Comparison of ease of intubation between GlideScope® and C-MAC® Videolaryngoscopes for novices

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ABSTRACT

Introduction: In recent years, video laryngoscopes, like GlideScope® and C-MAC®, have emerged as essential tools in the management of unanticipated difficult or failed laryngoscopic intubation. The ease of directing and inserting the endotracheal tube through the vocal cord has improved significantly when intubating with such devices. This prospective, randomised, single blinded clinical trial compared the ease of intubation between GlideScope® and C-MAC® videolaryngoscopes for novices. **Materials and Methods:** A total of 56 American Society of Anaesthesiologists (ASA) physical status I or II patients scheduled for elective surgery requiring endotracheal intubation under general anaesthesia, without any features suggestive of difficult intubation, were randomly allocated to either the GlideScope® Group (n=28) or C-MAC® Group (n=28). Following induction of anaesthesia with intravenous fentanyl, propofol and either rocuronium or atracurium, endotracheal intubation was carried out by junior anaesthesiology trainees using either one of the two videolaryngoscopes. The following parameters were recorded: the success of intubation at first attempt, the intubation time for successful first attempt and the number of optimisation manoeuvres required. **Results:** More novices in the GlideScope® Group (14.3%) required more than one intubation attempts and optimisation manoeuvres compared to those in the C-MAC® Group. The intubation time for successful first attempt was significantly longer in the GlideScope® Group compared to the C-MAC® Group (median 51.0 vs 37.0 seconds). **Conclusion:** C-MAC® videolaryngoscope significantly provided ease of intubation for novices compared to GlideScope® videolaryngoscope in patients without any features suggestive of difficult intubation.

Keywords: airway management, endotracheal intubation, general anaesthesia, videolaryngoscope

INTRODUCTION

Complications arising from unanticipated difficult or failed endotracheal intubation remain a leading cause of anaesthetic morbidity and mortality. [1-3] Although poor glottic visualisation is encountered between 1.5% and 8.5% of attempts using direct laryngoscopy, successful intubation can generally be achieved

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with external laryngeal manipulation, or with the assistance of an airway adjunct, such as a gum elastic bougie and a stylet. [4] However, poor glottic visualisation is more likely to involve prolonged or multiple intubation attempts which may be associated with complications such as oxygen desaturation and airway or dental injuries. [4]

Risk of cervical spinal cord injury during tracheal intubation can be reduced by using manual in-line axial stabilisation (MIAS) of the cervical spine in patients with actual or suspected cervical spine injuries. However, utilisation of MIAS may lead to difficult laryngeal visualisation with conventional laryngoscopy due to challenges in achieving the oral, pharyngeal and laryngeal axes alignment when the neck is immobilised, which may then result in failure to secure the airway via endotracheal intubation. On the other hand, tracheal intubation with indirect laryngoscopy is easier to achieve as only the alignment of similarly angulated pharyngeal and laryngeal axes are required. This may make tracheal intubation easier to accomplish in these patients. [3, 5]

