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The performance of C-MAC videostylet versus D-Blade during tracheal intubation in patients with simulated cervical immobilization: A randomized comparative trial

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ABSTRACT

Background: Concerning patients with suspected cervical spine (C-spine) fractures or other cervical pathologies, tracheal intubation must be done very carefully to avoid injury to the spinal cord.

Methods: Fifty-two patients within a range of 20–60 years old, and arranged for elective surgery, were indiscriminately allocated into two groups; Group S was intubated with the C MAC Videostylet (VS), whereas Group L was intubated by D blade Video Laryngoscope (VL) during cervical immobilization by Philadelphia collar. The first successful attempt duration, total number of intubation attempts, the total duration of the intubation, haemodynamic parameters, stress response of intubation, the degree of C-spine movement and complications were evaluated in both groups.

Results: Group L showed substantially shorter times for the first successful attempt (p-value <0.001) and the whole intubation procedure (p-value <0.001) compared to Group S. Group S had a significantly more total number of intubation attempts (p-value = 0.010). The haemodynamic parameters did not significantly differ throughout the measurements among groups. Regarding the blood cortisol measurements at different periods, there were statistically insignificant changes among the groups. Concerning the greatest alteration in C-spine angulation at the occiput-C1, C1-C2, and C2-C5 segments during laryngoscopy and intubation, there were statistically insignificant differences among groups.

Conclusion: The C MAC D-blade VL is superior to the VS in terms of the number and duration of intubation attempts during C-spine immobilization. Conversely, the VS showed comparable results to the D blade regarding C-spine motion and stress response.

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Tracheal intubation and cervical spine movement; cervical spine injury; cervical immobilization; video stylet; D blade video laryngoscope

1. Introduction

Concerning individuals with suspected cervical spine (C-spine) fractures or other pathologies, tracheal intubation must be done very carefully to avoid injury to the spinal cord [1]. There is ongoing debate about the best tracheal intubation method for those who may have a C-spine injury [2]. To prevent additional neurologic deficits in these patients, head and neck manual inline stabilization (MILS) or the usage of a semi-rigid cervical collar, or even a Philadelphia collar, has been recommended [3]. The cervical collar severely restricts cervical extension and minimizes mouth opening, making the procedure challenging [4–6].

The video laryngoscope (VL) offers indirect laryngeal visualization, even with restricted neck motion, making it suitable for tracheal intubation in C-spine immobilized patients [7].

The video stylet (VS) offers an alternative method for tracheal intubation in cervical immobilized individuals, which is more easily prepared and portable than a flexible fiberoptic bronchoscope. Using VS eliminates the need to extend the neck during tracheal intubation and permits an indirect view of the laryngopharyngeal structures. Consequently, there may be a considerable decrease in C-spine motion and risk of injury during tracheal intubation. Previous research has demonstrated the efficiency of VS for tracheal intubation in cervically immobilized patients [8–10].

The objective of this trial was the assessment of clinical efficacy of the C MAC VS in comparison to D blade VL in participants scheduled for general anaesthesia (GA) with tracheal intubation during simulated C-spine immobilization. The primary endpoint was the time of the first successful trial of intubation.

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Secondary endpoints included the degree of C-spine mobility during intubation, the stress of intubation and complications.

2. Methods

The current trial was documented in the Pan African Clinical Trials Registry (PACTR202204474067468) after receiving the approval of the Alexandria Faculty of Medicine Ethical Committee (IRB NO: 00012098).

Between May 2022 and April 2023 and after obtaining each patient's informed consent. Fifty-two adult ASA I and II participants, aged 20 to 60, who had been planned for elective surgery with GA and tracheal intubation were enrolled in a randomized, prospective and comparative trial at Medical Research Institute Hospital, Alexandria University. The criteria for exclusion were patient refusal, clinical or radiological evidence of abnormalities in the C-spine or airway trauma, Simplified Airway Risk Index (SARI) score ≥ 4 [11] (Figure 1), morbid obesity (BMI ≥40 kg/m^2), previous neck surgery, pregnancy, mouth opening less than two fingers and full stomach.

