Original Article

The Use of McGrath MAC Video Laryngoscope Versus McCoy Laryngoscope in Adults with Anticipated Difficult Airway Undergoing Elective Surgery

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Abstract

Background: Difficult airway management remains one of the most challenging clinical situations encountered by anaesthetists. **Aim:** The study compared the effectiveness of the McGrath MAC video laryngoscope to the McCoy® laryngoscope in patients with difficult airway. **Materials and Methods:** Following the institution's ethical approval, the randomised controlled trial was conducted involving 74 adults with American Society of anaesthesiologists' physical status (ASA) grading of I-III scheduled for elective surgery. The Patients were randomised into either group MVL (McGrath MAC) or group MCC (McCoy) and intubated after preoxygenation with 100% oxygen and administration of IV propofol and suxamethonium. The Intubation Difficulty Score (IDS), success rate of intubation, time to intubation, number of optimising manoeuvres and complications was assessed. Statistical analysis was performed using the statistical Package for Social Sciences (SPSS) version 24.0 computer software (IBM SPSS Statistics, IBM Corp. NY, United States). Numerical and categorical data were compared using the student's t-test and Chi square (χ^2) test respectively. A value of $P < 0.05$ was considered statistically significant. **Results:** Lower IDS scores were noted in the McGrath group; 54.1% vs. 5.4% of patients had IDS score of 0 in the McGrath and McCoy groups respectively, ($P < 0.001$). Overall success rate was higher in the McGrath group (100% vs. 89.1%), $P = 0.040$. **Conclusion:** Lower IDS scores and improved intubation success rate was achieved with the McGrath compared with the McCoy laryngoscope in patients with predicted difficult airway. The McGrath has proved to be useful in managing patients with difficult airway.

Keywords: *Difficult airway, Intubation, McCoy laryngoscope, McGrath MAC video laryngoscope*

Introduction

Management of the difficult airway remains one of the most challenging clinical situations encountered by anaesthesia care providers. A survey in Uganda highlighted that airway complications are a major contributor to intraoperative anaesthesia morbidity and mortality in resource-poor countries.[1] Studies on difficult airway management in Nigeria focus mainly on predictive tests and the incidence of difficult airway, there is hardly any mention of the morbidity and mortality associated with it.[2,3] Analysis of the American Society of Anesthesiologists' (ASA) 'closed claims project' database has shown that the development of an airway emergency increases the odds of death or brain damage by up to 15-fold. Thirty percent of the mortalities in the claims were the result of an inability to manage a difficult airway.[4] As such, management of the difficult airway is of grave importance in order to prevent the associated morbidity and mortality.

Difficult airway is defined as the clinical situation where by a conventionally trained anaesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both.[5] Magnitude of difficult laryngoscopy and intubation is varied, ranging from 3.4% to 10.0% in published studies.[2,3,6] A study done in Lagos University Teaching Hospital (LUTH) by Merah *et al*.[2] has revealed the incidence of difficult laryngoscopy in surgical patients to be 3.4%.

In an effort to improve the management of the difficult airway, the ASA has included video laryngoscopes in its updated algorithm.[5] The role of video laryngoscopy in difficult airway management has been

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recognised by the difficult airway society (DAS) in its updated 2015 guidelines,[7] hence its recommended inclusion in the difficult airway trolley. Indirect (video) laryngoscopy is a new addition to airway management and there is increasing evidence of its usefulness in management of the difficult airway.[8-12] Video laryngoscopes offer indirect laryngoscopy, combining features of both flexible fibreoptic scopes and standard rigid laryngoscopes. They contain miniature video cameras enabling the operator to visualise the glottis indirectly, improving the view of the glottis, decreasing complication rates and improving the success rate compared to conventional laryngoscopes.[13-15] They can be used in difficult intubation (including awake intubation) and routine tracheal intubation.[16]

The McCoy laryngoscope (Penlon Ltd, Abingdon, UK) is similar to the standard Macintosh blade but it has a hinged tip operated by a lever mechanism present on the back of the handle. It is designed to elevate the epiglottis with its hinged tip and is suited for both routine use and in cases of difficult intubation. Even though the McCoy laryngoscope improves the Cormack and Lehane laryngoscopic view by 1 grade in comparison to the conventional Macintosh blade in patients with cervical spine injury,[17] several studies have proven the superiority of video laryngoscopes over the McCoy laryngoscope.[13,14,18,19]