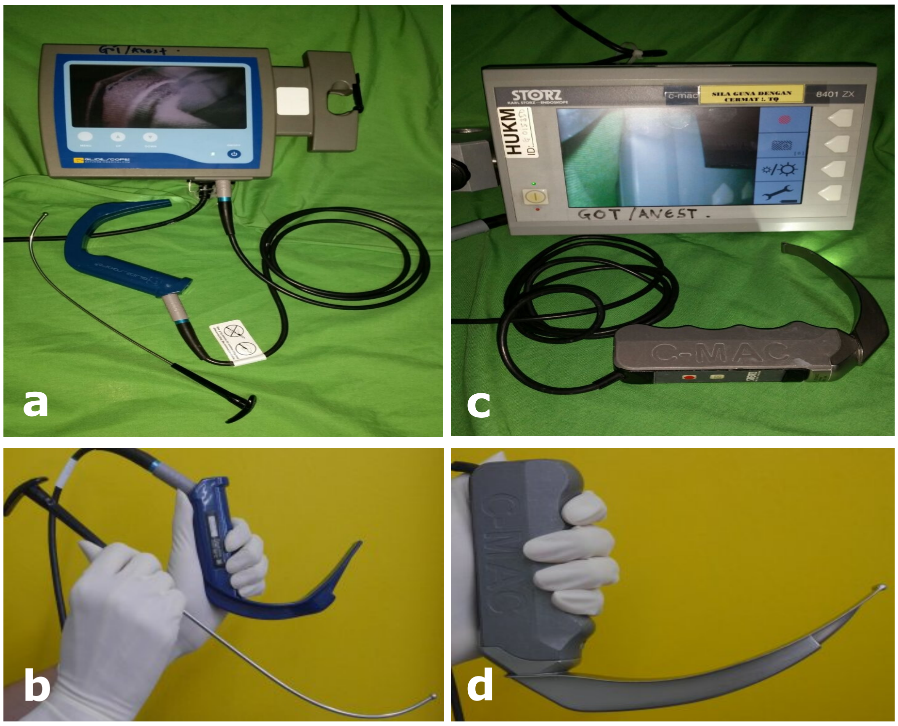
In recent years, videolaryngoscopes, like the GlideScope® and C-MAC®, have emerged as essential tools in the management of unanticipated difficult or failed conventional laryngoscopic intubation. [6] A videolaryngoscope is a device which uses a video camera mounted on its laryngoscope blade, thus providing better access and view to the larynx. [4] Visualisation of the vocal cords can be achieved without alignment of the oral, pharyngeal and tracheal axes. [4, 7] The GlideScope® (Verathon Inc., Bothell, Washington, USA) is a videolaryngoscope with a high resolution camera embedded within the blade with a light source besides the camera for illumination. The 18 mm wide blades have a slightly greater curvature than the regular Macintosh blade, as it bends at a 60^o angle at the midline, providing a more anterior view of the larynx. [7, 8] Since the tip of the blade is not visible, a compatible custom curved intubation stylet known as the GlideRite® Rigid Stylet, is required during intubation. [2, 3, 7] The C-MAC® (Karl Storz, Tuttlingen, Germany) videolaryngoscope is an intubating device utilising a modified Macintosh blade. It is designed based on the Macintosh prototype closed steel blade modelled in three sizes. The C-MAC® blade is flattened, resulting in a slim blade profile (maximum 14 mm) with slanted edges to avoid oral and dental damage. The C-MAC® videolaryngoscope incorporates a small (2 mm) digital camera and a high powered light emitting-diode, located laterally in the distal third of the blade. The embedded optical lens has an increased aperture angle of 80^o. In comparison to the GlideScope®, the blade tip can be observed and manoeuvred into the vallecula.[9]

The aim of this prospective, randomised, single blinded clinical trial was to compare the ease of intubation between GlideScope® and C-MAC® videolaryngoscope for novice anaesthesiologists, in patients without any features to suggest difficult intubation.

MATERIALS AND METHODS

Following approval from the institution's Research & Ethics Committee, 56 patients with American Society of Anaesthesiologist (ASA) physical status I or II scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were enrolled and informed consents were obtained. Their demographic characteristics and airway assessment were recorded preoperatively. The airway assessment included Mallampati score, thyromental distance (TMD) and the mouth opening. The Mallampati score was recorded using the modified Samsoon and Young test. TMD was measured as the distance between the anterior chin and the thyroid notch with the head in full extension. Mouth opening was taken as the distance between the upper and the lower incisor teeth when the mouth was maximally opened. Exclusion criteria included pregnancy, body mass index (BMI) of more than 30 kg/m^2, the presence of respiratory tract disease, patients with high risk of regurgitation or aspiration, and those with known history or who were suspected to have difficult intubation. The 'novices' were seven first year anaesthesiology trainees who had no prior experience of intubating patients using either videolaryngoscopes.

Patients were seen for preoperative anaesthetic assessment on the day before the surgery and premedicated with oral midazolam 3.75-7.5 mg on night. In the operating room, patients were randomized into two groups by computer generated randomization numbers to either the GlideScope® or C-MAC® group. A total of 28 patients per group were required in order for the seven novices to perform four intubations for each videolaryngoscope. Intravenous access was established and standard monitoring devices were applied. Prior to induction of anaesthesia, the patients were placed in the 'sniffing morning air position' with their head supported on a pillow, and three minutes of preoxygenation with 100% oxygen at 8-10 L/min was performed. Patients were induced with intravenous (IV) fentanyl 1.5 µg/kg and IV propofol 2-2.5 mg/kg, followed by either IV rocuronium 0.6 mg/kg or atracurium 0.5 mg/kg for neuromuscular blockade. General anaesthesia was maintained with a mixture of oxygen/air



Figs. 1: a) GlideScope® (with video attached), b) GlideScope® blade and stylet, c) a C-MAC® (with video attached), and d) C-MAC® blade.