The sample size was determined through the PASS Version 20 Program. The minimum hypothesized total sample size was 52 eligible patients (26 per group), assuming a 0.8 proportional difference in the length of the first successful intubation attempt when employing C MAC D blade VL against VS and alpha error = 0.05 and power = 80%. Allocation to either Group S (C MAC VS) or Group L (D blade VL) was accomplished using permuted block randomization.

After the placement of a Philadelphia collar around each patient's neck to maintain a neutral position and fit smoothly without obstructing their airflow, patients were carefully moved into a supine posture. An intravenous line was inserted and standard monitoring was attached using a multichannel monitor (Dräger;

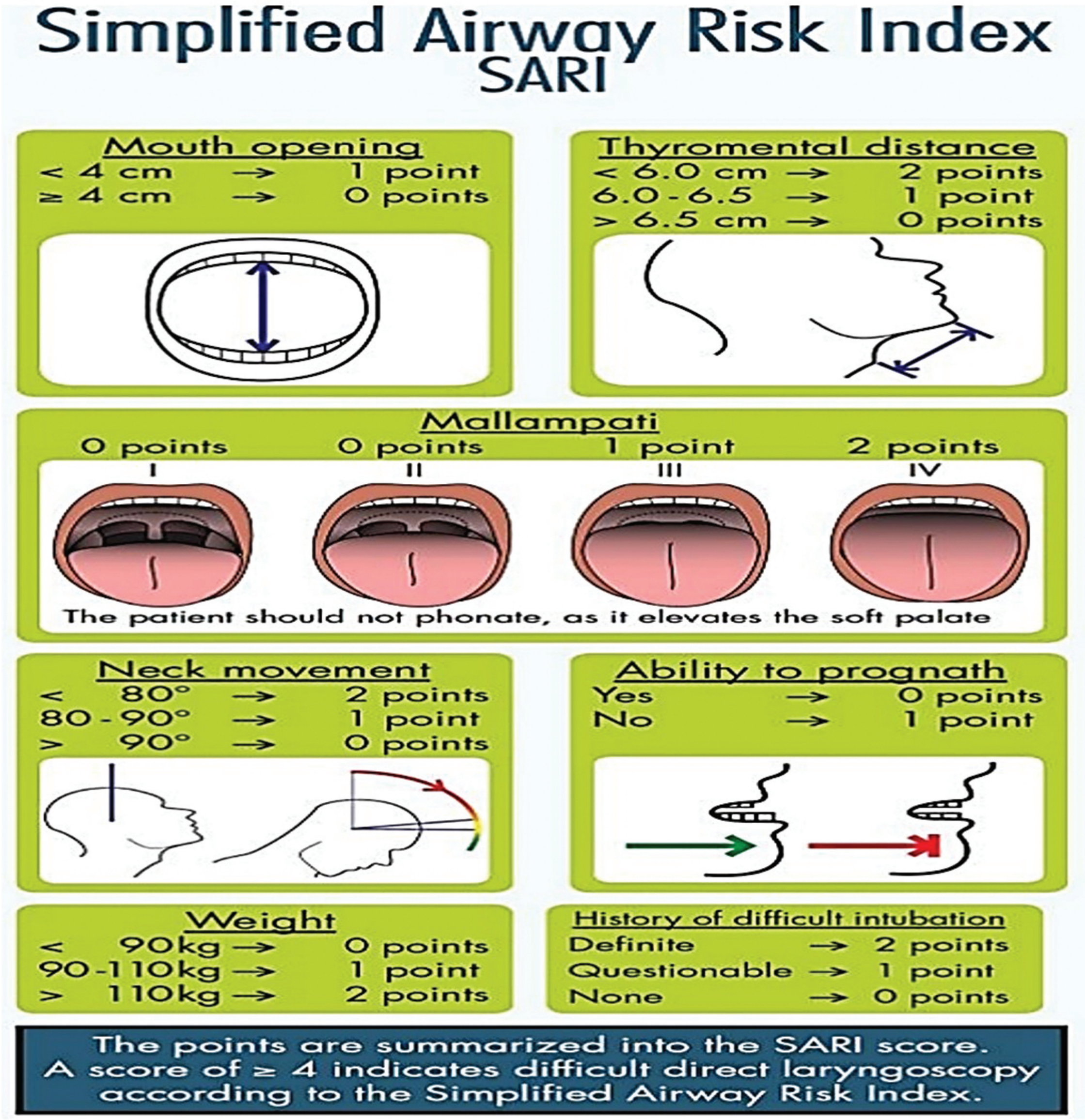

Figure 1. Simplified airway risk index (SARI) score.[11]

Infinity, Germany). Five minutes before induction of GA, participants received a 2 mg intravenous dose of midazolam as a premedication. Following appropriate preoxygenation with 100% oxygen via a facemask, we induced GA by fentanyl (1 μg/kg) administration intravenously with propofol (2 mg/kg) and rocuronium (0.6 mg/kg). Using isoflurane (1.2%) in 100% oxygen, intermittent positive pressure ventilation was started and maintained. According to the assigned group, intubation was performed in the supine position using either a C MAC VS or a C MAC D blade VL. To reduce interoperator variability, a single anesthesiologist conducted every intubation. Capnography was used to verify successful tracheal intubation in both groups.

In group S, after lubrication of the C MAC VS shaft with gel, was passed through a tracheal tube and advanced through the midline of the mouth toward the glottis. If necessary, a jaw-thrust technique was employed to create a pharyngeal space for visualization of laryngeal structures. After the vocal cords and epiglottis were visible on the screen, the tube was gently advanced into the trachea following the adjustment of the VS tip until it was directly in front of the vocal cords [10].

