Original Article

A comparative study of the C-MAC D-blade videolaryngoscope and McCoy laryngoscope for oro-tracheal intubation with manual in-line stabilization of neck in patients undergoing cervical spine surgery

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Abstract

Background and Aims: Airway management in cervical spine injury patients requires manual in-line stabilization (MILS) of the neck to avoid exacerbation of cord injury, which impedes visualization of glottis during laryngoscopy. Specially designed blades such as McCoy and C-MAC D-blades can improve laryngoscopic view in such patients. This study was performed to compare the efficacy of C-MAC D-blades and the McCoy laryngoscope for oro-tracheal intubation using MILS in patients undergoing cervical spine surgery.

Material and Methods: This randomized, prospective study was performed in 60 adult patients of American Society of Anesthesiologists grade I–III, either sex, 18 to 60 years of age undergoing elective cervical spine surgery. Patients were randomly categorized into two groups, group D and group M. Intubation was performed using a C-MAC D-blade videolaryngoscope in group D and a McCoy laryngoscope in group M using MILS. The intubation difficulty scale (IDS) score, laryngoscopy and intubation times, percentage of glottic opening (POGO) score, Cormack Lehane (CL) grading with and without external laryngeal pressure (ELP), need for bougie or change of blade or operator, and change in hemodynamics following intubation were recorded.

Results: Group D showed lower mean IDS scores than group M (P value < 0.0001). There were statistically significant differences found in duration of laryngoscopy (group D < group M), CL grading without ELP (group D: CL-1,2a >CL-2b, 3; group M: CL-1,2a <CL-2b, 3), mean POGO scores without ELP (group D > group M), need for ELP and lifting force (group D < group M), and hemodynamic responses after intubation (group D < group M).

Conclusion: A C-MAC D-blade videolaryngoscope provides better and rapid visualization of glottis with less intubation difficulties than a McCoy laryngoscope during intubation using MILS in patients with cervical spine injury.

Keywords: C-MAC, Cormack-Lehane, IDS, McCoy, MILS, POGO, videolaryngoscope

Introduction

Endotracheal intubation in cervical spine injury patients is challenging as neck movements during laryngoscopy can exacerbate cord injury.[1,2] Cervical spine stabilization techniques such as manual in-line stabilization (MILS) of the neck prevent neck movements during laryngoscopy but impair visualization of glottis as alignment of airway axes is no longer possible.[2,3] Specially designed McCoy laryngoscopes and C-MAC D-blade videolaryngoscopes can improve laryngoscopic view without much need for axis alignment.[4,5]

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Access this article online

Quick Response Code:

Website: https://journals.lww.com/joacp

DOI: 10.4103/joacp.joacp_471_21

How to cite this article: Kumari A, Choudhuri P, Agrawal N. A comparative study of the C-MAC D-blade videolaryngoscope and McCoy laryngoscope for oro-tracheal intubation with manual in-line stabilization of neck in patients undergoing cervical spine surgery. J Anaesthesiol Clin Pharmacol 2023;39:435-43.

Submitted: 03-Oct-2021 **Revised:** 03-May-2022
Accepted: 15-May-2022 **Published:** 14-Oct-2022

There is paucity of studies comparing C-MAC D-blades and McCoy laryngoscopes for intubation using MILS.

This study was conducted with the hypothesis that for intubation with neck stabilization, a C-MAC D-blade provides better glottic visualization and lesser intubation difficulty than a McCoy laryngoscope.

Material and Methods

After obtaining written informed consent, with due prior approval from the institutional ethics committee (Institute Ethics Committee, VMMC and Safdarjung Hospital, New Delhi, Trial Registration Code: IEC/VMMC/SJH/Thesis/October/2017-011 dated 30-10-2017), and registration with clinical trial registry (CTRI/2018/05/013598) this prospective, randomized, comparative study was conducted in 60 patients of either sex, 18 to 60 years of age, and American Society of Anesthesiologists (ASA) physical status I–III undergoing elective cervical spine surgery (such as anterior cervical decompression and fixation or ACDF surgery in the supine position, skip disectomy with ACDF in the supine position, laminoplasty in the prone position, and posterior pedicle screw fixation in the prone position) under general anesthesia. Patients with anticipated difficult airway (Modified Mallampati class IV,[6] inter-incisor distance <4.0 cm, upper lip bite test class >1,[7] buck teeth, poor dentition with high risk of damage, any oropharyngeal or facial pathology, body mass index >30 kg/meter^2), hypertension, hemodynamic compromise, and high risk of aspiration and pregnant females were excluded from the study.