The McGrath MAC (Aircraft Medical, Edinburgh, UK) video laryngoscope is a portable video laryngoscope with a single use, Macintosh-based blade available in both paediatric and adult sizes. The blade is angulated and it does not have a guiding channel. It has a battery powered handle on top of which is an adjustable liquid crystal display monitor. It can be used both in patients with normal and difficult airways.[8,9,15,20] Recent evidence show that the McGrath MAC video laryngoscope has a high first-attempt intubation success, low soft tissue injury and a reduced overall incidence of difficult intubation.[11,15,20,21]

A search in the literature revealed paucity of discourse on the use of both laryngoscopes in difficult airway patients. As most anaesthetists are more familiar with direct laryngoscopy as opposed to indirect video laryngoscopy, it has become necessary to find out if the video laryngoscopes have an advantage over direct laryngoscopes especially in poor resource settings like ours. Most of the available literature comparing the McGrath MAC video laryngoscope to the McCoy laryngoscope either use easy airways or simulated difficult airways using manikins.[8-10,12,15,20] It has remained unclear which will be superior in the setting of a difficult airway when performed by a provider who is experienced with the use of both devices on real patients.

This study compared the efficacy of the McGrath MAC video laryngoscope with the McCoy laryngoscope for oral intubation in adults with anticipated difficult airway scheduled for elective surgery.

Materials and Methods

Seventy-four ASA I-III patients aged between 18–65 years with anticipated difficult airway scheduled for elective surgeries requiring general anaesthesia with endotracheal intubation at the tertiary institution were included in this prospective cross-sectional study. Ethical Approval from the institution was obtained before commencement of the study. The study was conducted within the period December, 2020 to February, 2021. Written and verbal informed consent was taken from the prospective patients. Patients with history of difficult intubation, inability to prognath, obesity (BMI≥30kg m^{-2}), reduction of atlanto-occipital joint extension, thyromental distance <6.5 cm, sternomental distance <12.5 cm, Mallampati class≥ III, inter-incisor distance between 2.5 cm-3.5 cm were included in the study. Patients with increased risk of pulmonary aspiration, those scheduled for emergency surgery, Patients having Mallampati I or II, inter incisor distance <2.5 cm or >3.5 cm, thyromental distance ≥6.5 cm, sternomental distance ≥12.5 cm, inability to identify the cricothyroid membrane, ASA IV or V patients, Obstetric patients, Patients requiring nasotracheal intubation or those with cervical spine pathology were excluded from participating in the study.

Consecutive sampling was used and a computer-derived random number sequence, (QuickCalcs-GraphPad software, La Jolla, California, USA) was used to generate random number tables. Random numbers were picked from the tables and matched to the patients that fit the inclusion criteria till the required sample was reached (sample saturation). The patients were randomly allocated to either of the two groups; Group MVL to be intubated with the McGrath MAC video laryngoscope and Group MCC to be intubated with the McCoy laryngoscope. Information regarding group and number assignment was folded in small sheets of paper and sealed in opaque envelopes. The trained research assistant drew an envelope and informed the researcher the treatment group just prior to induction of anaesthesia.

After eligibility was confirmed and written informed consent was obtained from each of the prospective patients that fit the inclusion criteria, preoperative assessment was done by the researcher a day to surgery. The patients' demographic and clinical data (age, sex, weight, height, BMI, ASA status) were recorded in the data collection forms. An airway assessment was done to assess for possible airway difficulty. The patient was examined for physical abnormalities like receding mandible, presence of tumour or macroglossia, range of neck flexion and extension and ability to prognath. The sternomental distance, thyromental distance, inter incisor distance and mallampati scoring was also assessed. Baseline investigations such as full blood count and electrolytes and urea were also reviewed as well as other relevant investigations based on the patient's

clinical state. Fitness for surgery was assessed using the American Society of Anesthesiologists'(ASA) physical status classification system. Fasting guidelines (6hours to solids and 2 hours to clear fluids) was prescribed and oral diazepam 5-10 mg was given to the patient by the ward nurse at 22:00 hrs and 06:00 hours with a sip of water to allay anxiety. A suitably qualified otolaryngologist was informed to be on stand-by on the day of surgery with equipment to perform a surgical airway if the need arose.