In group L, the D blade VL was positioned in the midline of the mouth, and the tip was guided under vision towards the base of the tongue, then under monitor view towards the vallecula, allowing visibility of the glottic opening. Subsequently, close to the blade edge, the tracheal tube over stylet was advanced under direct vision, taking care to maintain the tube tip visible at all times. The tube was advanced over the stylet immediately in front of the arytenoid cartilages with the assistance of monitor guidance [12].

If the initial attempt failed (taking more than 120 seconds), the same anesthesiologist was given another chance After one minute of 100% oxygen mask ventilation. In case of the third intubation trial failed, the technique was considered as failed technique and the patient was excluded from the study.

A digital fluoroscopy unit (BV Endura mobile C-arm with vascular package; Philips Medical Systems Nederland B.V., Eindhoven, The Netherlands) was used to record continuous fluoroscopy during the intubation to measure the maximum amount of angulation at the occiput – C1, C1–C2, and C2–C5 segments. Prior to the administration of GA, the C-arm was positioned centrally on the C-spine to incorporate both the occiput (Occ) and fifth cervical vertebra (C5) in the lateral view. The line that connects the Sella base to the opisthion is the reference line for the occiput, and the C1 reference line connects both the lower cortical borders of C1 anterior arch and the C1 spinous process. The C2 reference line connects the lower cortical boundary of the C2 spinous process to both the anterior and inferior margins of the C2 body. The C5 reference line is defined as a tangent aligned superiorly parallel to the end plate of the C5 body (Figures 2 and 3) [13,14].

SARI score, the successful attempt duration (time from the intubating device passes the central incisors until confirmation of tracheal intubation by capnography), the number of attempts, and total

