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C-Mac or McGrath Video Laryngoscope - Which is Easier to Conquer? A Comparison of Their Learning Curves in Conventionally Trained Anaesthesiologists

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ABSTRACT

Background: With the ever widening spectrum of video laryngoscopes at our disposal and their availability becoming a necessity with difficult intubation, the primary matter of concern now is to find the most cost effective, easiest to master, with the best success rate. Objective: To compare the learning curves of video laryngoscopes (VL), C-Mac and McGrath in terms of time to visualisation of vocal cords and time to successful tracheal intubation. **Methods:** In this study, 20 anaesthesiologists with training only in conventional Macintosh laryngoscopy and intubation were randomly allocated to two groups; viz group CM (C-Mac VL, n=10) and group MG (McGrath VL, n=10). As per the group, they were given 5 attempts with the assigned device in an intubation manikin. Thereafter, they performed a total of 10 tracheal intubations each in adults with the designated device. The time to optimum visualisation of the vocal cords (insertion of laryngoscope blade to visualisation of vocal cords) and time to tracheal intubation (insertion of laryngoscope blade to confirmation of tracheal intubation with the consistent square wave on the capnograph) were noted and the corresponding values compared. Associated haemodynamic changes and complications were also noted. **Results:** The intergroup differences in the time to optimum view of the cords or time to intubation were found to be significantly shorter with C-Mac VL. A success rate of 100% was observed with C-Mac VL whereas there were 4 failed attempts with McGrath VL. Procedure associated haemodynamic alterations and complications were minimal and comparable. **Conclusion**: The C-Mac VL appears easier to master compared with the McGrath VL in anaesthesiologists trained in conventional Macintosh laryngoscopy and intubation. Multicentric trials with larger sample size may be needed to establish the same.

Keywords: Intubation time, Learning curve, video laryngoscope.

INTRODUCTION

The spectrum of video laryngoscopes appears ever widening. With the first commercial device developed in 2001, we have more than 10 devices now at our disposal within a period of less than 20 years. The basic concept of a video laryngoscope (VL) is the indirect visualization of the vocal cords on a screen through a video system, with a camera on the blade and no intervening fiberoptic components. This is in contrast to the conventional direct laryngoscope with which the larynx and cords are visualised in the direct line of sight. The VL also permits sharing of information among the team, others can see and help; thus, an anticipated higher success rate especially in difficult airway situations.

With all such advantages and an array of devices at hand, the prime question now is to procure a device most cost-effective, easiest to master and with a high success rate.

By December 2010, there were only six video laryngoscopes available in market in the UK. Thereafter, a long list followed. These include GlideScope (Standard and Ranger with different sized blades), McGrath laryngoscope, AirTraq optical laryngoscope, Daiken Medical Coopdech C-Scope VLP-100, the Storz C-Mac, Pentax AWS (airway scope), AP Advance VL, SensaScope and the Berci DCI laryngoscopes, and Co-pilot VL and King Vision video laryngoscopes.

Tracheal intubation by video laryngoscope has been stated as the most innovative advancement and a completely different experience as compared with conventional Macintosh laryngoscope, and the skills

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needed for the former are very different too.1 As reported by Peiter and colleagues2, devices with a Macintosh-type blade scored higher in user satisfaction.

McGrath® VL, a product of the Medtronic Covidien, MA, USA, is a portable device, easy to setup, lacking wires and cables. It has a 1.7-inch LCD screen, with adjustable angle, mounted atop the handle of the laryngoscope to display the image. The blade has the configuration of Macintosh conventional laryngoscope, the length adjustable with the overlying cover of the camera stick [Figure 1(a)].

In contrast, the C-Mac VL (Karl Storz, Tuttlingen, Germany) has a dedicated 7-inch portable external monitor to display a high resolution image with 80-degree angle of view. The image is acquired by a CMOS (Complementary metal–oxide–semiconductor) chip incorporated into the blade along with an LED (light emitting diode) light source. Apart from the standard sizes of Mac blade, angulated blade, called C-Mac D Blade, is also available [Figure 1(b)].

A comparative analysis shows that McGrath VL is marginally cost effective. The next question of concern now is how easy they are to master. Most of the studies 3 report learning curves of novices who have had no training with laryngoscopy or intubation being taught video laryngoscopy. This study was primarily aimed at comparing the learning curves of video laryngoscope (VL), C-Mac and McGrath, in terms of visualization of vocal cords and time to successful tracheal intubation in anaesthesiologists trained solely in conventional Macintosh laryngoscopy and intubation. Procedure associated haemodynamic changes, complications and user satisfaction were also noted.