The primary outcome of this study was to compare intubation difficulty scale scores, and the secondary outcomes were to compare the time taken to secure airway, the percentage of glottic opening score, and the number of attempts for intubation.

All patients underwent thorough pre-anesthetic check-up. The height and body weight of the patients were recorded. Patients were kept fast for 8 hours. All patients were given tablet ranitidine (150 mg) and tablet metoclopramide (10 mg) orally the night before surgery and 2 hours prior to surgery. In the operation theater, monitors for continuous electrocardiogram, non-invasive blood pressure, pulse oximetry, and temperature were attached and baseline vitals were noted. The patient's neck collar was removed. Pre-operative airway was assessed in the neutral position of the head in the supine position by an anesthesiologist blinded to the group allocation. The airway parameters assessed were Modified Mallampati class, inter-incisor gap, thyromental and sternomental distances, and neck circumference at the level of thyroid cartilage. Manual in-line stabilization of the neck was achieved by an anesthesiologist (experienced in trauma management) who stood on the right side of the supine patient facing the patient's head and whose hands were placed on either side of the patient's neck with fingers pressed on the mastoid process, ensuring neutral alignment and immobilization of the head and neck of the patient.

Patients were randomly allocated to two groups of 30 each, group D and group M, using block randomization in a series of blocks of ten with the allocation concealed in sealed envelopes which were opened just before start of anesthesia. Group D patients underwent intubation using a C-MAC D-blade videolaryngoscope, and group M patients underwent intubation with a McCoy laryngoscope. The bispectral index (BIS), capnography, and train of four (TOF) sensors were applied. After pre-oxygenation with 100% oxygen using a facemask for 5 minutes, induction of anesthesia was performed with intravenous fentanyl (2 μg/kg) and propofol (2 mg/kg). After checking ventilation, intravenous vecuronium bromide (0.1 mg/kg) was given. Oro-tracheal intubation was performed using one of the two laryngoscopes as per group allocation, when BIS was around 50,[8] and response to TOF stimulation to the ulnar nerve was abolished. In all cases, laryngoscopy was performed by a single, experienced anesthesiologist who had performed at least 30 successful intubations with each laryngoscope.

In group D patients, a C-MAC D-blade was inserted in the mid-line of the oral cavity and advanced till its tip reached the vallecula to visualize glottis on the monitor. In group M patients, a McCoy laryngoscope was introduced from the right side of the oral cavity and its tip advanced till the vallecula and lever activated to visualize glottis under direct vision. An appropriate sized styletted cuffed flexometallic endotracheal tube was used in all cases. In group D, the styletted flexometallic endotracheal tube was moulded along the curvature of the D-blade before intubation.

An attempt of intubation was terminated if SpO_2 fell below 95%. The next intubation trial was given using the same technique only after achieving SpO_2 to at least 98% with manual ventilation with 100% O_2. Inability to intubate trachea in 120 seconds or in two attempts was considered as a 'failure of intubation,' and further intubation was attempted using a fiber-optic bronchoscope.

Anesthesia was maintained with isoflurane (a minimum alveolar concentration of 0.8–1.0) in an oxygen and nitrous oxide mixture, with supplemental doses of vecuronium bromide and fentanyl. Intra-operative BIS was maintained in the range of 50 to 60. At the end of surgery, muscle relaxation

was reversed with intravenous neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg). Extubation was performed 'on table' if the reversal from anesthesia is adequate. In the case of difficult extubation (such as fiber-optic guided intubation or duration surgery more than 180 minutes or any lesion involving more than two levels or above the C4 level),[9] the plan was to delay extubation and shift the patient to the post-operative care unit for elective ventilation till the time patient recovers fully.