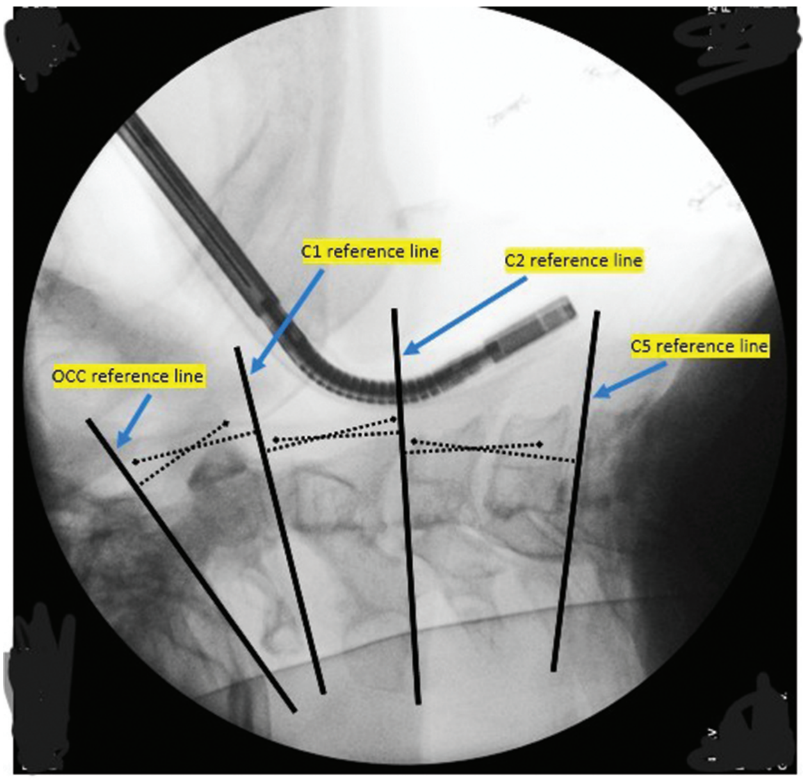

Figure 2. Lateral fluoroscopic cervical X-ray image during intubation with videostylet.

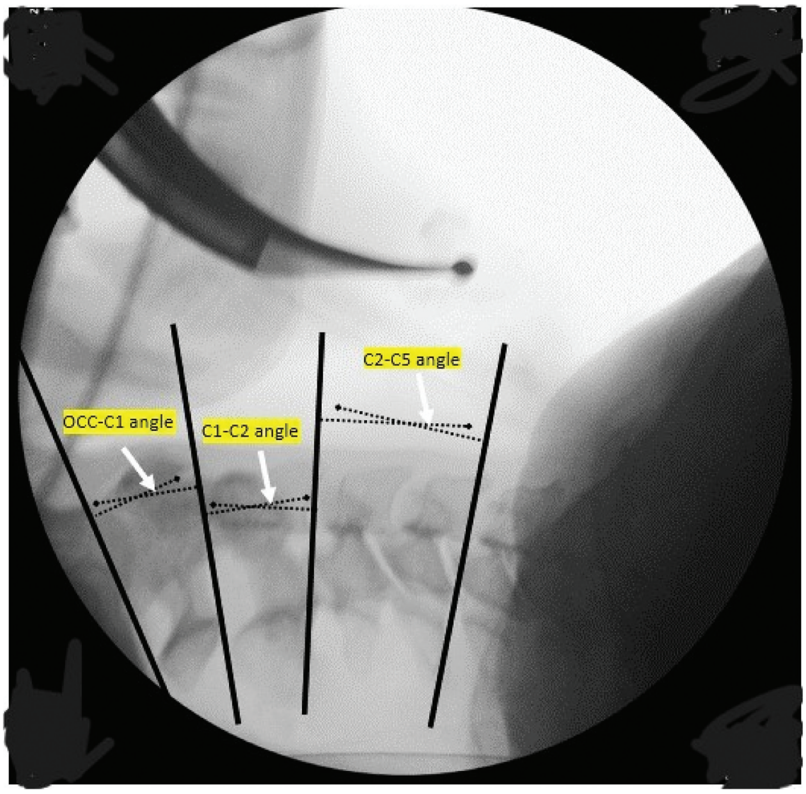

Figure 3. Lateral fluoroscopic cervical X-ray image during intubation with D blade.

duration for intubation attempts (starts from the first trial to the end of successful intubation), intubation failure (failed intubation after three attempts), Hemodynamic parameters including the mean arterial blood pressure (MABP) and the heart rate (HR) (were monitored continuously then