MATERIALS AND METHODS

Study Design & Subjects

This randomised trial was conducted in a tertiary care centre and educational institute after due approval from the Institutional Ethics Committee. The study duration was from February 2018 to August 2018. Manikin based training was done during the month of February; thereafter, patient recruitment and the main study were completed.

Twenty anaesthesiologists trained only in conventional (macintosh) laryngoscopy and intubation were randomly allocated to two groups of 10 each, group CM (C-Mac VL, n = 10) and group MG (McGrath, n=10), using a computer generated random number table. Participation was voluntary. Each of them was given 5 attempts of laryngoscopy and intubation in an intubation manikin with the device as per the group assigned. After this, they performed a total of 10 tracheal intubations each in adults, with their respective device.

The patients included were between 18–60 years of age, weighing between 50-70kg, ASA class I–III, planned for elective surgery under general anesthesia with an anticipated easy laryngoscopy and intubation (Mallampati class I or II). Patients with a high risk of aspiration, known allergy to the standard medications being used in the study, head or neck pathology, and/or a documented history of previous difficult intubation were excluded. A written informed consent for general anaesthesia was obtained from all patients after due explanation of the study protocol and procedure.

Intervention

A standard protocol for anaesthesia was adhered to in all patients. The nil per oral status was ensured and a review preanaesthetic evaluation was carried out in the preoperative room. Premedication consisted of oral alprazolam 0.25mg, the night before surgery; intravenous injections of midazolam (0.02 – 0.03mg/kg), fentanyl (1.5mcg/kg) and dexamethasone (0.01 – 0.02mg/kg) were given on the day of surgery. Upon arrival to the operating room, standard monitoring of vital parameters; pulse oximeter, non-invasive blood pressure, temperature etc, was initiated. The patients were positioned in a neutral position and 100% oxygen was administered through a face mask for 3 min. Anaesthesia was induced with intravenous injection of propofol (2mg/kg). After loss of eyelash reflex and no response to verbal commands, injection vecuronium 0.01mg/kg was given intravenously. Once adequate muscle relaxation was ensured, the trachea was intubated by the concerned anaesthesiologist with the device assigned to him.

The time to optimum view of vocal cords (TA) was calculated as the time from insertion of laryngoscope blade into the patient's oral cavity to visualization of vocal cords, indicated by picking up of the endotracheal tube by the Anaesthesiologist. Glottic visualization was also graded using the four-point scale proposed by Cormack and Lehane4, which was confirmed by an attending anaesthesiologist through the image on the screen of the VL.

The time to tracheal intubation (TB) was calculated from the insertion of the laryngoscope blade in to the patient's mouth to confirmation of correct placement of the endotracheal tube with consistent square wave on the capnograph. The values were noted in both the study groups and the corresponding values compared.

Surgery commenced after collection of the last hemodynamic data 5 minutes after intubation. The recorded vital parameters included pulse rate, mean arterial blood pressure (MAP) and oxygen saturation (SpO2) recorded at baseline (before induction of anesthesia – T0), immediately after intubation (Ti), 1 minute (T1), 3 minutes (T3) and 5 minutes (T5) after intubation.

Maintenance of anaesthesia was done with 60% nitrous oxide in oxygen, propofol, and vecuronium (intermittently) with or without isoflurane (as needed). Upon completion of the surgery, residual neuromuscular blockade was reversed with a combination of intravenous neostigmine (40mcg/kg) and glycopyrrolate (10mcg/kg). After ensuring adequate reversal of neuromuscular blockade, the endotracheal tube was removed. The patients were shifted to the post-anesthesia care unit (PACU) after 10minutes of monitoring and supplemental oxygen administration within the operating room.

Device related problems and complications, reinsertion and subsequent repositioning; incidence of desaturation (peripheral oxygen saturation ≤ 90%), bradycardia (HR < 50/min), hypo- or hypertension (MAP < 60 or >110 mmHg); and incidence of trauma to the oropharyngeal mucosa or teeth were also enumerated.

A maximum of 2 attempts was allowed with the device, after which it was documented as a failed attempt and the airway, in such cases, was secured with a supraglottic airway device. The intervention was also abandoned if any airway injury, bronchospasm, technical failure of the video laryngoscope, or a reduction of oxygen saturation below 90% occurred.