Intraoperatively, a pre anaesthetic check was done according to Association of Anaesthetists of Great Britain and Ireland (AAGBI) guidelines,[22] Drugs to be used for the procedure were drawn and labelled in syringes including emergency drugs, the difficult intubation tray was prepared and kept on standby. The patient was subsequently wheeled into the operating room and IV access was secured using a size 16G cannula. The multiparameter monitor, GE Dash 5000 (Soma Tech Intl, Connecticut) was used for standard monitoring, which included peripheral oxygen saturation (SPO_2) non-invasive blood pressure (NIBP), end tidal capnography ($ETCO_2$) and electrocardiography (ECG). Baseline values of the vital signs were recorded and all patients were premedicated with 0.4 mg of IV glycopyrrolate. Both of the devices to be used were prepared before hand and a trained research assistant, a junior resident anaesthetist, used a stopwatch (OEM, PS-51, China) to record the time on the data collection form.

All of the patients were preoxygenated for 5 minutes with 100% oxygen via an appropriately sized facemask after which anaesthesia was induced with IV Propofol, 2 mg/kg till loss of verbal contact occured. Test ventilation was done to confirm ability to ventilate before IV suxamethonium 2 mg/kg was administered to facilitate endotracheal intubation. At that stage, the sealed envelope was opened to reveal the group the patient belonged to, the patient's neck was flexed forward and the head extended (sniffing position) and laryngoscopy was attempted at the end of muscular fasciculations or after 60 seconds of administration of suxamethonium. In the MVL group, McGrath MAC 4 disposable laryngoscope blade was used for intubation, following manufacturer's instructions.[23] The patient's mouth was opened and the laryngoscope blade was inserted into the right side of the mouth, the device was moved to a central location, sweeping the tongue to the left. The tip of the McGrath MAC blade was advanced into the vallecular which was lifted upwards and forwards to expose the glottis in the central upper section of the screen. The endotracheal tube (entering from the right-hand side of the display) was then advanced through the vocal cords.

In the MCC group, size 4 McCoy blade was used. The blade of the laryngoscope was inserted through the right side of the mouth, pushing the tongue to the left till it reached the vallecular where it was lifted upwards and forwards to expose the glottis. The lever was activated whenever needed. The endotracheal tube was then passed through the vocal cords.

Whenever adequate glottic view was not achieved, rescue adjuncts like external laryngeal manipulation [BURP manoeuvre, optimal external laryngeal manipulation (OELM)] and use of the gum elastic bougie was employed and this was noted in the data collection form. The researcher said 'start' on introduction of the laryngoscope blade at the angle of the mouth and 'stop' after the best view of the vocal cords was obtained. This was taken as 'time to laryngoscopy' (TTL). Researcher said 'start' again from that moment till when the endotracheal tube passed through the vocal cords, after which researcher said 'stop'. The sum of the two times above was taken as the 'time to intubation' (TTI). Thus, the 'time to intubation' (duration of successful intubation attempt) was defined as the time measured from the introduction of the blade between the patient's teeth till the tube passed through the vocal cords and 'Time to glottic visualisation' (TTG), (also referred to as 'duration of laryngoscopy' or 'time to laryngoscopy'), was defined as the time from the insertion of the device until the best possible view of the glottis was obtained. A trained research assistant used a stop watch (OEM, PS-51, China) to record the time on the proforma.

After achieving the best possible view of the glottis, the vocal cord visualisation using the modified Cormack and Lehane grading[24] and the percentage of glottic opening score (POGO)[25] was noted. The Intubation difficulty scale (IDS) score as described by Adnet *et al*.[26] was calculated as the primary outcome. The ease of intubation was also noted using the visual analogue scale (VAS) of 0–10 with 0 being the easiest and 10 being the most difficult intubation, equivalent to failed intubation. An appropriately sized endotracheal tube was used to intubate the trachea (7.0 mm or 7.5 mm internal diameter for women) and (7.5 mm or 8.0 mm internal diameter for men). Appropriately sized Mallinckrodt™ intubating stylet was used in all of the intubations. Correct tube placement and adequacy of ventilation was confirmed with the presence of 3 or more continuous waveforms of $ETCO_2$ and bilateral chest auscultation for presence of equal breath sounds. The breathing circuit was connected to the endotracheal tube and all of the patients were mechanically ventilated with intermittent positive – pressure ventilation for the duration of the surgical procedure. After successful intubation, anaesthesia was maintained with varying concentrations of isoflurane (0.8–1.5%) in oxygen. Neuromuscular blockade was achieved with maintenance doses of IV atracurium 0.5 mg/kg initially, and then one third of the intubating dose every 30-40minutes. All tracheal intubations were performed by the researcher (senior registrar) whose previous experience included more than 40 intubations with both laryngoscopes. The incidence of oesophageal intubation, mucosal trauma, lip or dental injury was recorded. Inspection of the teeth and soft tissue was done

to rule out trauma. Mucosal injury was defined as the presence of blood on the device following intubation in a previously normal mucosa.