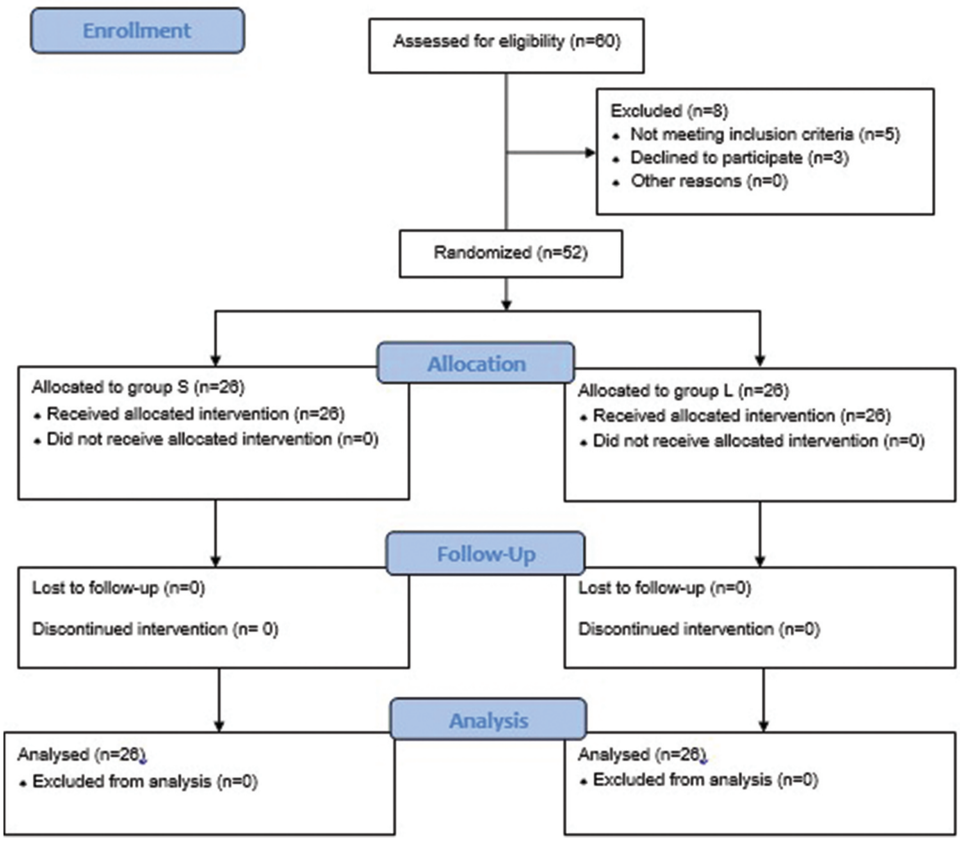

Figure 4. The research participants' flow diagram.

documented on arrival to the theatre, just before intubation and just after intubation), baseline (just before induction of anaesthesia) and five minutes after intubation serum cortisol level s using a radioimmunoassay technique (Gamma Coat® Cortisol 125 IRIA), complications and the greatest variation in C-spine angles between (Occ-C1), (C1-C2), and (C2-C5) were measured for both groups and statistically analysed.

3. The data's statistical analysis

The computer was fed data, and IBM SPSS software package version 20.0 was used for analysis. (IBM Corp., Armonk, NY) Numbers and percentages were used to describe the qualitative data. To confirm that the distribution was normal, the Shapiro-Wilk test was performed. The terms range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR) were used to characterize quantitative data. The results were deemed significant at the 5% level.

4. Results

Fifty-two patients (26 in each group) were assigned and statistically analyzed (Figure 4). The age, body mass index, and SARI score of the patients in both groups show statistically insignificant variations (Table 1).

There were insignificant variations in HR and MABP among groups on arrival to the operative theatre, just before and just after intubation (Figure 5). Five minutes after intubation, Serum cortisol levels in both groups did not significantly change in comparison to baseline levels (Table 2).

