and 8 mm for males were used. Intubation using the McCoy laryngoscopes was performed using the standard technique. The lever of the McCoy laryngoscope was activated during intubation if required.

The blade of the CMAC® videolaryngoscope was inserted from midline, and once the tip crossed the base of the tongue, the blade was lifted to get the best laryngeal view on the videoscreen. Visualizing the glottic aperture, the curved ETT mounted on a stylet was guided through the vocal cords.

Anesthesia was maintained with nitrous oxide and Oxygen (60:40) and isoflurane.

The primary outcome was the Intubation Difficulty Scale (IDS) score described by Adnet *et al.*[12] [Annexure 1].

Failure to intubate was defined as the inability to intubate the patient's trachea within 120 s or 3 intubation attempts. In that case, the trachea was intubated in the traditional position by the anesthetist using a device of her choice.

The time taken to intubate was defined as the time from handling the device till the 1st capnographic trace was visible. Time taken to place the ETT was defined as time taken from best glottic view to the first capnographic trace. The number of intubation attempts were recorded. Blood pressure and the pulse rate were recorded before and after the induction of anesthesia, and thereafter at 1, 3, 5, 7 and 10 min after

Annexure 1

Adnet's Intubation Difficulty Score (IDS)

The IDS score is the sum of the following seven variables:

N1: Number of intubation attempts >1
N2: The number of operators >1
N3: The number of alternative techniques used
N4: Glottic exposure (Cormack and Lehane grade −1)
N5: Lifting force required during laryngoscopy (0 = normal; 1 = increased)
N6: Necessity for laryngeal pressure (0 = not applied; 1 = applied)
N7: Vocal cord mobility (abduction = 0; adduction = 1)
Total IDS = Sum of scores

endotracheal intubation. The number of patients who required external laryngeal manipulation was also noted.

Sample size calculation was based on IDS score. Based on our initial pilot study, we considered a change in mean IDS score of 2 with a standard deviation (SD) of 2.25 between the two groups as clinically important. Based on these figures, using $\alpha = 0.05$ and $\beta = 0.2$, we estimated a sample size of 22 would be required per group. Taking into account the attrition rate, we aimed to enroll 65 patients.

Statistical analysis

SPSS version 10 (SPSS Ltd, Chicago, IL, USA) was used to analyze the data. Normality of the quantitative data were checked by Kolmogorov-Smirnov test. Continuous data were presented as mean ± SD, ordinal data as median with an interquartile range and categorical data as frequency and proportions. Two-sided unpaired Student's *t*-test was used to analyze continuous data and Fisher's exact test for categorical data. Repeated measures ANOVA was applied to see the trend of the hemodynamics for the two groups and compare the two groups. $P < 0.05$ was considered to be significant.

Results

Of 65 patients assessed for eligibility, one patient with MMP IV, two with receding jaw and two with TMD <6 cm were excluded. Sixty patients found eligible were randomized into two study groups.

Patient characteristics

There was no significant difference in between the groups with regard to the patient's characteristics namely age, weight, ASA status, MO, MMP and TMD as seen in Table 1. None of the patients in either group had MCL IV.

Table 1: Baseline characteristics of the patient undergoing intubation using McCoy and CMAC® videolaryngoscope

Parameters	McCoy (n = 30)	CMAC® (n = 30)	*P*
Age (year)	44.2±11.3	42.1±16.4	0.52
Weight (kg)	62.7±8.5	60.9±8.9	0.44
Sex (male:female) (n)	16:14; 53.3:46.6	12:18; 40:60	>0.05
ASA status (I/II) (n)	22:8; 73.3:26.6	24:6; 80:20	0.32
MO without collar (cm)	4.3±0.6	4.2±0.5	>0.05
MO with collar (cm)	2.4±0.3	2.4±0.3	>0.05
TMD (cm)	6.3±1.2	6.4±1.1	>0.05
MMP (n) (%)			
1	10 (33)	14 (46.6)	0.29
2	16 (53.3)	14 (46.6)	
>2	4 (13.3)	2 (6.6)	
Laryngoscopic view - n (%) (Macintosh laryngoscope)			
MCL Grade I	3 (10)	4 (13.3)	
MCL Grade IIA	8 (26.6)	6 (20)	
MCL Grade IIB	11 (36.6)	13 (43.3)	
MCL Grade III	8 (26.6)	7 (23.3)	

Values are expressed as mean ± SD or number (%), SD = Standard deviation, ASA = American society of anesthesiologists, MO = Mouth opening, TMD = Thyromental distance, MMP = Modified Mallampati, MCL = Modified cormack-lehane

Intubation parameters

All the patients in CMAC® group were intubated using size three blade while one patient in McCoy group required size four blade. The IDS scores, time taken for glottic visualization, to negotiate ETT, and the total taken to intubate, the number of intubation attempts and the MCL view obtained are shown in Table 2.

