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ORIGINAL ARTICLE

Comparing the Ease of Intubation between C-MAC, McGrath, and Conventional Macintosh Laryngoscope in a Simulated Difficult Airway of a Laerdal Mannequin

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ABSTRACT

Tracheal intubation is an essential skill for doctors. Tracheal intubation is done in patients with questionable airway patency, poor respiratory drive, hypercarbia, or hypoxia. The objective of this study was to compare the ease of tracheal intubation using Macintosh Laryngoscopes, C-MAC, and McGrath on a simulated difficult airway mannequin. The rationale of the study was to identify the easiest device to use for tracheal intubation. This randomized clinical trial was done at the Teluk Intan Hospital, Perak, Malaysia, from March 2020 to February 2021. Sixty-five medical officers participated in this study. The results showed that the mean time for tracheal intubation was significantly shorter when the participants were using the C-MAC than the conventional direct laryngoscope and McGrath. (C-MAC: 20.8 seconds, Direct Laryngoscope: 27.7 seconds, McGrath: 34.6 seconds) The results showed that C-MAC and McGrath had a better first-attempt success rate than conventional direct laryngoscopes. C-MAC scored the highest first-attempt success rate, followed by McGrath. (95% compared to 83%) Regarding Cormack-Lehane grading, the C-MAC device showed a better view than McGrath and Direct Laryngoscope. The preferred device by medical officers for tracheal intubation was the C-MAC. (45% compared to other devices) In conclusion, the C-MAC device was superior in first attempt success rate and was the most preferred device compared to

McGrath and direct laryngoscope. However, using the C-MAC device must be accompanied by adequate training and practice.

INTRODUCTION

Tracheal intubation is a vital skill to have as a doctor. Endotracheal intubation involves placing a breathing tube into the lungs. The objective of this is to secure the patient's airway. Tracheal intubation is done in patients with questionable airway patency, poor respiratory drive, hypercarbia, or hypoxia (Alvarado & Panakos, 2020). However, failure of tracheal intubation may lead to an increase in morbidity and mortality (Mort, 2004). Therefore, human resources, devices used, and patients' latest conditions must be optimized to improve the success rate of tracheal intubation (Frerk et al., 2015).

Direct laryngoscopy is a vital component of airway management. The efficacy of a direct laryngoscope relies on the ability of the operator to obtain direct vision between the laryngeal inlet and the eye (McCluskey & Stephens, 2020). It has a high success rate, and hundreds of laryngoscope blades have been developed (Cheyne & Doyle, 2010). However, endotracheal intubation with a direct laryngoscope is not risk-free. The complications of endotracheal intubation with a direct laryngoscope range from minor soft tissue injuries, to lacerations and arytenoid dislocation (Finucane et al., 2010). In recent years, the use of video laryngoscopes has revolutionized airway management. When difficult intubation is anticipated, many doctors use video laryngoscopes as their primary strategy (McCluskey & Stephens, 2020). One advantage of video laryngoscopy is improved laryngeal visualization without aligning three airway axes and easy identification of airway structures (Maldini et al., 2016). Therefore, a video laryngoscope has also been adopted to manage difficult airways (Apfelbaum et al., 2013).

The standard video laryngoscopes currently in use are the C-MAC (Karl Storz, Germany) and McGrath (Aircraft Medical Ltd, UK). The C-MAC was developed in 1999. A colour video camera is attached to a laryngoscope handle with a typical Macintosh blade. The video system is usually installed on a small cart to ease mobility (Aziz & Brambrink, 2011). Studies have shown that the C-MAC can produce a faster intubation time and reduced intubation attempts when this device is used in patients with Mallampati grade three or four (Ng et al., 2012). The McGrath was released in 2012. It is also attached to a Macintosh blade, and the video display is mounted on top of the handle (Arai et al., 2014). Studies have shown that McGrath increased the intubation success rate (Shippey et al., 2007; Shippey et al., 2008).

Each video laryngoscope device has its strengths and weaknesses. The objective of this study was to compare the ease of tracheal intubation among medical officers using Macintosh Laryngoscopes, C-MAC, and McGrath on a simulated difficult airway mannequin. No similar published studies compare these three intubation techniques in a simulated difficult intubation mannequin.

MATERIALS AND METHODS

This study was a randomized cross-over study. Randomization was done using computer software. The study was conducted between March 2020 till February 2021. It was approved by the Ethics Committee (NMRR-19-104-46225). Sixty-five medical officers working in Teluk Intan Hospital, Perak, Malaysia, were randomly recruited for this study.

The C-MAC, Macintosh laryngoscope, and McGrath (Figure 1) used a blade size 3. A 7.5 mm cuffed endotracheal tube was used for tracheal intubation with the help of a plastic stylet. A Laerdal mannequin was used in this study.