Data Analysis

Data was assessed for normality using the Kolmogorov-Smirnov (KS) test. The normally distributed data were expressed as mean and standard deviation (mean ± SD). Qualitative data was analysed using the Chi-square test. Time changing quantitative parameters, hemodynamic changes, were compared using one way repeated measures ANOVA (analysis of variance) test. The pre-induction values were considered as baseline. Intergroup comparison of values was carried out using the unpaired t test.

A 'p' value < 0.05 was considered statistically significant. All data was analysed using web-based GraphPad calculus.

RESULTS

Subject Characteristics

The ten anaesthesiologist from each of the two study groups, after manikin attempts with the assigned device, performed a total of 10 tracheal intubations each, in adults, with the device. As a result, a total of 200 patients were enrolled in the study, with 100 patients in each group.

The duration, nature and conditions of training was same for all 20 anaesthesiologists. Also, the demographic profile and baseline haemodyamic parameters were observed to be similar in the patients of the both study groups, with the minor differences found to be statistically insignificant (p > 0.05).

Table 1: Demographic & Baseline Profile of patients Anaesthesiologist experience

S. No.	Demographic Characteristic	Group CM n = 100	Group MG n=100	P-Value
1.	Age (years)	40.82 ± 10.56	44.36 ± 7.42	0.204
2.	Sex (M:F)	56:44	51:49	0.196
3.	Weight (kg)	59.24 ± 10.02	57.90 ± 10.39	0.307
4.	ASA physical status (I/II/III)	60/32/8	68/28/4	0.405
5.	Mallampatti grade (I/II)	74/26	77/23	0.357
6.	Previous Experience with Macintosh (patient attempts)	300	300	-

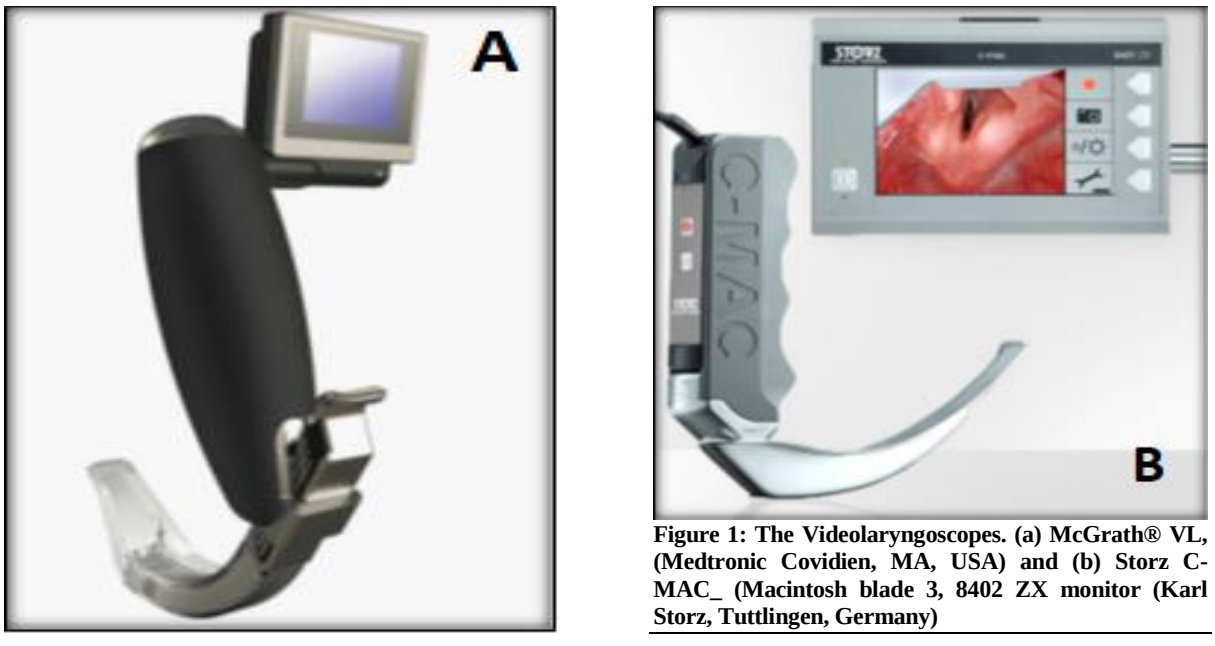

Figure 1: The Videolaryngoscopes. (a) McGrath® VL, (Medtronic Covidien, MA, USA) and (b) Storz C-MAC_ (Macintosh blade 3, 8402 ZX monitor (Karl Storz, Tuttlingen, Germany)