An intubation attempt was defined as the introduction of the laryngoscope blade into the mouth and its removal regardless of whether an endotracheal tube was successfully inserted or not. If the first intubation attempt failed, the next attempt was made after bag mask ventilation for 1 minute. In each of the groups, tracheal intubation was considered a failure when it could not be achieved after 2 attempts, or if it required more than 120seconds to perform. In that case, intubation was accomplished by the anaesthetist by the device of his choice (gum elastic bougie, another video laryngoscope, McCoy laryngoscope, rigid stylet, intubating LMA (iLMA), flexible fibreoptic bronchoscope). In between attempts, bag mask ventilation was done to ensure the SPO_2 was at least 95%. The trained research assistant recorded the time on the data collection sheet.

Haemodynamic data – systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), peripheral O_2 saturation (SPO_2), were recorded at predefined time points by the trained assistant: baseline – T_B (30s prior to induction of anaesthesia), post induction – T_P (30s prior to laryngoscopy), immediately after the endotracheal tube was inserted – T_0, and at 1,3,5 and 10 minutes post intubation – T_1, T_3, T_5, T_{10} respectively. Episodes of hypotension (MAP <20% of baseline), bradycardia (Heart rate <60 bpm), tachycardia (Heart rate >100 bpm), hypertension (MAP> 20% of baseline), cardiac arrhythmia or hypoxaemia (SPO2 <90%) were noted. Fogging of the lens was also noted in the McGrath MAC group.

At the end of surgery, the patient was reversed of residual neuromuscular blockade with neostigmine 0.05 mg/kg together with atropine 0.02 mg/kg to counteract the muscarinic side effects of neostigmine, extubated awake and taken to the post anaesthesia care unit (PACU). In the PACU, vital signs were monitore closely and the Presence or absence of hoarseness of voice was assessed by a trained assistant (the On-call house officer) at 6hrs,12 hrs and 24 hrs post extubation. The primary outcome was the Intubation difficulty score (IDS), secondary outcomes were: success rate of intubation, time to laryngoscopy (TTL), POGO score, time to intubation (TTI), number of optimising manoeuvres, haemodynamic variables and number of complications with the use of each device.

The data collection form consisted of the patient's demographic data and preoperative assessment including airway assessment parameters, indication for surgery, ASA classification, intraoperative findings and post-operative events. All outcome measurements were recorded immediately the patient was intubated.

Statistical analysis was performed using the statistical Package for Social Sciences (SPSS) version 24 computer software (IBM SPSS Statistics, IBM Corp. NY, United States). Numerical data was presented as mean ± standard deviation and statistical comparison between the groups and tests of significance was performed using the student's t-test. Categorical data for qualitative variables was presented as counts and percentages and compared using the Chi square (χ^2) test. A p value <0.05 was considered statistically significant.

Results

In total, seventy-four patients consented to and participated in this prospective study and were included in the data analysis. The mean age of the patients that participated was 39.8 ± 6.7 yrs vs. 44.5 ± 11.4 yrs in the McCoy and McGrath groups respectively, *P*=0.030. Fifty-one percent of patients in the McCoy group were males and 49% were females vs. 40.5% and 59.4% in the McGrath group, *P*=0.351. Mean BMI of study participants was 31.9 ± 2.8 vs. 31.5 ± 3.5kgm^{-2} in the McCoy and McGrath groups respectively, *P*=0.681. ASA classification of participants in both groups was comparable, *P*=0.346 [Table 1].