The parameters noted were total intubation difficulty scale score [Appendix 1],[10] duration of laryngoscopy attempt (time from insertion of the laryngoscope blade between the teeth to the time taken to obtain the best glottic view), duration of intubation attempt (time from obtaining the best glottic view to the time of appearance of the first capnographic square wave), duration of second attempt laryngoscopy and intubation if first attempt unsuccessful, use of external laryngeal pressure (ELP) percentage of glottic opening score (POGO score) without ELP,[11] Cormack Lehane (CL) grading of glottis view without ELP,[12] lifting force needed during laryngoscopy, mobility of vocal cord (adducted or abducted), number of attempts for intubation, change of blade, change of operator for intubation, use of bougie, need for rescue device, heart rate and blood pressure just before laryngoscopy, at 1, 3, and 5 minutes after intubation, and any complication associated with laryngoscopy such as trauma, de-saturation, incidence of failed intubation, or esophageal intubation.

Sample size was calculated as per the study by Hosalli V *et al.*[13] The mean value of intubation difficulty scale score with the McCoy laryngoscope for tracheal intubation in patients with cervical spine immobilization was 1.6 ± 1.49. Assuming the decrease of 1.2 in the mean value of intubation difficulty severity score with the C-MAC D-blade as clinically significant, the minimum required sample size with 80% power of study and 5% level of significance was 25 patients in each study group. The total sample size taken was 60 to reduce the margin of error (30 patients per group).

For statistical analysis, categorical variables were presented in number and percentage (%) and continuous variables as mean ± SD and median. The normality of study data was tested by Kolmogorov–Smirnov test. If the normality was rejected, the non-parametric test was used.

Unpaired t-test/Mann–Whitney test was used for comparing quantitative variables (when the data sets were not normally distributed) between the two groups, and Chi-square test/Fisher's exact test was used for comparing qualitative variables. A P value of <0.05 was considered statistically significant. Data entry was performed in MS EXCEL spreadsheets, and analysis was performed using a latest version of Statistical Package for Social Sciences (SPSS version 19).

Results

All 60 patients fulfilled the inclusion criteria. The demographic profile, weight, height, body mass index (BMI), ASA physical status, pre-operative hemodynamic profile, and oxygen saturation of the patients in both the groups were comparable [Table 1]. There were no statistically significant differences found in the inter-incisor gap, neck circumference, thyromental distance, sternomental distance, and Mallampati class in both the groups of patients [Table 2].

The mean intubation difficulty scale (IDS) score in group D was significantly lower as compared to group M (P value < 0.0001). More patients in group D (80%) had IDS scores of 0 and 1 as compared to those in group M (16.67%), whereas around 50% patients belonged to IDS scores of 3 and 4 in group M in comparison to only 3.33% patients in group D. IDS scores of 5 and 6 were found in about 6.67% and 13.33% patients, respectively, in group M, whereas none of the patients in group D had an IDS score of 5 or 6. Statistically significant differences were found between the groups in terms of duration of laryngoscopy with a P value of 0.021, the mean POGO score without application of ELP (P value < 0.0001), and the CL grade without application of ELP between the groups (P value < 0.0001). In group D, more patients showed CL grade 1 and 2a, compared to group M (group D 80%, group M 20%). In group M, 60% patients showed CL grade 3, whereas no patient in group D had CL grade 3. More lifting force was required in group M patients than in group D patients (P value < 0.0001). Significantly more patients in group M required ELP for visualization of glottis compared to group D with P value <0.0001 [Table 3].

There were no statistically significant differences found in duration of intubation, requirement of bougie, and the number of tracheal tube passes in both the groups. None of the patients in group D needed bougie to aid intubation, whereas five patients in group M required bougie-aided intubation. The difference was statistically insignificant [Table 3]. Higher readings of systolic blood pressure and heart rate were noted at 1 minute and 3 minutes after intubation in group M than in group D, and a higher diastolic blood pressure and mean arterial pressure were observed at 1, 3, and 5 minutes after intubation in patients in group M as compared to group D with P value <0.05 [Table 4].