No difference was observed in hemodynamic variables like pulse, systolic blood pressure and diastolic blood pressure between the groups at predefined time intervals [Figures 1-3].

Discussion

The results of our study demonstrated that CMAC® videolaryngoscope reduces the difficulty of endotracheal intubation as measured by IDS score and improves the view of the glottic aperture in comparison to the McCoy laryngoscope in patients having neck stabilization with the rigid cervical collar. However, the total time taken to intubate, number of attempts, maneuvers required were comparable with both the devices.

Application of rigid collars in patients with suspected cervical spine injury can decrease the mobility of cervical spine by 30-50% and reduce the exacerbation of neurological injury associated with laryngoscopy.[13] However, the presence of a rigid collar not only prevents the alignment

Table 2: Device performance in patients undergoing intubation with McCoy and CMAC® videolaryngoscope

Intubation parameters	McCoy (n = 30)	CMAC® (n = 30)	P
IDS	4 (3-6)	1 (0-1)	<0.001
Total intubation time (s)	26 (19-32)	22 (10-30)	0.110
Time to view glottic opening (s)	14 (8-15)	5 (5-7)	<0.001
Time to intubate (s)	12 (10-15)	18 (10-23)	0.03
Number of attempts (I/II/III) n (%)	26 (86.7)/4 (13.3)/0	28 (93.3)/2 (6.7)/0	>0.05
Number of patients requiring optimizing maneuvers n (%)	12 (40)	14 (46.6)	>0.05
Laryngoscopic view n (%)			
MCL Grade I	16 (53.3)	29 (96.7)	<0.0001
MCL Grade IIA	12 (40)	1 (3.3)	
MCL Grade IIB	2 (6.7)	0	
MCL Grade III	0	0	
MCL Grade IV	0	0	

Values are median (IQR) (range) or number (%), IDS = Intubation difficulty scale, MCL = Modified cormack-lehane, IQR = Interquartile range

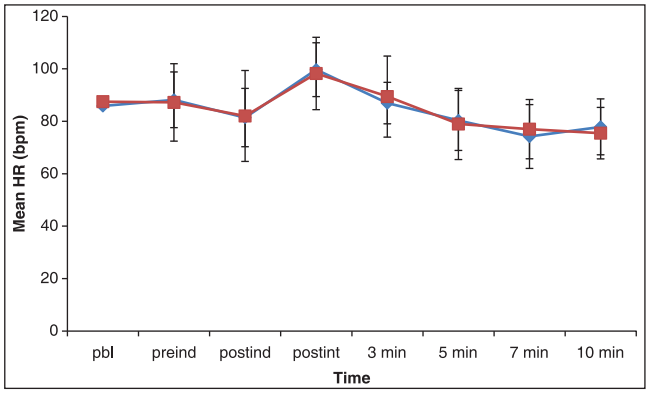

Figure 1: The pulse rate variation during peri-induction period with McCoy laryngoscope and CMAC® videolaryngoscope

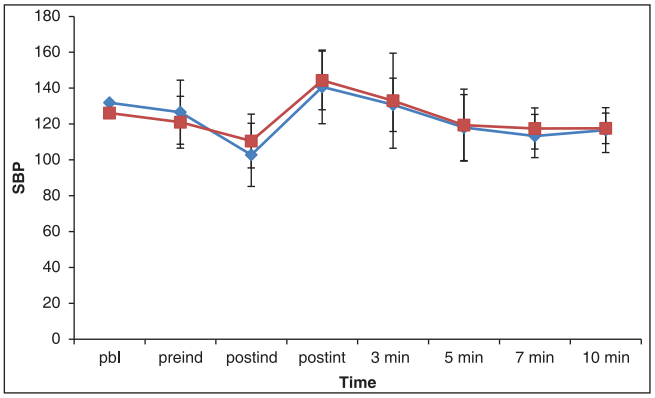

Figure 2: The systolic blood pressure, diastolic blood pressure variation during peri-induction period with McCoy laryngoscope and CMAC® videolaryngoscope

