A randomized clinical trial comparing the King Vision (channeled blade) and the CMAC (D blade) videolaryngoscopes in patients with cervical spine immobilization

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Abstract

Background and Aims: Cervical spine immobilization renders direct laryngoscopy difficult. The CMAC D blade and the channeled blade of the King Vision videolaryngoscopes, have both been used for difficult airway management. Our hypothesis is that the channeled blade of the King Vision would be superior to the CMAC D blade in terms of ease of intubation. We tested this hypothesis in a randomized comparison of the two videolaryngoscopes in patients with simulated cervical spine immobilization.

Material and Methods: Hundred patients with no anticipated airway difficulty were randomly allocated to two groups after obtaining informed written consent. Following induction, manual inline stabilization (MILS) was applied to simulate a cervical spine injury and immobilization. Patients were intubated with either of the two videolaryngoscopes. Time for visualization of the glottis, procedural time, intubation difficulty scale (IDS), and hemodynamic response were recorded.

Results: The time to visualize the glottis was shorter in the CMAC D group as compared to the King Vision group ($P < 0.001$). The incidence of external laryngeal manipulation was less in the King Vision group ($P < 0.001$). The ease of intubation was superior in the King Vision group, based on the IDS ($P < 0.001$). The haemodynamic response was similar between the groups.

Conclusion: King Vision channeled videolaryngoscope was difficult to introduce into the mouth of the patient during laryngoscopy. Once introduced into the mouth, the time for intubation was less and less external laryngeal manipulation maneuvers were performed to achieve successful intubation. The ease of endotracheal intubation was superior for the King Vision videolaryngoscope. The King Vision videolaryngoscope with proper training, could be a safe and portable alternative in patients with cervical spine immobilization.

Keywords: Equipment, laryngoscopy, laryngoscope

Introduction

Intubating patients with cervical spine pathology is a challenge as manipulation of the neck during endotracheal intubation can lead to permanent spinal cord damage.\[1,2\] According to Greenlands three-column model, cervical spine immobilization is a posterior column pathology and results in difficult laryngoscopy.\[3\] Cervical immobilization often renders direct laryngoscopy and tracheal intubation difficult.\[4\] Videolaryngoscopes provide better visualization of the glottis and are useful tools for intubation in patients with cervical spine pathology.\[5\] The CMAC (Karl Storz, Tutlingen, Germany) was introduced in 2009. The D blade, developed by Dr Volker Dorges, claims to be...
an easy option in difficult intubations owing to its greater angulation (40°). CMAC videolaryngoscope has been found to be superior to Macintosh and McCoy laryngoscopes in terms of time to visualize glottis and first-attempt intubation success in patients with cervical spine immobilization.\(^5\)\(^-\)\(^7\) The King Vision videolaryngoscope (KVL) (King systems, Noblesville, USA) provides a disposable channeled blade which aids in guiding the endotracheal tube through the vocal cords. King Vision was found to be superior to Macintosh and McCoy laryngoscopes in terms of time to visualize glottis and first-attempt intubation success. It had shorter intubation times in patients with cervical spine immobilization.\(^5\)\(^-\)\(^8\)\(^,\)\(^9\) There is a paucity of literature comparing the CMAC D blade with the channeled blade of the King Vision videolaryngoscope in patients with cervical spine immobilization. Our hypothesis is that the channeled blade of the King Vision would be superior to the CMAC D blade in terms of ease of intubation.

The primary objectives were to compare the laryngoscopy time, intubation time and procedural time between the two videolaryngoscopes. The secondary objectives were to grade the intubation difficulty scale (IDS)\(^10\) and compare the hemodynamic response to intubation.