Table 1: Comparison of the demographic profile, weight, height, BMI, ASA physical status, pre-operative HR, SBP, DBP, MAP, and SpO_2 of patients in both the groups

Variables	C MAC D-blade (Group D)	McCoy (Group M)	*P*
Age (Years) Number (%)			
<=20	5 (16.67%)	5 (16.67%)	0.513
21-30	6 (20.00%)	7 (23.33%)	
31-40	7 (23.33%)	7 (23.33%)	
41-50	7 (23.33%)	10 (33.33%)	
51-60	5 (16.67%)	1 (3.33%)	
Gender (M: F)	25:5 (83.33%:16.67%)	25:5 (83.33%:16.67%)	1.000
Weight (Kg) Median (IQR)	60.5 (55-65)	60 (55-62)	0.556
Height (cm) Median (IQR)	163.5 (159-170)	162 (150-172)	0.573
BMI (Kg/M^2) Median (IQR)	22.6 (21.4-24.5)	23.05 (20.8-24.4)	0.569
ASA (I/II/III) Number (%)	16/10/4 (53.33/33.33/13.33)	14/15/1 (46.67/50.00/3.33)	0.231
Pre-op HR (bpm) Mean±SD	75.37±14.41	73.03±13.26	0.517
Pre-op SBP (mmHg) Mean±SD	106.17±9.76	110.5±13.22	0.154
Pre-op DBP (mmHg) Mean±SD	64.47±8.15	68.53±10.76	0.184
Pre-op MAP (mmHg) Mean±SD	78.2±7.04	82.6±10.82	0.067
Pre-op SpO_2 (%) Mean±SD	100±0	99.93±0.37	0.317

BMI - Body mass index, ASA - American Society of Anesthesiologists, HR - Heart rate, SBP - Systolic blood pressure, DBP - Diastolic blood pressure, MAP - Mean arterial blood pressure, SpO_2 - Oxygen saturation of blood, SD - Standard deviation, IQR Inter-quartile range, Kg - Kilogram, cm - Centimeter, M - Meter, bpm - Beats per minute, mmHg - Millimeter of mercury

Table 2: Comparison of inter-incisor gap, neck circumference, thyromental distance, sternomental distance, and Mallampati class of patients in both the groups

Variables	C MAC D-blade (Group D)	McCoy (Group M)	*P*
Inter-incisor gap (cm) Median (IQR)	4.3 (4.1-4.6)	4.3 (4.2-4.5)	0.759
Neck circumference (cm) Median (IQR)	37 (36-38)	38 (37-39)	0.300
Thyromental distance (neutral position) (cm) Median (IQR)	5.5 (5.2-5.8)	5.2 (5-5.8)	0.104
Sternomental distance (neutral position) (cm) Median (IQR)	12 (11-13)	12.05 (11.9-12.7)	0.941
Mallampati Class *n* (%)			
I	11 (36.67%)	11 (36.67%)	0.562
II	12 (40.00%)	15 (50.00%)	
III	7 (23.33%)	4 (13.33%)	

IQR - Inter-quartile range, cm - Centimeter

There were no significant differences found in terms of complications, such as the presence of blood on the blade and trauma to the lip [Table 5].

Discussion

Endotracheal intubation involves extensive movement at the level of cervical vertebrae with the potential to cause disastrous neurological consequences in patients with cervical spine injury.[1] MILS has been recognized as a standard technique of neck stabilization to reduce the risk of cord injury.[3] MILS prevents alignment of the three axes during laryngoscopy and makes visualization of glottis difficult.[2] The McCoy laryngoscope, a direct laryngoscope, is designed to elevate epiglottis with its hinged tip and thus improves the laryngoscopic view in patients with difficult airway.[14] The C-MAC videolaryngoscope is an indirect laryngoscope which uses video camera technology to visualize magnified glottis images on an external monitor and does not require alignment of all the three axes for visualization of glottis.[15] The D-blade consists of an embedded optical lens with an aperture angle of 80 degrees and a complementary metal oxide semiconductor (CMOS) digital camera placed at its tip.[5]

Very few studies were found comparing the C-MAC D-blade videolaryngoscope and McCoy laryngoscope. A good number of research works were performed under simulated conditions. Simulation cannot reproduce the real scenario accurately.[16]