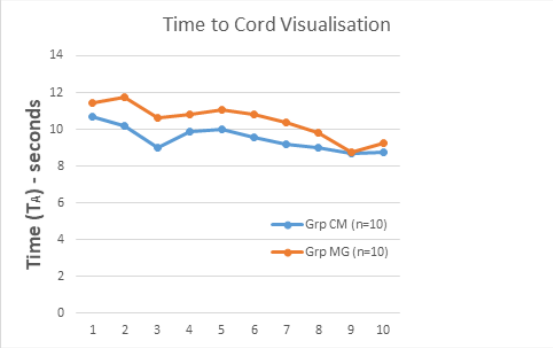

Figure 2(a): Time to Visualization of Vocal Cords

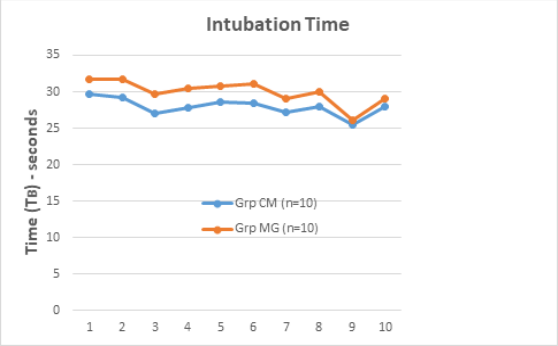

Figure 2(b): Intubation Time

Vital Parameters

The pulse rate and mean arterial pressure (MAP) remained stable throughout the intervention in each of the two study groups, the minor deviations from the baseline were found to be statistically insignificant (Figure 1). The SpO2 was also maintained in both the study groups and never decreased to less than 97% throughout the intervention.

Glottic Visualisation & Intubation

The time to visualisation of the glottic opening (TA) and the time to intubation (TB) were observed to be shorter in the C-Mac group in the initial 8 attempts as compared to the initial 8 attempts with McGrath VL. However, this difference between the two study groups faded in the last 2 attempts of each Anaesthesiologist with the designated device. [Figure 2 (a) and (b)]

The glottic view was CL grade I or II (76 and 24 patients respectively) in all patients enrolled in group CM whereas in group MG, 74 patients had a CL grade I, 22 patients with CL grade II and in the remaining 4, a CL grade III was recorded.

Safety Analysis

The haemodynamic parameters (pulse rate, blood pressure and oxygen saturation) remained stable throughout the intervention in both the study groups and the minor differences / deviations from the baseline were found to be statistically insignificant ($p>0.05$). There were 4 failed attempts of intubation with the McGrath VL whereas the attempts with C-Mac VL were 100% successful. No complication was observed in any of the two devices.

DISCUSSION

This randomised trial consisted of a comparison of the learning curves of 2 video laryngoscopes; viz. C-Mac and McGrath. It was carried out in 20 Anaesthesiologists trained only in laryngoscopy and intubation with the conventional Macintosh laryngoscope. After 5 attempts on an intubation manikin with the VL as designated by the assigned group, each anaesthesiologist attempted laryngoscopy and intubation with his assigned VL on 10 patients scheduled for surgery under general anaesthesia. As a result, data from 200 patients was collected in this study. No such patient-based study on trained anaesthesiologists has been reported till date.

The duration and nature of training in conventional Macintosh laryngoscopy and intubation were same for all the 20 anaesthesiologists enrolled in the study and subsequently divided randomly into the two study groups. The baseline demographic and haemodynamic parameters of patients of both the study groups, i.e. C-Mac and McGrath, were similar and the minor differences were found to be statistically insignificant ($p>0.05$).

The data obtained from this study showed that the time to visualisation of the glottis opening and the time to intubation with C-Mac VL were shorter as compared to the corresponding values with McGrath VL in the first 8 attempts by an anaesthesiologist in an adult patient. This time difference disappeared with the subsequent attempts. The minor haemodynamic changes associated with the intervention were found to be statistically insignificant in both the study groups. There were, however, 4 failed intubation attempts with McGrath VL whereas with the C-Mac VL, all the 100 attempts (10 anaesthesiologists on 10 patients each) were successful.