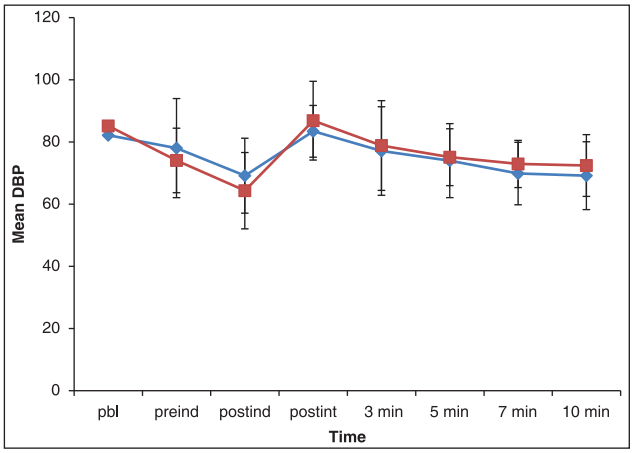

Figure 3: The diastolic blood pressure variation during peri-induction period with McCoy laryngoscope and CMAC® videolaryngoscope

of the oropharyngeal-laryngeal axis, but also restricts the Mo,[3,14] thereby increasing the incidence of airway related complications.[15,16]

We found that CMAC® videolaryngoscope provided a higher proportion of MCL Grade I visualizations compared to McCoy laryngoscope. This is in accordance with the previous trials.[16,17] The use of video technology in CMAC® videolaryngoscope provides an extended view of 60% in the vertical plane and 80% in the vertical plane of the glottic area, which offers an advantage in cases of anteriorly placed larynx.[18,19]

We did not include the Macintosh laryngoscope in our study as both the devices used in our study have been independently evaluated and compared with the gold standard Macintosh laryngoscope in the previous studies. McCoy laryngoscope has been successfully used in the airway management of cervical spine patients.[20,21] Previous trials have documented an improvement of at least Grade I CL laryngoscopic view in patients with restricted neck mobility with the use of McCoy blade.[5,21] Our study demonstrated significant prolongation in the time taken to negotiate the ETT through the glottic aperture with the CMAC® laryngoscope in comparison to McCoy laryngoscope. However, the total time taken to intubate was comparable. Our study failed to show the superiority of one device over the other with respect to the total time taken to intubate. The activation of the McCoy configuration to get the best possible MCL view could be responsible for the longer time taken for glottic visualization.

Previous studies have demonstrated longer intubation time with videolaryngoscopes compared to the Macintosh laryngoscope.[22] McElwain and Laffey found longer intubation time with the CMAC® video laryngoscope.[23] Increasing the angulation of the blade, helps in the visualization of the anterior larynx, however the difficulty can be encountered in negotiating the tube. Previous studies comparing angulated videolaryngoscopes like glide scope with direct laryngoscopes have demonstrated difficulties in negotiating the ETT through the glottic aperture.[24] The use of conventional Macintosh blade coupled with the use of video technology offers an advantage in providing both inline and out of line vision of the glottic aperture.

Hemodynamic response during airway management is generally due to the stimulation of the oropharyngeal structures during laryngoscopy or laryngeal stimulation during passage of ETT through the glottic opening. McCoy laryngoscope has been reported to cause less hemodynamic changes compared to the Macintosh laryngoscope.[25,26] Ng *et al*. found lesser pressor response with CMAC® than the McGrath videolaryngoscope.[27] Both the devices exert less lifting force in comparison to the Macintosh laryngoscope.[26,28] However, we did not compare the devices with the Macintosh laryngoscope.

We recruited more patients than calculated in view of the anticipated attrition attributed to the patients having MCL Grade IV, an exclusion criteria after randomization. This post-randomization exclusion was a limitation of our study design. However, none of the patients had MCL Grade IV and hence the results were not have been affected.

Another limitation of our study was that the anesthetist recording the laryngoscopic view could not be blinded to the device being used, so the observer's bias could not be eliminated. However, the observer recording the data for the time taken to intubate, number of attempts, hemodynamic parameters and the complications was blinded to the group allocation.

Cormack and Lehane grading system were introduced to grade the laryngoscopic view during direct laryngoscopy. Currently, there is no definitive accepted grading system for videolaryngoscopes; therefore in our study, we have used the MCL grading for laryngoscopic view, which might not be applicable.

To conclude, CMAC® videolaryngoscope results in better glottic visualization and lower IDS than the McCoy laryngoscope without causing hemodynamic in the airway management of simulated cervical spine patients with a cervical collar *in situ*.

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