Seo KH *et al.*[17] compared the efficacy of the C-MAC D-blade videolaryngoscope and McCoy laryngoscope for nasotracheal intubation in patients with simulated cervical spine injuries using modified nasal intubation difficulty scale score (NIDS) to assess intubation difficulty. As per their findings, the C-MAC group showed a shorter total intubation duration, faster glottis visualization, more patients with 'no difficulty in intubation' as per modified NIDS score, more cases with CL grade 1, and higher POGO scores in comparison with the McCoy group. Their findings supported present study findings, except total intubation time, which was comparable between groups in our study. The authors suggested that the nasotracheal tube took lesser time to reach the glottic inlet from the oropharynx with the C-MAC D-blade because of better

Table 3: Comparison of IDS score, duration of first attempt laryngoscopy and intubation, POGO score without ELP, CL grade without ELP, lifting force required during laryngoscopy, and need of external laryngeal pressure in patients in both the groups

Parameters	C-MAC (Group D)	McCoy (Group M)	*p*
Total IDS Score Median (IQR)	1 (0-1)	3 (2-4)	< 0.0001
IDS			
0	13 (43.33%)	2 (6.67%)	0.0001
1	11 (36.67%)	3 (10.00%)	
2	5 (16.67%)	4 (13.33%)	
3	1 (3.33%)	9 (30.00%)	
4	0 (0.00%)	6 (20.00%)	
5	0 (0.00%)	2 (6.67%)	
6	0 (0.00%)	4 (13.33%)	
Duration Of Laryngoscopy (seconds) Median (IQR)	10 (9-15)	12 (10-20)	0.021
Duration Of intubation (seconds) (Mean±SD)	26.1±3.60	25.1±9.85	0.60
Total duration of airway management (seconds) Median (IQR)	38 (33-40)	35.5 (30-45)	0.36
POGO SCORE - without ELP (%) (Mean±SD)	78.16±29.19	19.53±29.9	<0.0001
Use Of Bougie *n*(%) No/Yes	30 (100.00%)/0 (0.00%)	25 (83.33%)/5 (16.67%)	0.052
Cormack–Lehane grade without application of ELP *n* (%)			
1	16 (53.33%)	2 (6.67%)	<0.0001
2a	8 (26.67%)	4 (13.33%)	
2b	6 (20.00%)	6 (20.00%)	
3	0 (0.00%)	18 (60.00%)	
4	0 (0.00%)	0 (0.00%)	
Lifting force required during laryngoscopy *n* (%)			
0	29 (96.67%)	10 (33.33%)	<0.0001
1	1 (3.33%)	20 (66.67%)	
Need of external laryngeal Pressure *n* (%)	0 (0%)	26 (86.67%)	<0.0001
No. of tube passes Number (%)			
1	20 (66.67%)	24 (80.00%)	0.3817
2	10 (33.33%)	6 (20.00%)	

IDS - Intubation Difficulty Scale, POGO - Percentage of glottic opening, CL - Cormack–Lehane, ELP - External laryngeal pressure, SD - Standard deviation, IQR – Inter-quartile range

visualization and also lesser requirement of supporting aids for intubation as compared to the McCoy group. Therefore, the modified NIDS score was lesser in the C-MAC group.

Jain D *et al.*[18] compared the C-MAC videolaryngoscope and McCoy laryngoscope in simulated patients with a cervical collar. They found that the C-MAC videolaryngoscope had significantly faster visualization of glottis, lesser difficulty in intubation as per IDS score, and more cases of CL grade 1 in comparison to the McCoy group. Their findings supported our study results. The findings showed that in the C-MAC group, the required time to negotiate the tube into the glottis was significantly higher than that in McCoy group, although total intubation times were comparable. They opined that because of increased angulation of the blade in C-MAC, visualization of the anterior larynx becomes easy, but negotiation of the tube may be difficult; however, activation of McCoy configuration takes a longer time to achieve the best view. Similarly, the present study showed that the C-MAC group had a significantly lower laryngoscopic time than the McCoy group, but the intubation time in the C-MAC group was slightly more than that in the McCoy group, although the difference was statistically insignificant.