The findings suggest that C-Mac VL is apparently easier to master from the very first attempt as compared to the McGrath VL.

The findings of the current study are consistent with earlier studies in which a longer time to tracheal intubation was observed with McGrath VL in both manikins and patients.[5,6]

A comparison of 7 VLs with the Macintosh conventional laryngoscope has been done by Pieters and his colleagues.2 The study comprised of 65 anaesthetists, 67 residents in anaesthesia, 56 paramedics and 65 medical students intubating the trachea of a standardised manikin model with a normal airway using seven devices: Macintosh classic laryngoscope, Airtraq, Storz C-MAC, Coopdech VLP-100, Storz C-MAC D-Blade, GlideScope Cobalt, McGrath Series5 and Pentax AWS in random order. Time to and proportion of successful intubation, complications and user satisfaction were compared. All groups were fastest using devices with a Macintosh-type blade and all

needed significantly more attempts using the Airtraq and Pentax AWS (all $p < 0.05$). Devices with a Macintosh-type blade (classic laryngoscope and C-MAC) scored highest in user satisfaction. The trained Anaesthetists showed a 100% success rate with C-Mac VL in this trial as compared to 91% with McGrath VL, findings consistent with this study on patients wherein the success rates for C-Mac and McGrath VLs were 100% and 96% respectively.

A similar manikin based study was conducted by Shin et al,[7] on medical students comparing McGrath Mac VL and C-Mac VL use in manikins. Though there were no difference found in the intubation time and success rate with the devices, the medical students when asked to choose the more handy device, selected McGrath Mac VL. This could be due to the compact single unit property of McGrath Mac VL. These findings were in contradiction with the current study, wherein both the intubation time and success rate were significantly better with the C-Mac VL. The user satisfaction was also reported better with the C-Mac in the current study.

A shorter time to glottis visualisation and subsequent intubation with C-Mac VL when compared with McGrath VL may be presumed due to a more clear view with a larger screen, which could have eased out even the initial attempts with C-Mac VL. Hence, a better user satisfaction could also be documented with the same.

A higher success rate has also consistently been observed with videolaryngoscopes when compared with conventional technique in novices as well as in remote locations.[8-10]

The two videolaryngoscopes chosen for comparison in this trial were those with classic Macintosh type blade. This choice was based on the reports 2 that the VLs with the classic type blade provide a greater user satisfaction. As the interventionalists in this study were trained with conventional Macintosh laryngoscopy and intubation, it was presumed that VLs with conventional blades would be easier to tame/ easier to master, a familiar technique. McElwain et al,[11] compared C-Mac, the Glidescope and Airtraq VLs in easy and difficult manikin simulations given to trained Anaesthesiogists. The Glidescope and Airtraq employ a 'hockey-stick' shaped laryngoscope blade, foregoing the need to align the oral, pharyngeal and laryngeal axes whereas, the C-Mac has a blade shape based on the standard Macintosh laryngoscope and so may be advantageous by offering a familiar technique to those trained in the use of direct laryngoscopy. C-Mac was found to be the easiest to use.

Bacil and colleagues have reported in their study that the success rate may be higher with Airtraq as compared to the conventional Macintosh laryngoscopy when novices are trained in the two devices.[12]

Though a number of other studies,[13] have been reported comparing the learning curves of different VLs, no such study has been reported in which conventional trained anaesthesiologists were given attempts with these two VLs and their intubation characteristics noted and compared.

Butchart and Young,[14] state that the ease and user satisfaction seen with C-Mac VL demonstrates the value of combining indirect video technology and the familiar technique of Macintosh classic blade for successful intubation of the difficult airway.

Large scale multicentric trials would further emphasize the importance of combining the benefits of familiarity with the conventional Macintosh blade along with the advantages of videolaryngoscopy incorporated, not to forget, a larger clearer view provides an add-on benefit.

CONCLUSION

The C-Mac VL appears easier to master compared with the McGrath VL in anaesthesiologists trained in conventional Macintosh laryngoscopy and intubation. Multicentric trials with larger sample size may be needed to establish the same.

Limitations

A small sample size including only 20 Anaesthesiologists, with enrolment on a voluntary basis are the basic limitations. Moreover, the study was single-centred.

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