The predictors of difficult airway were comparable between both groups except for a higher mean sternomental distance (SMD) and thyromental distance (TMD) in the McCoy group. TMD was 6.3 ± 1.2 cm and 5.8 ± 0.6 cm in the McCoy and McGrath groups respectively, *P*=0.026. SMD was

Table 1: Comparison of demographic and clinical characteristics between the McGrath and McCoy laryngoscope groups

Parameters	McCoy Group (n=37)	McGrath Group (n=37)	*P* value
Age (yrs)	39.8 ± 6.7	44.5 ± 11.4	**0.030**
Sex (male:female)	19(51.0):18(49.0)	15(40.5):22(59.4)	0.351
BMI (kg/m^2)	31.9 ± 2.8	31.5 ± 3.5	0.681
ASA I/II/III			
I	4(10.8)	5(13.5)	0.346
II	25(67.6)	19(51.4)	
III	8(21.6)	13(35.1)	

Values are expressed as mean ± SD or number (%), SD = Standard deviation

11.9 ± 1.7 cm and 11.2 ± 1.0 cm in the McCoy and McGrath groups respectively, *P*=0.038 [Table 2].

The duration of tracheal intubation performed with the video laryngoscope was significantly shorter than that performed with the McCoy laryngoscope (*P*=0.010). The mean TTG was 9.0 ± 6.1 vs 12.4 ± 3.0secs (*P = 0.004)* consequently making the mean time to intubation (TTI) shorter in the McGrath group, (22.8 ± 7.1 vs 29.0 ± 12.3secs in the McGrath and McCoy groups respectively), *P*=0.010 [Table 3].

There was a significant difference in laryngoscopic view according to the Cormack and Lehane classification as modified by Yentis and Lee. The McGrath was superior to the McCoy in this regard with more patients having Cormack and Lehane grading ≤ IIa compared with the McCoy group [35 patients (94.6%) vs 11 patients (28.9%), *P*<0.001]. About seventy percent of patients in the McCoy group had Cormack and Lehane grading ≥IIb compared with only 5% of patients in the video laryngoscope group [Table 4]. A similar observation was seen in the POGO score as it was significantly reduced in the McCoy group compared with the McGrath group. Mean POGO score was 61.6 ± 13.4% vs 93.8 ± 8.0% in the McCoy and McGrath groups respectively, *P*<0.001 [Table 4].

The intubation difficulty score (IDS) was significantly increased in the McCoy group compared with the McGrath group [Table 3]. Twenty patients in the McGrath group (54%) had IDS of 0 (easy intubation) compared with only two patients in the McCoy group (5.4%) and this was statistically significant (*P* < 0.001). Four patients in the McCoy group (10.8%) had IDS score >5 vs none in the McGrath group. Similarly, the proportion of patients with high visual analogue score (VAS) was more in the McCoy

Table 2: Comparison of predictors of difficult airway between the McGrath and McCoy groups

Pre-op airway parameters	McCoy (n=37)	McGrath (n=37)	*P* value
Mallampati score, n(%)			
III	28(75.7)	31(83.8)	0.386
IV	9(24.3)	6(16.2)	
Inter-incisor distance (IID) (cm)			
2.5-3.0	32(86.5)	28(75.7)	0.235
3.1-3.5	5(13.5)	9(24.3)	
Mean±SD	2.8 ± 0.3	3.0 ± 0.3	0.079
Thyromental distance (TMD) (cm)			
<5.5	7(18.9)	6(16.2)	0.539
5.5-6.5	27(73.0)	30(81.0)	
>6.5	3(8.1)	1(2.7)	
mean±SD	6.3 ± 1.2	5.8 ± 0.6	**0.026**
Sternomental distance (SMD) (cm)			
<10.5	6(16.2)	10(27.0)	0.244
10.5-12.5	27(73.0)	26(70.3)	
>12.5	4(10.8)	1(2.7)	
mean±SD	11.9 ± 1.7	11.2 ± 1.0	**0.038**
Upper lip bite test (ULBT) (n) (%)			
Adequate	27(73.0)	29(78.4)	0.588
Not adequate	10(27.0)	8(21.6)	
Head and neck movement (n) (%)			
Normal	17(46.0)	13(35.1)	0.605
Reduced	17(46.0)	18(48.6)	
Markedly reduced	2(5.4)	5(13.5)	
Fixed	1(2.7)	1(2.7)	
Face deformity (n) (%)			
Yes	3(8.1)	6(16.2)	0.286
No	34(91.9)	31(83.8)	
Upper incisor status (n) (%)			
Normal	35(94.6)	33(89.2)	0.357
Absent	0(0)	2(5.4)	
Protruding	2(5.4)	2(5.4)	
Receding mandible (n) (%)			
Present	36(97.3)	33(89.2)	0.165
Absent	1(2.7)	4(10.8)	