**Material and Methods**

The study was registered with Clinical Trial Registry of India (CTRI/2019/06/019726). After obtaining approval from Institutional Review Board, one hundred ASA 1 and 2 patients, between the ages of 18 to 70 years, posted for surgery under general anesthesia and planned endotracheal intubation, were recruited into the study. Signed informed written consent was obtained from them. Patients with anticipated difficult airway (Mallampati 3 and 4, limited neck extension, limited mouth opening, buck teeth, retrognathia, obesity, etc.) were excluded from the study. Permitted Block randomization of size 2, 4, or 6 was used to generate the random sequence and this was done using SAS 9.1.3 software. This computer-generated randomization was put in serially numbered opaque sealed envelopes and kept in the operating room. The sealed envelopes were given to the anesthetist just before the induction of anesthesia. During intubation, the method provided in the envelope was administered by the anesthetist. Group 1 patients were intubated with the channeled blade of KVL and group 2 patients were intubated with the CMAC D blade with a conventional stylet. The anesthetic plan was standardized for all patients.

Patients were pre oxygenated to an ETO2 of more than 90%. Propofol (2-3 mg/kg) and Fentanyl (2 mcg/kg) was used to induce the patient. Vecuronium (0.1 mg/kg) was used to facilitate tracheal intubation. Manual inline stabilization (MILS) was applied by one of the investigators to simulate stabilization of a cervical spine injury. MILS was applied from the head end of the patient after the induction of anesthesia and muscle paralysis. Based on randomization, one of the two video laryngoscopes was used to intubate the trachea. Assuming the learning curve to be around 20 cases, all investigators performed 10 intubations on mannequins and 10 intubations on patients with either device before participating in the study.

After ensuring adequate paralysis, the patient’s trachea was intubated by one of the trained anesthetists. The laryngoscopy time (time from the introduction of laryngoscope into the patient’s mouth to glottis visualization), and procedural time (time from introduction of the laryngoscope to visualizing the black line on the endotracheal tube go past the cords), were recorded by an independent observer. Intubation time (from the end of the laryngoscopy till final confirmation of tube position), was derived by subtracting laryngoscopy time from procedural time. The Intubation Difficulty Scale (IDS) was graded based on the ease of intubation by the anesthetist who intubated the patient. For patients in whom the King Vision laryngoscope could not be inserted as a whole, the display unit was detached and the blade was negotiated into the oral cavity and subsequently the monitor was attached to view the glottis. Hemodynamic effects were noted at baseline, and at 1, 3, and 5 min after successful intubation.

In case of failure to intubate with the study device, external laryngeal manipulation was used to facilitate intubation. If that failed, MILS was discontinued, sniffing position was achieved along with external laryngeal manipulation and the patient was intubated with the McCoy laryngoscope [Figure 3].

**Statistical analysis**

Since both the devices are new, we assume that their performance will be similar. Hence, for continuous equivalence trial we assumed \(\alpha=0.05, \ 1-\beta=0.9, \ SD = 12\), and the difference in intubation time between the two devices to be less than 25 seconds. The minimum number of samples was 49 in each group. However, to have a margin of safety and round the figure, 50 patients in each group were included for the study.

Data was entered using EPIDATA software. Data were screened for outliers and extreme values using Box-Cox plot and histogram. All baseline variables were expressed in terms of mean \(\pm SD\) if they were continuous variables. All categorical variables were reported using frequencies and percentages. Mann-Whitney \(U\) test was used to compare Scope with time 1, time2 and time difference. Chi-square test performed for categorical variables and the outcome variable.
ANOVA was done where the outcome had more than two groups. Differences were considered significant at \( P < 0.05 \). The statistical analysis was performed using SPSS 18.