The duration of successful intubation attempt for group L (25.42 ± 5.20 secs) was significantly shorter than the video stylet group (37.73 ± 8.87 secs) (p value < 0.001). Group S exhibited a significantly greater number of intubation trials compared to Group L (p value = 0.010), all cases were intubated from the first attempt in Group L (first attempt success rate 100%), while in Group S 20 cases only were intubated from the first trial (first attempt success rate 77%). The total duration of intubation attempts was substantially shorter in Group L than in Group S (p-value <0.001) (Table 2).

There was no intubation failure with comparable frequency of complications between the two groups (Table 3). Regarding the maximum change in angulation during intubation at the OCC-C1, C1-C2, and C2-C5 segments, there were insignificant differences between the two groups (Figure 6).

5. Discussion

Following tracheal intubation, individuals with C-spine instability, whether verified or suspected, are often at

Table 1. The patients' demographics and SARI score of the two studied groups.

	Group S (n = 26)	Group L (n = 26)	Test of significance	P
Age (years)				
(Min. – Max.)	22.0–60.0	24.0–60.0	t = 0.553	0.582
Mean ± SD.	46.54 ± 11.16	48.15 ± 9.85		
BMI (kg/m^2)				
Min. – Max.	24.0–35.0	22.0–37.0	t = 1.008	0.318
Mean ± SD.	28.35 ± 2.76	29.15 ± 3.02		
SARI score				
Median (IQR)	1.0 (1.0–2.0)	1.0 (1.0–2.0)	U = 320.0	0.723

SD: Standard deviation.
IQR: Inter quartile range.
U: Mann Whitney test.
t: Student t-test
p:p-value for comparison between the studied groups

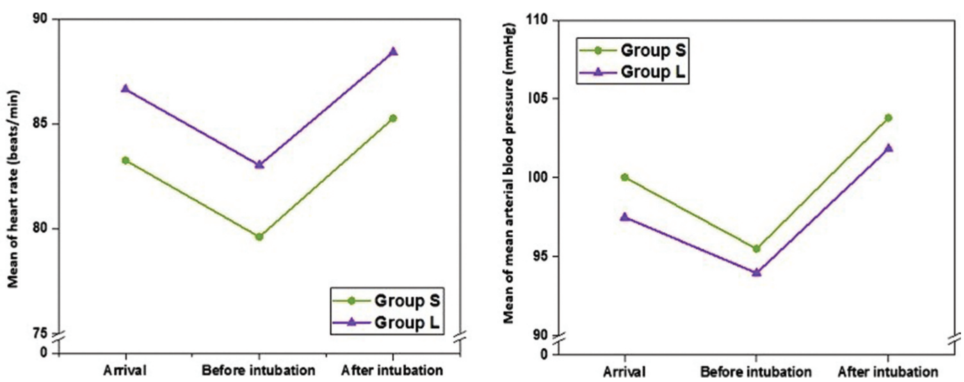

Figure 5. The two-group comparison Left image: regarding heart rate (beats/min). Right image: regarding mean arterial blood pressure (mmHg).

Table 2. Comparison between the two groups regarding intubation parameters and serum cortisol level.

	Group S ($n = 26$)	Group L ($n = 26$)	Test of significance	P
No. of attempts				
Min. – Max.	1.0–3.0	1.0–1.0	U = 260.0*	0.010*
Median (IQR)	1.0 (1.0–1.0)	1.0		
Successful attempt time (second)				
Min. – Max.	27.0–62.0	17.0–37.0	t = 6.105	<0.001*
Mean ± SD.	37.73 ± 8.87	25.42 ± 5.20		
Total intubation time (second)				
Min. – Max.	27.0–162.0	17.0–37.0	U = 5.161*	<0.001*
Median (IQR)	36.0 (32.0–62.0)	25.0 (22.0–29.0)		
Baseline Serum cortisol (mcg/dl)				
Min. – Max	9.30–33.20	8.90–30.80	t = 0.617	0.540
Mean ± SD	19.92 ± 6.28	20.97 ± 5.94		
Serum cortisol level 5 minutes after intubation (mcg/dl)				
Min. – Max	11.10–34.10	11.50–29.20	t = 0.825	0.413
Mean ± SD	20.32 ± 5.56	21.52 ± 4.91		
t_0 (p_0)	1.512(0.143)	1.58(0.126)		

IQR: Inter quartile range.
SD: Standard deviation.
t: Student t-test
U: Mann Whitney test.
p0: p-value for comparing Serum cortisol within the same group
p: p-value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$.