Values are expressed as mean ± SD or no (%)

group compared with the McGrath group (mean VAS 6.8 ± 1.4 in the McCoy group compared with 2.9 ± 1.2) in the McCoy group [*P* < 0.001). [Table 4]

Using the McCoy laryngoscope resulted in four failed intubations, all of which were intubated successfully at the third attempt with the McGrath video laryngoscope as the rescue device. Consequently, the overall success rate and first-attempt success rate was significantly higher in the McGrath group compared with the McCoy group [Table 5]. First attempt success rate was 100% vs 70.2% (p=0.002) and overall success rate being 100% vs 89.1% (p=0.04) in the McGrath and McCoy groups respectively.

The use of adjuncts to aid intubation and optimisation manoeuvres to improve laryngoscopic view were required less often in the McGrath group compared with the McCoy group. Seven patients (18.9%) in the McGrath group vs twenty-two patients (59.4%) in the McCoy group needed some form of optimisation manoeuvres to improve laryngeal view, *P*=0.002. Ten patients (27%) in the McCoy group vs 2 patients (5.4%) in the McGrath group needed BURP, 12 patients (32.4%) in the McCoy group vs 5 patients (13.5%) in the McGrath group needed OELM. Similarly, two patients (5.4%) in the McGrath group vs sixteen patients (43.2%) in the McCoy group needed adjuncts in the form of the gum elastic bougie (GEB) to aid endotracheal intubation (*P*<0.001) [Table 5].

Endotracheal intubation with the McCoy was associated with more complications than the McGrath [Table 6]. There was in total, thirty-one patients who had complications, twenty-six in the McCoy group and five in the McGrath video laryngoscope group (70.3% vs 13.5%), and this was statistically significant, (*P*<0.001). Four patients in the McCoy group had hypoxaemia (SPO_2 < 90%) and this corresponded to the four failed intubations in that same group. No patient in the McGrath group had hypoxaemia (*P*=0.040). Eleven patients in the McCoy group and one patient in the McGrath group had minor mucosal trauma as evidenced by blood staining the device (*P*=0.002). This did not require any further management. Two patients in the McCoy group had lip/dental injury compared with none in

Table 3: Comparison of time to intubation and time to glottis visualisation between the McGrath and McCoy groups

Parameter	McCoy n=37	McGrath n=37	*P* value
TTG (sec)	12.4 ± 3.0	9.0 ± 6.1	**0.004**
TTI (sec)	29.0 ± 12.3	22.8 ± 7.1	**0.010**

Table 4: Comparison of intubation parameters between the McGrath and McCoy groups

Intubation parameters	McCoy (n=37)	McGrath (n=37)	*P* value
Modified Cormack and Lehane grading n (%)			
I	3(8.1)	25(67.6)	**<0.001**
IIa	8(21.6)	10(27.0)	
IIb	12(32.4)	2(5.4)	
III	11(29.7)	0(0)	
IV	3(8.1)	0(0)	
POGO (%)	61.6 ± 13.4	93.8 ± 8.0	**<0.001**
IDS n (%)			
0	2(5.4)	20(54.1)	**<0.001**
1-5	31(83.8)	17(45.9)	
>5	4(10.8)	0(0)	
VAS(1-10)	6.8 ± 1.4	2.9 ± 1.2	**<0.001**
Attempts n (%)			
One	26(70.3)	37(100)	**0.002**
Two	7(18.9)	0(0)	
>Two	4(10.8)	0(0)	
Success rate n (%)			
First attempt	26(70.2)	37(100)	**0.002**
Overall	33(89.1)	37(100)	

Values are expressed as mean ± SD or counts (%)

Table 5: Laryngoscopy and intubation data with McCoy and McGrath laryngoscopes

Parameter	McCoy n=37	McGrath n=37	*P* value
Adjuncts (GEB)	16 (43.2)	2 (5.4)	**<0.001**
Optimisation manoeuvres			
BURP	10(27.0)	2(5.4)	**0.002**
OELM	12(32.4)	5(13.5)	
None	15(40.5)	30(81.1)	