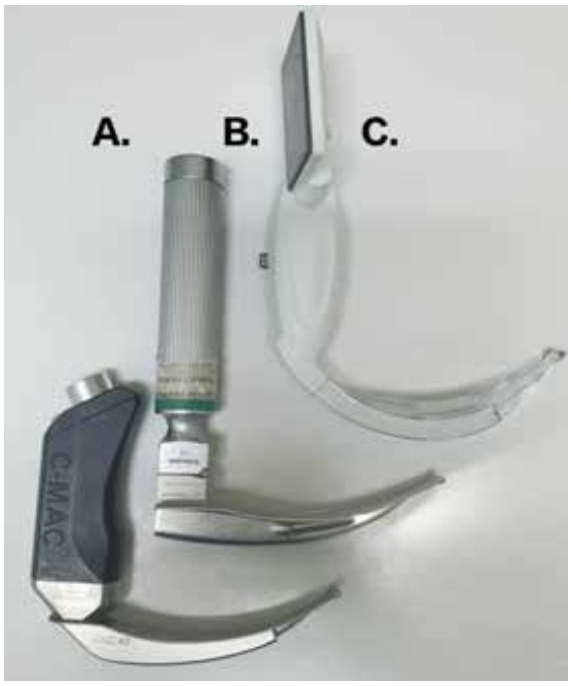

Figure 1 The three intubating devices used in the study; (A) C-MAC, (B) Macintosh laryngoscope, and (C) McGrath

All participants were given a briefing on the steps of tracheal intubation for all devices for 15 minutes. After the briefing session, the medical officers were allowed to try each device for five minutes to familiarize themselves with the devices on standard airway mannequins. The study began when the participants performed tracheal intubation on a simulated difficult airway. A difficult airway on a mannequin was simulated using the application of a cervical collar and forehead strapping on the mannequin. This will obliterate neck movement, including small movements that usually facilitate intubation (Durga et al., 2014). Several studies have shown that tracheal intubation will be difficult in the presence of a cervical collar (Wakeling & Nightingale, 2000; Komatsu et al., 2004; Aoi et al., 2011). All the participants were allowed a maximum of three attempts with each device. They were randomized to receive the first device and subsequently received the second and third devices. Based on the Cormack-Lehane, the participants were asked to grade the laryngeal view during their intubation attempts.

Data collected was the number of attempts for successful tracheal intubation, intubation time, Commack Lehane grading during intubation, and the preferred device used for tracheal intubation. The intubation time was defined as the time from the blade insertion into the oral cavity until the placement of the endotracheal tube into the trachea. Failed intubation was defined as a failure to achieve successful intubation after three attempts (Walls, 2012).

Data were analyzed using the SPSS (Statistical Package for the Social Sciences) software version 24. The one-way-ANOVA test was used to analyze the data.

RESULTS

Sixty-five medical officers were enrolled in this study. All participants performed tracheal intubation using a direct laryngoscope, the C-MAC, and the McGrath video laryngoscope. The results showed that the mean time for intubation was shorter when the participants were using the C-MAC than the conventional direct laryngoscope and McGrath (Table 1). The results are statistically significant ($p<0.05$).

Table 1 Time taken for intubation using Direct Laryngoscope, C-MAC, and McGrath devices

Device	Min (Seconds)	Max (Seconds)	Mean (SD)	95% Confidence Interval (Lower; Upper)	p-value
Direct Laryngoscope	6.04	90.08	27.68 (17.14)	22.59; 32.77	p = 0.03*
C-MAC	3.3	49.2	20.80 (10.57)	18.12; 23.49	
McGrath	3.6	107.5	34.58 (31.38)	25.76; 40.45	

* Significant when $p<0.05$

Our study also showed that three participants had failed intubation while using the direct laryngoscope. The McGrath group had two failed intubation incidences, but during the use of the C-MAC device, there was no failed intubation (Table 2).

Table 2 Successful intubation attempts, Cormack-Lehane grading and preferred device for tracheal intubation

	Direct Laryngoscope (%)	C-MAC (%)	McGrath (%)	X^2, p-value
Successful intubation				
1st attempt	46 (71)	62 (95)	54 (83)	$X^2(6) = 15.27$,
2nd attempt	12 (18)	1 (2)	7 (11)	$p = 0.02^*$
3rd attempt	4 (6)	2 (3)	2 (3)	
Failed intubation	3 (5)	0	2 (3)	
Cormack-Lehane grading				
I	11 (17)	40 (62)	32 (49)	$X^2(6) = 32.05$,
II	39 (60)	23 (35)	26 (40)	$p = 0.00^{**}$
III	9 (14)	2 (3)	5 (8)	
IV	6 (9)	0	2 (3)	
Preference as				
1st choice	8 (12.3)	45 (69)	12 (18)	$X^2(5) = 59.75$,
2nd choice	23 (35.3)	16 (25)	26 (40)	$p = 0.00^{**}$
3rd choice	34 (52.3)	4 (6)	27 (42)	

** significant when $p<0.01$

* significant when $p<0.05$

The result shows that both video laryngoscopes had a better first-attempt success rate than direct laryngoscopes. C-MAC scored the highest first-attempt success rate, followed by McGrath. Regarding Cormack-Lehane grading, the C-MAC device showed a better view than the McGrath device and Direct Laryngoscope. This was statistically significant ($p<0.05$).