**Results**

A hundred patients between 18 to 70 years, with a mean age of 33 years (SD ± 11.04) were included in this study [Table 1]. Laryngoscopy time (T1) for the CMAC D blade (13.6 ± 10.89 secs) was significantly less as compared to the King Vision (22.43 ± 12.65 secs), \( (P < 0.001) \). The procedural time (T2) was similar between the two scopes, however, the time for intubation (T DIFF) was significantly shorter for the King vision (10.78 ± 7.1 sec) as compared to the CMAC D blade (24.02 ± 14.9 sec) \( (P < 0.001) \) [Table 2]. Based on the IDS, 55.3% of the intubations were scored ‘Easy’ and 44.7% were scored ‘Slightly difficult’ in the KVL group. In comparison, for the CMAC D group, 21.7% of the intubations were scored ‘Easy’ and 78.3% were scored ‘Slightly difficult’ \( (P = 0.001) \). In the KVL group, 31.2% \( (n = 15) \) required external laryngeal pressure to aid in tracheal intubation. On the other hand, in the CMAC D group, 63.8% \( (n = 30) \) required external laryngeal pressure to aid in tracheal intubation \( (p = 0.001) \). Hemodynamic response to intubation in the King Vision group and CMAC D blade group were similar [Figures 1 and 2].

**Discussion**

In patients with cervical spine injury and immobilization, laryngoscopy and intubation are difficult due to the poor alignment of primary and secondary curves, with increased tendency of endotracheal tube to impinge on the anterior subglottis. Any excessive force to align the line of sight could jeopardize the spinal cord. We compared two angulated videolaryngoscope blades which could negotiate the primary curve without the need for excessive lifting pressure. We compared the channeled blade of KVL and the D blade of CMAC with the hypothesis that the channeled blade may be superior as it can be difficult negotiating the tube along the D blade without an angulated stylet. We did not use Cormack Lehane grading or POGO score as an outcome measure as we kept the tip of the blade a little proximal which was expected to result in an inferior glottic view but better maneuverability of the endotracheal tube.\(^{[11]}\)

We found that the time to visualize the glottis was significantly shorter in the CMAC D blade group (13.6 ± 10.89 secs) as compared to the KVL group (22.43 ± 12.65 secs) \( (P < 0.001) \). Liu *et al.* on the other hand showed similar times for visualization of the glottis between both the channelled (airtraq) and non channeled (glidescope) video laryngoscopes.\(^{[12]}\) This is probably because the operators performing the study had similar experience with both the scopes. In our study, the majority of the cases were performed by trainees, who had more experience with the CMAC than the King Vision scope. We feel that 10 intubations, as suggested by literature,\(^{[13]}\) is not adequate for optimum expertise. The time for visualization of the glottis and the time for intubation improved as the study progressed. The CMAC videolaryngoscope has superior optics with a larger screen, better resolution and magnification. The D blade provides a wider angle of vision owing to its unique blade design \( (63.1 \times 47.8^\circ) \) compared to KVL \( (51.8 \times 40.8^\circ) \).\(^{[14]}\) The KVL scope is considerably thicker \( (29 \text{ mm}) \) than the CMAC D blade \( (10 \text{ mm}) \) owing to the presence of a channel. The longer length of the blade with the attached screen caused impingement on the anterior chest wall (during anterior midline introduction of the blade during MILS), necessitating a disconnection of the screen from the blade, followed by reattachment in few of the patients. This resulted in more time spent on the procedure.

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{figure1.png}
\caption{Line graph comparing the mean heart rate at baseline and 1, 3 and 5 minutes post intubation with the two study video laryngoscopes}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{figure2.png}
\caption{Line graph comparing the mean systolic blood pressure at baseline and 1, 3 and 5 minutes post intubation with the two study video laryngoscopes}
\end{figure}
in prolonged time to visualize the glottis and a risk of trauma as the blade is introduced blind. Our findings were similar to Ajmal et al., but didn’t match Shravanalakshmi et al., who found the D blade more difficult to insert, probably because they used the non channeled blade of KVL.\[16\]