Table 3. Comparison between the two groups regarding complications.

	Group S ($n = 26$)		Group L ($n = 26$)			
	No.	%	No.	%	χ^2	^{FE}p
Bleeding	2	7.7	0	0.0	2.080	0.490
Desaturation (SpO_2 <95%)	4	15.4	0	0.0	9.091	0.110

χ2: Chi-square test.
FE: Fisher Exact.
p: p-value for comparing between the two studied groups

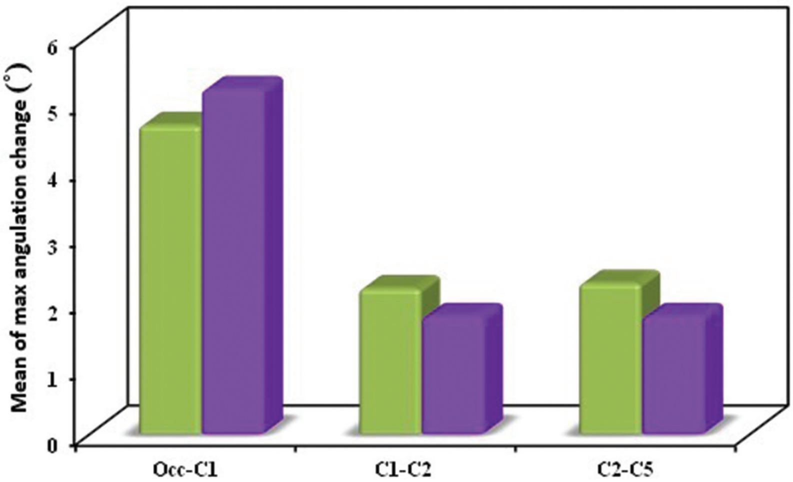

Figure 6. Comparison between the two groups regarding maximum segmental spine motion.

risk of developing subsequent iatrogenic spinal cord compromise. Semi-rigid collars are frequently utilised to reduce C-spine movement [15,16].

We reported a mean duration of the successful intubation attempt in Group L of 25.42 ± 5.20 seconds and all cases were intubated from the first attempt (100% success rate of the first attempt), while in Group S the mean duration of the successful intubation attempt was 37.73 ± 8.87 seconds and 20 cases only were intubated from the first attempt (77% success rate of the first attempt).

Kumari et al. [17] utilised the D blade VL in patients with C-spine injuries and reported a better glottis view during intubation with MILS with a mean intubation duration of 26.1 ± 3.60 seconds. Also, Seo et al. [18] studied the efficacy of the D blade VL in nasotracheal intubation in simulated C-spine immobilisation and documented the total intubation duration of 39.5 ± 11.4 seconds. The more prolonged intubation time in their study was most probably due to time taken for nasotracheal intubation.

Paik et al. [19] studied C-spine motility during intubation with the D blade VL in simulated C-spine immobilization. They reported a 100% success rate in the first trial with intubation duration of (5.0 [3.4–9.5] seconds). The shorter duration in their study may be explained by being measured from the device passing the incisors till just before passing the tube into the trachea, not up to capnography confirmation of intubation as in our study.

Nabecker et al. [20] evaluated awake intubation with C MAC VS and showed that the intubation time was (45 [21–88]seconds) with 80% success rate from the first trial.