Table 6: Comparison of complications between the McCoy and McGrath groups

Complication	McCoy n(%)	McGrath n(%)	*P* value
Presence of complication	26(70.3)	5(13.5)	**<0.001**
Haemodynamics			
Hypertension	22(59.5)	5(13.5)	**<0.001**
Hypotension	1(2.7)	0(0)	0.314
Bradycardia	1(2.7)	0(0)	0.314
Tachycardia	19(51.4%)	5(13.5)	**0.001**
Arrythmia	2(5.4)	0(0)	0.152
Airway related			
Hypoxaemia	4(10.8)	0(0)	**0.040**
Mucosal trauma	11(29.7)	1(2.7)	**0.002**
Lip/dental injury	2(5.4)	0(0)	0.152
Others			
Lens fogging	0(0)	1(2.7)	0.314
Hoarseness of voice	9(24.3)	0(0)	**0.001**

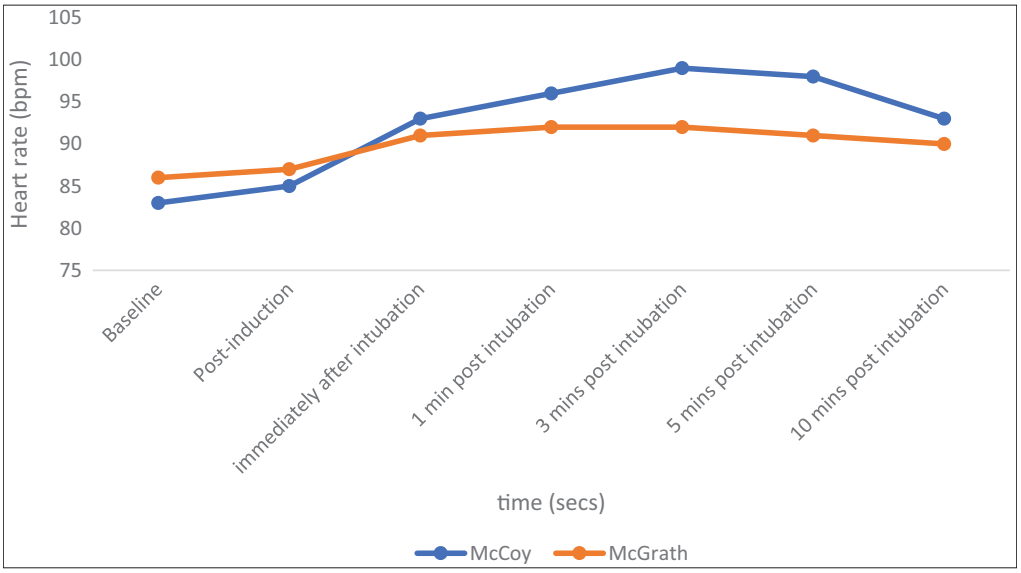

Figure 1: Mean heart rate trend during peri-induction period with McCoy and McGrath laryngoscope

the McGrath group. More patients in the McCoy group had hoarseness of voice than in the video laryngoscope group (9 vs 0, *P*=0.001). Lens fogging occurred in one patient in the video laryngoscope group. None of the seventy-four patients had oesophageal intubation or cardiac arrest.

Intubation with the McCoy laryngoscope was associated with more variations in MAP, heart rate and Blood pressure compared with the McGrath MAC Video laryngoscope at predefined time intervals [Figures 1 and 2]. There was a transient increase in heart rate after intubation in both groups which returned towards baseline after about 5 minutes. Intubation with the McCoy laryngoscope resulted in persistently higher MAP values than the McGrath laryngoscope [Figure 2].

Discussion

The McGrath video laryngoscope was designed to ease the difficulty in intubation and improve the success rate in patients with difficult airway. The outcome of the study suggests that the McGrath video laryngoscope, when used in patients with two or more predictors of difficult airway, resulted in an improved success rate of intubation, improved laryngeal view, decreased use of optimisation manoeuvres and adjuncts for airway management, decreased IDS score, decreased time to glottic visualisation and time to intubation and decreased complications.