Once the vocal cords were visualized, the time for intubation was significantly shorter in the King Vision group. In the KVL group, the mean time to intubation was (10.78 ± 7.1 seconds), compared to (24.02 ± 14.9 seconds) (P < 0.001) in the CMAC group. Laffey et al. and Liu et al. showed similar results in their respective studies.\[5,12\] The success rate for the first attempt at intubation was 85.7% and 95.7% with the KVL and CMAC D blade respectively. This was similar to the results obtained by Shravanalaxmi et al.\[16\] This seems contradictory to anticipated results, but reflects the experience of the performer as we analyzed the study. The commonest cause of failure was the tube impinging on the right arytenoid. This can be corrected by ensuring proper alignment and distance of the tip of the scope relative to the glottis. The use of a smaller ET tube facilitated 90° counter-clockwise rotation within the channel which rectified impingement on right arytenoid and facilitated intubation. The failures occurred in the initial few cases and got corrected with the above-mentioned technique.

A significantly larger number of patients required external laryngeal manipulations in the CMAC group (63.8%). The angulated CMAC stylet (60°) is shaped like the D blade and improves the ease of tube negotiation through the vocal cords.\[17\] In comparison, when the endotracheal tube is loaded over a conventional hockey stick-shaped stylet with 35° angulation and used with a CMAC D blade, negotiating the tube through the oropharynx and the glottis becomes difficult. This study was done before the custom-made stylet of CMAC was introduced and this contributed to increased incidence of optimization maneuvers in our study. Optimization maneuvers are less frequently used in channeled video laryngoscopes as compared to non channeled video laryngoscopes.\[5\] The King Vision video laryngoscope, being a channeled scope, requires a mere guidance of the endotracheal tube through the glottis, once the primary curve has been bypassed by the blade. The IDS was compared between both the video laryngoscope groups. While 78.3% of the anesthetists scored it ‘slightly difficult’ to

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**Table 1: Demographics**

| Variables | Scope | KVL | CMAC D | \(P\) |
|-----------|-------|-----|--------|-------|
|           | \(n\) | %   | \(n\)  | %     |
| Age (mean\(\pm SD\)) | \(30.37\pm10.15\) | 34.94\±11.02 | 0.03  |
| Gender    |       |     |        |       |
| Male      | 33    | 55.0| 27     | 45.0  | 0.39  |
| Female    | 18    | 46.2| 21     | 53.8  |
| BMI \(\leq25\) | 42    | 53.8| 36     | 46.2  | 0.14  |
| BMI \(>25\) | 5     | 33.3| 10     | 66.7  |

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**Figure 3:** Participant flow on the consort statement
intubate the airway in the CMAC D group, only 44.7% in the KVL Group scored it ‘slightly difficult’. The Hemodynamic response to intubation was similar in both groups. Our results were comparable to both and Laffey et al. and Liu et al’s studies which showed no difference in hemodynamics between the channeled and non channeled scope.[15,12]

The limitations of this study are the potential for bias, as it is impossible to blind the operator or the independent observer to the video laryngoscope being used. In this study, most of the participants were trainees. Despite the 10 learning attempts with the King vision laryngoscope, spatial orientation of the scope blade improved only during the later part of the study. Prior experience of the operators with the CMAC scope probably contributed for higher first-attempt intubation success with the D blade. The ease of intubation, as provided by the IDS, is a subjective scale and was mainly designed for direct laryngoscopy. The study was done on patients with normal airway with simulated cervical spine immobilization. The results may not be completely extrapolated to actual trauma patients with cervical spine instability.

To conclude, the King vision channeled video-laryngoscope, was difficult to introduce into the mouth of the patient during laryngoscopy using anterior midline approach. Once introduced into the mouth of the patient, the time for intubation was less and less external laryngeal manipulation maneuvers were performed to achieve successful intubation. The ease of endotracheal intubation was better for the King Vision as compared to the CMAC D videolaryngoscope. The King Vision videolaryngoscope with proper training, could be a safe and portable alternative in patients with cervical spine immobilization.

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Conflicts of interest
There are no conflicts of interest.

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