Hosalli V *et al.*[13] compared Macintosh, McCoy, and Airtraq in patients requiring tracheal intubation with MILS. They found the Airtraq videolaryngoscope group to be associated with more cases with IDS score 0 and CL grade 1 as compared to both McCoy and Macintosh laryngoscopes. Bharti N *et al.*[19] compared the effectiveness of Macintosh, McCoy, and TruView videolaryngoscopes in patients with MILS of the cervical spine, and they found significantly more patients with IDS score 0 with TruView than the McCoy laryngoscope, but the intubation time was more with TruView than McCoy

Table 4: Comparison of HR, SBP, DBP, MAP of patients in both the groups

Parameters	C-MAC (Group D)	McCoy (Group M)	*P*
Heart rate (bpm) (Mean±SD)			
Before laryngoscopy	72.47±8.26	71.37±9.67	0.637
1 min post intubation	75.97±8.54	85.1±12.75	0.002
3 min post intubation	75.03±9.23	80.33±12.84	0.042
5 min post intubation	74.1±8.56	76.7±11.6	0.327
Systolic Blood Pressure (mmHg) (Mean±SD)			
Before laryngoscopy	101.03±10.06	100.97±11.04	0.981
1 min post intubation	106±9.74	120.4±11.81	<.0001
3 min post intubation	106.27±8.47	115.83±11.68	0.001
5 min post intubation	106.8±8.36	110.23±10.03	0.155
Diastolic Blood Pressure (mmHg) (Mean±SD)			
Before laryngoscopy	61.27±7.86	62.53±9.61	0.678
1 min post intubation	64.5±7.68	74.8±11.09	0.0001
3 min post intubation	63.07±7.47	69.13±10.69	0.035
5 min post intubation	62.13±7.06	67.3±10.98	0.048
Mean Arterial Pressure (mmHg) (Mean±SD)			
Before laryngoscopy	74.4±7.85	75.23±9.95	0.720
1 min post intubation	77.97±7.72	89.13±10.68	<.0001
3 min post intubation	76.67±6.51	84.23±10.16	0.001
5 min post intubation	75.9±6.33	81.23±9.24	0.012

HR - Heart rate, SBP - Systolic blood pressure, DBP - Diastolic blood pressure, MAP - Mean arterial blood pressure, bpm - Beats per minute, mmHg - Millimeter of mercury, SD - Standard deviation

Table 5: Comparison of complications associated with the airway management of the patients in both the groups

Complications Number (%)	C-MAC (Group D)	McCoy (Group M)	Total	*P*
Nil	29 (96.67%)	24 (80.00%)	53 (176.67%)	0.126
Blood on the blade	1 (3.33%)	5 (16.67%)	6 (10.00%)	
Trauma to the lip	0 (0.00%)	1 (3.33%)	1 (1.67%)	

groups, although statistically insignificant. They suggested that TruView does not require airway axis alignment to visualize glottis, but advancement of the tube into the glottis may be difficult. Moreover, distal lens fogging in the case of TruView increases the difficulty in negotiation of the tube. Findings of the studies performed by Hosalli V *et al.*[13] and Bharti N *et al.*[19] supported the findings of the present study. Durga *P et al.*[20] compared the intubation condition using Airtraq in two groups of patients, one with and another without cervical collar. They found that intubation with Airtraq in the presence of cervical collar showed comparable results in terms of success rate as compared to no collar group. They remarked that as intubation using Airtraq can be performed in the neutral position of the neck without achieving airway axis alignment, intubation with Airtraq in the presence of cervical collar may not be difficult.

Sagadhevan R and team compared C-MAC and McCoy blades for intubation with MILS in patients with simulated cervical spine injury. In their study, the C-MAC group required significant less time for laryngoscopy, better visualization of glottis, a lower IDS score, and a significant longer time for intubation than the McCoy group. Their results supported the present study findings, but the difference in intubation times was statistically insignificant in the present study.[21]