The study ended by asking the participants which device they preferred, and most chose C-MAC as their first choice. This was statistically significant ($p<0.05$).

DISCUSSION

Our study showed that in a simulated difficult airway, the intubation time of doctors using C-MAC was shorter than the McGrath and direct laryngoscope devices. Our results echoed a previous study in Australia (Ng et al., 2012), showing the C-MAC had a reduced number of tracheal intubation attempts, quicker intubation time, and greater ease of tracheal intubation compared to the McGrath device and direct laryngoscope.

There have been different findings on the effectiveness of video laryngoscopes. Several studies comparing direct laryngoscope and video laryngoscope in patients with a normal airway revealed that video laryngoscopy can provide a better laryngeal view (Van Zundert et al., 2009; Kaplan et al., 2006; Shimada et al., 2012). In patients with a difficult airway, video laryngoscopes provided shorter intubation time, improved laryngeal view, more successful intubations during the first attempt, and reduced the need for adjuncts (Jungbauer et al., 2009; Aziz et al., 2012). During failed tracheal intubation attempts using the direct laryngoscope, the C-MAC proved to have an improved laryngeal view. This, in turn, made

it possible to achieve a 86% success rate of tracheal intubation during the first attempt of intubation and a 100% successful tracheal intubation (Kilicaslan et al., 2014). There was also a significant reduction in failed intubation during emergencies when a C-MAC was used compared to a direct laryngoscope (Goksu et al., 2016; Sakles et al., 2015; Sakles et al., 2012).

In a study comparing McGrath and C-MAC devices, the C-MAC provided fewer intubation attempts, quicker intubation time, and easier use of intubation in patients with difficult airways compared to the McGrath device (Ng et al., 2012). In addition, compared to flexible fiberoptic scope intubation, the C-MAC used in cervical spine immobilization showed a significant decrease in time to obtain a better laryngeal view to produce successful intubation (Yumul et al., 2016).

The C-MAC is also an excellent tool for teaching tracheal intubation. The C-MAC device can shorten the learning curve, improve the success rate and decrease the rate of failed intubation during teaching (Howard et al., 2008; Herbstreit et al., 2011). The C-MAC also showed that medical officers received it well during tracheal intubation training (Boedeker et al., 2011).

A good view of the airway and vocal cords during tracheal intubation directly affects the safety and morbidity of patients (Cook et al., 2011). The Cormack-Lehane classification is a standard grading used to describe the laryngeal view during tracheal intubation (Cormack et al., 1984). It is the gold standard for airway classification in routine clinical practice (Benumof, 1996; Rosenblattet et al., 2006). In patients with difficult airways, the C-MAC device can achieve a better Cormack-Lehane grading than a direct laryngoscope, producing a higher tracheal intubation success rate and shorter intubation time (Aziz et al., 2012; Jungbauer et al., 2009; Gaszyński, 2014). For emergency airways, the C-MAC device performs better with a Cormack-Lehane grade three or four (Hossfeld et al., 2015; Jones et al., 2013; Sakles et al., 2016; Vassiliadis et al., 2015). Therefore, the C-MAC can be recommended for difficult airway management (Xue et al., 2017). However, it must be noted that no one device is perfect. For example, the C-MAC has proven to provide a better intubation success rate, but it does not give a 100% success rate for tracheal intubation (Akbar & Ooi, 2015; Cavus et al., 2011).

Our study had limitations. The study was performed on mannequins and should not be directly applied to clinical situations. We did this as there was an ethical concern regarding choosing medical officers to perform difficult intubation on actual patients. Besides that, the medical officers were also not blinded to which laryngoscope devices they used. It should also be noted that not all hospitals have video-laryngoscopes and mainly use direct laryngoscopes for their routine tracheal intubation.

CONCLUSION

Video laryngoscopy is a better alternative to direct laryngoscopy. The C-MAC and McGrath showed a decrease in intubation time compared to the conventional Macintosh blade in a difficult airway scenario. In addition, the C-MAC was superior in first attempt success rate and was the most preferred device compared to McGrath and direct laryngoscope. This makes the C-MAC a better device to be used for tracheal intubation. To optimize the use of the C-MAC device, medical officers must be adequately trained and allowed ample practice. Despite this conclusion, doctors should master several different airway devices and techniques and have a contingency plan for failure. This will enhance patient care and safety.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this article.

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