(50% / 50%) and sevoflurane to achieve a MAC of 1.0-1.2 intraoperatively.

After adequate muscle relaxation had been achieved, patients were intubated using either the GlideScope® or C-MAC® videolaryngoscope. For each patient, an appropriate sized regular Portex® cuffed endotracheal tube (ETT) was used. For the GlideScope® group, the GlideRite® Rigid Stylet, with a 'hockey-stick' J-curvature was inserted into the ETT whereas for the C-MAC® group, a standard stylet was used. Intubation was attempted if the glottic opening was visualised on the video screen. External manipulation of the larynx such as the backward, upward and rightward manoeuvre was performed to help with the visualisation of the glottic opening when needed. Endotracheal intubation was considered successful once the placement of ETT was confirmed by appearance of the first capnograph tracing followed by lung auscultation. The operator was allowed a maximum of three attempts provided there was no significant oxygen desaturation (SpO_2 <95%) or airway injury during or between attempts. During each attempt, if the endotracheal intubation was not successful after 90 seconds (from the time laryngoscope entered the patient's mouth) or if the oxygen saturation dropped to less than 95%, the videolaryngoscope was removed and bag mask ventilation recommenced between each attempt.

The number of endotracheal intubation attempts was the primary end point in this study. Endotracheal intubation was deemed as a failed procedure if the patient was not successfully intubated by the third attempt. In this event, the patients would be 'rescued' using either of the videolaryngoscopes by the investigator. The duration of time taken for successful intubation at the first attempt was the secondary end point. An assistant utilising a stopwatch would measure the time in seconds from the time the video-laryngoscope entered the patient's mouth until end tidal carbon dioxide was detected on the capnograph. The third end point was the success rate of endotracheal intubation, which was done by comparing the percentages of patients successfully intubated using either videolaryngoscope at the first attempt. The number of optimisation manoeuvres (e.g. re-adjustment of the head position and external laryngeal manipulation) required to assist in the intubation procedure was also noted.

Sample size was calculated based on an alpha value of 0.05 and a power of 80 %. Using the power and sample size calculation, a sample size of 46 patients was obtained. Considering a dropout rate of 20%, a total of 56 patients were required.

Statistical Analysis: SPSS (version 19.0; SPSS Inc Chicago, IL) was used for statistical analysis. Paired student's t-test was used for parametric data and Mann Whitney test for non parametric data. Data was presented as mean with standard deviation or median and range. A *p* value of < 0.05 was considered to be statistically significant.

RESULTS

A total of 56 patients were enrolled into the study and their demographic data are presented in Table 1.

Table 2 shows that all patients in the C-MAC® group were successfully intubated at the first attempt compared to 85.7% of pa-

Table 1: Demographic data of subjects.

	Glidescope® (n = 28)	C-MAC® (n=28)
Age (years)	55.3 ± 17.9	36.3 ± 15.2
BMI (kg/m²)	23.9 ± 3.2	23.9 ± 3.5
Gender		
Male	21 (75.0)	15 (53.6)
Female	7 (25.0)	13 (46.4)
ASA status		
I	10 (35.7)	19 (67.9)
II	18 (64.3)	9 (32.1)

Values are expressed as mean ± standard deviation (SD) or numbers with percentage in parentheses

tients in the GlideScope® group. More novices in the GlideScope® group required optimisation manoeuvres to assist in intubation compared to novices in the C-MAC® group. None of the novices required a third intubation attempt in both groups.

The time taken for successful intubation at the first attempt is shown in Table 3. Four patients in the GlideScope® group were excluded because they required a second attempt for successful intubation. The time taken to successfully intubate at the first attempt was significantly longer in the GlideScope® group compared to the C-MAC® group. In the C-MAC® group, 96.5% of patients were intubated within 60 seconds (median 37 seconds) compared to 87.5% of patients in the GlideScope® group (median 51 seconds).

DISCUSSION

The main difficulty for endotracheal intubation using direct laryngoscopy is to ensure alignment of the laryngeal, pharyngeal and oral axes. In order to achieve glottic visualisation, positioning of the head and neck, and retraction of the soft and skeletal tissues need to be done. However, such manipulations are not always successful. [1, 10] Over the past few years, video assisted techniques have been developed to provide a better view and access to the larynx. They aid visualisation of the vocal cords without the need for alignment of the oral, pharyngeal and tracheal axes therefore improving success of intubation. [2] This could be a very useful advantage over direct laryngoscopy especially in patients who require cervical spine immobilisation, in order to reduce the risk of cord injury during tracheal intubation. [7, 8]

The number of attempts and the time taken for successful intubation are some of the important factors to consider when evaluating a new instrument. Although glottic visualisation may be improved with the use of videolaryngoscopes, this may not make any difference if the time taken for intubation is long or if the process of intubation require many attempts. [2] A user friendly videolaryngoscope would also be beneficial for the pur-

Table 2: Number of intubation attempts and optimisation manoeuvres.