Additionally, Pius et al. [21] tested the VS to the Macintosh VL of the C MAC system in manikin with a simulated difficult airway. According to the study, the VS took less intubation time (17 [13.5–25] seconds. In both groups, every tracheal intubation was completed successfully on the first trial. The fact that the investigation was carried out on a manikin could account for the shortened intubation time and high success rate. This could possibly account for the VS's superior performance in manikin experiments, however since the camera is at the tip of the device, secretions made it impossible to replicate the results in live participants during ETI. On the other hand, the VL's camera lens is situated closer to the user and is shielded by the blade, which may be beneficial in avoiding oral secretion contamination. [22, 23, 24].

In contrast to our findings, Osman et al. [25], in contrast to our findings, reported a greater first attempt success rate with a shorter duration for the C MAC VS in comparison with the D blade VL for intubation in an anticipated difficult airway. Their study focused on difficult airway patients rather than cervical immobilized instances and the performance of the devices differs according to the cause of airway difficulty. The VS had a significantly shorter intubation duration for individuals who were obese and have restricted mouth opening. However, the D blade showed a much-reduced intubation time in circumstances with limited neck motion.

We reported insignificant variations in the HR and MABP at various intervals compared to the baseline among groups. as well as serum cortisol levels didn't show a significant increase after intubation in the two groups.

In their research, Rastogi et al. [26] compared the Macintosh laryngoscopes, Video laryngoscopes, and Fiberoptic bronchoscopes to monitor stress response. The salivary alpha-amylase level was used to measure the sympathetic adrenomedullary activity and serum cortisol for the hypothalamus-pituitary adrenocortical activity. The study demonstrated that the VL significantly reduced patients' stress response and hemodynamic changes.

Contrary to our findings, Osman et al. [25] found that the D blade group experienced a substantially higher increase in HR and MABP than the VS group. They explained that by the consequence of a more sympathetic response to the D-blade's pharyngeal manipulation as opposed to the more delicate manipulation with the VS.

In the current study, the C MAC VS didn't show a significant difference regarding the C-spine motion in comparison to D blade VL. Even in situations where there is cervical immobilization, C-spine movement particularly extension of the upper C-spine is a necessary part of achieving a line of sight during direct laryngoscopy during intubation. However, with an indirect laryngoscopy, the laryngoscopic view is captured by a camera located at the tip of the device. This allows for a reduced extension of the cervical spine during intubation, eliminating the need to precisely align the oral, pharyngeal, and tracheal axes [18].

There are just two studies in the literature comparing VS and VL in terms of cervical motion. According to Nam et al. [10] found that, when intubating patients with simulated cervical immobilization, the Optiscope VS induces less motion in the C-spine than the McGrath VL. Additionally, Fan et al. [28] investigated the C-spine motion during intubation by Shikani optical stylet (SOS) and the Glide Scope (GS) VL during elective cervical surgery without cervical immobilization. They demonstrated that the GS group's shift in the C2–5 angle from baseline was substantially greater than that of the SOS group. The disparity in the results from the present study may be due to differences in the device configurations used in the study by Nam et al. [10] and the absence of cervical immobilization in the Fan et al. [27] study.

Several studies were conducted comparing either VL or VS with conventional intubation techniques in studying C-spine motion and concluded that both devices are associated with reduced cervical motion in contrast to direct intubation methods [19, 28, 29, 30, 31, 32].

6. Conclusion

The clinical performance of the C MAC D-blade is superior to the videostylet in terms of duration, number of trials and first-attempt success rate of intubation in immobilized C-spine. The videostylet has a comparable result to the D-blade in C-spine motion during intubation. Both devices are associated with comparable hemodynamic response to intubation without considerable complications.

7. Limitations of the study

The lack of operator and assessor blindness to the device being investigated was one of the study limitations. Furthermore, the study was conducted on patients with normal airways and under cervical immobilization, so the results of the study cannot be guaranteed in patients with difficult airways.

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Disclosure statement

No potential conflict of interest was reported by the author (s).

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Data availability statement

All related data supporting the study's findings are incorporated in this article. Additional data can be obtained upon reasonable request from the corresponding author.

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