Sabry LA *et al.*[22] found an association of the C-MAC D-blade with a higher number of modified CL class 1 views and McCoy laryngoscopes with a higher number of class 2b and class 3 views during laryngoscopy using MILS, and the time taken for intubation was significantly longer with the C-MAC D-blade than with the McCoy laryngoscope. Their findings supported present study results, although the difference in intubation time was not statistically significant in the present study. The C-MAC D-blade is hyper-angulated, because of which a styletted endotracheal tube bent in the shape of the configuration of the blade is used for intubation. Sometimes, it is difficult to negotiate this tube through the glottic aperture using the C-MAC D-blade. Even an experienced anesthetist sometimes subconsciously tries to bring the oral, pharyngeal, and tracheal axes into one line, which often increases difficulties during intubation using a videolaryngoscope with an acutely angled blade.[23] Furthermore, CL grade correlates with success of intubation during direct laryngoscopy, and the correlation of view obtained with success of intubation is not well defined with a videolaryngoscope.[24] Because of the lack of a single ideal scoring system for videolaryngoscopy, IDS score along with POGO score, the number of attempts, and use of additional aids for visualization and intubation could be used to assess airway.[24] In group D patients of the present study, difficulty

was observed while negotiating the flexometallic endotracheal tube into the glottic aperture because of the hyper-angulated D-blade and the styletted endotracheal tube hit anterior larynx for which the tube was rotated clockwise to facilitate insertion. After achieving proper glottis view, the D-blade was withdrawn partially outward, which facilitated intubation by changing the angle between the styletted endotracheal tube and the plane of the laryngeal inlet.[25] After removal of the stylet, negotiation of the tube was easier because of less impingement owing to the pliable nature of the flexometallic tube.

Sabry LA *et al.*[22] found that the hemodynamic parameters were significantly higher in the patients in the McCoy group as compared to the C-MAC D-blade group until 4 minutes after intubation, somewhat similar to this study.

Seo KH *et al.*,[17] Jain D *et al.*,[18] and Sagadhevan R *et al.*[21] found comparable hemodynamic responses to laryngoscopy in the C-MAC group in comparison to the McCoy group, unlike the present study. Seo KH *et al.*[17] remarked that both the C-MAC D-blade and McCoy laryngoscope cause less airway irritation by applying less lifting force than Macintosh (as suggested by prior studies).

Studies performed by Aggarwal H *et al.*[26] and Buhari FS *et al.*[27] showed more hemodynamic responses to laryngoscopy with the C-MAC videolaryngoscope than with the McCoy laryngoscope, contradicting the findings of this study.

The reasons behind hemodynamic responses to laryngoscopy and intubation are stretching of the oropharyngeal tissue to align airway axes during laryngoscopy, duration of laryngoscopy and intubation, the depth of anesthesia, and the degree of lifting force causing sympathetic stimulation.[28-30] Aggarwal H *et al.*[26] and Buhari FS *et al.*[27] did not mention about monitoring of depth of anesthesia during induction of anesthesia. The depth of anesthesia has a strong relation with hemodynamic responses to laryngoscopy and intubation.[30]

This study has some limitations as well. The anesthesiologist assessed that the glottis view could not be blinded to avoid observer bias. In addition, no neurological assessment was performed after intubation to rule out any sensory and motor deficit as compared with pre-anesthesia baseline neurological findings, although no available literature had shown any statement on neurological assessment following airway management in patients undergoing cervical spine surgery.

Conclusion

As per the present study findings, we can conclude that the C-MAC D-blade videolaryngoscope provides better and rapid visualization of glottis, reduces intubation difficulty, and requires less lifting force and external laryngeal pressure as compared to the McCoy laryngoscope for oro-tracheal intubation with MILS in patients undergoing cervical spine surgery under general anesthesia. The hemodynamic response after intubation is more prominent with the McCoy laryngoscope than with the C-MAC D-blade videolaryngoscope.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Appendix 1: Total intubation difficulty scale score (IDS score)

Calculation is performed by adding the scores given to the seven parameters[10]	
N1	Number of intubation attempts >1
N2	Number of operators >1
N3	Number of alternative techniques used
N4	Exposure of glottis (Cormack and Lehane grade−1)
N5	Lifting force needed for laryngoscopy (0=normal; 1=increased)
N6	Necessity for laryngeal pressure (0=not applied; 1=applied)
N7	Mobility of the vocal cord (abduction=0; adduction=1)

IDS score 0: easy intubation. IDS score up to 5: slight difficult intubation. IDS score more than 5: intubation with moderate to major difficulty. infinite IDS score: impossible intubation