	Glidescope® (n = 28)	C-MAC® (n=28)
Number of intubation attempts		
1*	24 (85.7)	28 (100)
2	4 (14.3)	0 (0)
Number of optimisation maneuvers		
0**	17 (60.7)	26 (92.9)
1	11 (39.3)	2 (7.1)
2	0 (0)	0 (0)

* p=0.04 and ** p=0.07

Table 3: Time taken for intubation at the first attempt.

	Glidescope® (n=24)	C-MAC® (n=28)	*p* value
Intubation time (seconds)			
<30	0 (0)	5 (17.9)	0.001
30-60	21 (87.5)	22 (78.6)	
>60	3 (12.5)	1 (3.5)	
Median	51.0	37.0	

pose of training especially for the untrained anaesthetic personnel.

In the present study, all patients in the C-MAC® group were successfully intubated at the first attempt in contrast to 85.7% of patients in the GlideScope® group. We also found that novices required a longer time for intubation using the GlideScope® (median of 51 seconds) as compared to the C-MAC® (median 37 seconds). The time taken to successfully intubate in our study was longer compared to a similar study conducted by McElwain *et al*. [2] In their study, they found that the duration of the first successful intubation attempt was significantly longer with the GlideScope® (mean 33 seconds) as compared to the use of the C-MAC® (mean 16 seconds). They confirmed successful intubation when the tip of the ETT passed though the vocal cords, whereas we observed for the appearance of the first capnograph tracing followed by lung auscultation. They also found significantly more attempts at intubation were required with the GlideScope® compared to the C-MAC®.[4]

In this study, the C-MAC® was found easier to be used by the novices based on the three endpoints mentioned in the methodology. These findings where the GlideScope® performed less favourably were also supported by the studies by McElwain *et al*. [2], Sun *et ai.* [7] and Malik MA *et al*. [10] With the GlideScope®, a tube stylet is required to guide the ETT through the glottic opening. The manufacturer recommends the use of GlideRite® Rigid Stylet, a custom curved intubation stylet offered with the GlideScope®. [4, 5] Despite having the 'hockey-stick' J-curvature to enable easier passage of the ETT through the vocal cords, novices had difficulties in advancing the tube towards the glottic opening. In this study, more novices in the GlideScope® group required assistance for intubation in the form of optimisation maneuvers compared to those in the C-MAC® group. Failure of intubation at the first attempt in these patients were not due to the inability of visualising vocal cords but were mainly due to difficulty in advancing the ETT through the vocal cords.

The vocal cord is better visualised on the screen seen on the GlideScope monitor, as only a small portion of the blade is visible. In comparison, the whole tip of the C-MAC blade can be viewed on the screen. Despite presenting a better view of the vocal cords, the GlideScope® proved to be more challenging to the novices as it has a highly angulated blade causing difficulty in advancing the ETT into the trachea. [10-12] This could be because the technique to manoeuvre the ETT using the GlideRite® Rigid Stylet requires practice. This could explain why novices in this study required a greater number of intubation attempts, took longer times for successful intubation and required more optimisation manoeuvres with the GlideScope®. The requirement for a custom curved stylet with the use of the GlideScope® also meant that the type of ETT used for intubation was limited as only certain types of ETTs can be used with the stylet.

In contrast, the C-MAC® appeared to cause less of this problem despite not having a side channel to guide the ETT towards the glottic opening. The C-MAC® videolaryngoscope is a device that is familiar to all anaesthesiologists as it utilises a modified MacIntosh blade and can be held like a conventional

MacIntosh laryngoscope. Thus, the proficiency with the device may be easier to acquire than with other indirect laryngoscopes. [7] Another potential advantage of the C-MAC® is that it can be used as both a standard direct laryngoscope or as an indirect laryngoscope. This is because the embedded optical lens has an increased aperture angle of 80°. Therefore the view obtained includes the tip of the blade and allows visual guidance of the tip of blade into the vallecula. [9]

Direct visualisation of the ETT insertion through the vocal cords via the monitor, and the avoidance of neck extension, are the major advantages when intubating with a videolaryngoscope. [12] As for all new devices, a period of training is recommended to gain familiarity with the videolaryngoscopes and to improve the success of intubation. Unfamiliarity with the devices can lead to multiple attempts at intubation particularly by the untrained personnel and may lead to episodes of oxygen desaturation and airway injury.

There were some limitations in this study. The novices were the first year postgraduate trainees in anaesthesiology who did not have prior experience in using videolaryngoscopes. Unfortunately during the year when this study was conducted, there were only 7 first year trainees enrolled in the postgraduate programme, thus the number of novices in this study was limited. Due to the limited number of operators, each novice performed four intubations with each device hence gradual improvement in using both videolaryngoscopes may occur with each subsequent intubation attempt. [10] They were also not blinded to the type of videolaryngoscope used thus subjecting this study to potential bias which is a common problem when comparing different types of devices. [13] We also did not study other characteristics of each device such as the ease of assembly and handling of the device. [14]

In conclusion, the C-MAC® videolaryngoscope provided significant ease of intubation for novices compared to the GlideScope® videolaryngoscope in patients without any features suggestive of difficult intubation.

REFERENCES

1: Combes X, LeRoux B, Suen P, et al. Unanticipated difficult airway in anesthetized patients: prospective validation of a management algorithm. Anesthesiology 2004; 100:1146-50.

2: McElwain J, Malik MA, Harte BH, et al. Comparison of the C-MAC® videolaryngoscope with the Macintosh, GlideScope®, and Airtraq® laryngoscopes in easy and difficult laryngoscopy scenarios in mannikins. Anaesthesia 2010; 65:483-9.

3: Malik MA, Maharaj CH, Harte BH, et al. Comparison of Macintosh, Truview EVO2®, GlideScope® and Airway-Scope® laryngoscope use in patients with cervical spine immobilization. Br J Anaesth 2008; 101:723-30.

4: Cooper RM. Use of a new videolaryngoscope (GlideScope®) in the management of difficult airway. Can J Anaesth 2003; 50:611-3.

5: McElwain J, Laffey JG. Comparison of the C-MAC®, Airtraq® and Macintosh laryngoscope in patients undergoing tracheal intubation with cervical spine immobilization. Br J Anaesth 2011; 118:1-7.

6: Stroumpoulis K, Pagoulatou A, Violari M, et al. Videolaryngoscopy in the management of the difficult airway: a comparison with the Macintosh blade. Eur J Anaesthesiol 2009; 26:218-22.

7: Sun DA, Warriner CB, Parsons DG, et al. The GlideScope® videolaryngoscope: randomised clinical trial in 200 patients. Br J Anaesth 2005; 94:381-4.

8: Kaplan MB, Hagberg CA, Ward DS, et al. Comparison of direct and video-assisted views of the larynx during routine intubation. J Clin Anesth 2006; 18:357-62.

9: Cavus E, Kiechaefer J, Doerges V, et al. The C-MAC® videolaryngoscope: first experience with a new device for videolaryngoscopy-guided intubation. Anesth Analg 2010; 110:473-7.

10: Malik MA, Hasset P, Carney J, et al. A comparison of the GlideScope®, Pentax AWS® and Macintosh laryngoscopes when used by novice personnel: a mannikin study. Can J Anaesth 2009; 56:802-11.

11: Malik MA, Donoghue CO, Carney J, et al. Comparison of the GlideScope®, the Pentax AWS®, and the Trueview EVO2® with the Macintosh laryngoscope in experienced anaesthetists: a mannikin study. Br J Anaesth 2009; 102:128-34.

study. Br J Anaesth 2009; 102:128-34.

12: Sedeh N, Schumann P, Groeben M, et al. Laryngoscopy via Macintosh blade versus GlideScope®: success rate and time for endotracheal intubation in untrained medical personnel. Anesthesiology 2009; 110:32-7.

13: Serocki G, Neumann T, Scharf E, et al. Indirect videolaryngoscopy with C-MAC D-Blade and GlideScope: a randomized, controlled comparison in patients with suspected difficult airways. Minerva Anestesiol 2013; 79:121–9.

14: Kaki AM, AlMarakbi WA, Fawzi HM, et al. Use of Airtraq, C-MAC, and GlideScope laryngoscope is better than Macintosh in novice medical students' hands: A mannikin study. Saudi J Anaesth 2011; 5:376-81.