The results of the present study show that a greater proportion of patients in the McGrath group were found to have Intubation difficulty score of 0 (easy) compared with the McCoy group (54% vs 5.4%), correlating with the ease of endotracheal intubation. Lower IDS scores are expected in the video laryngoscope group compared with the McCoy group as the McGrath MAC video laryngoscope was developed to ease the difficulty in endotracheal intubation. This finding is in keeping with studies done with other laryngoscopes.[13,18,19] Jain *et al*.[13] compared the McCoy to

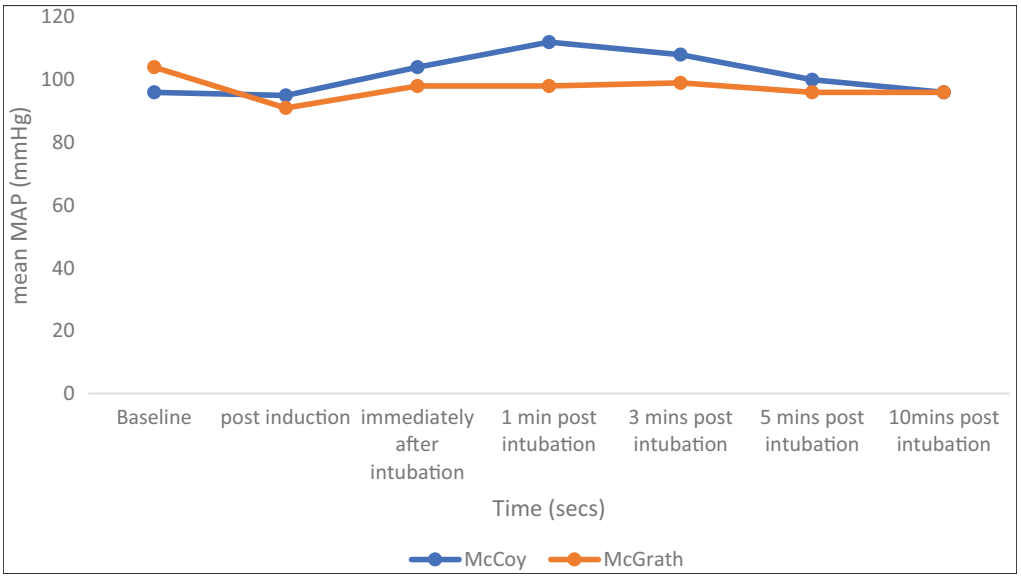

Figure 2: Mean arterial pressure variation during the peri-induction period with McCoy and McGrath video laryngoscope

the CMAC video laryngoscope in patients with cervical spine injury and found the IDS range to be significantly less in the CMAC compared with the McCoy group (median [interquartile range(IQR)], 1 [0–1] vs 4 [3–6], $P<0.05$). No patient in the CMAC group had IDS score of more than one. This does not completely agree with findings of 89.2% of patients in the McGrath group having IDS score of ≤ 1 and 16.2% of patients in the McCoy group having IDS score of ≤1 in the present study. It should be noted that their study was limited by a smaller sample size of sixty patients compared to the present study with a sample size of seventy-four patients. In addition, only one predictor of difficult airway (cervical spine immobilisation) was studied by Jain *et al*.[13] in contrast to the present study where seventy-one patients out of the seventy-four studied had 4 or more predictors of difficult airway. The IDS scores will be expected to be slightly higher in the present study. Saxena *et al*.[18] and Ali *et al*.[19] got similar IDS findings comparing different video laryngoscopes to the McCoy- fifty-four percent of patients in the index study had IDS score of 0 compared with 43% of patients in Ali's study.[19]

The slight difference in the results could be due to varying experience levels of the anaesthetists; the level of experience of the anaesthetist in Ali's[19] study was a minimum of 20 prior intubations with the device prior to commencement as opposed to the present study where the researcher had a minimum of 40 intubations with both devices, IDS would be expected to be lower in the present study. In addition, difficult airway patients were excluded from the study.

The higher first attempt success rate and overall success rate observed in the video laryngoscope group correlates well with other studies.[13,18,19] Previous studies have shown that the success rate of the McGrath video laryngoscope supersedes that of the McCoy. In the present study, the McGrath had a 100% success rate and all of the patients were intubated on the first attempt, the McCoy on the other hand had a first-attempt success rate of 70.2% and overall success rate of 89.1%. The McGrath has been reported in several studies to have a success rate ranging from 69%-100%, both in normal and difficult airways.[9-12,21,27] A higher success rate is expected with the video laryngoscope in the present study because of its curved blade which is better suited for difficult airway scenarios along with its screen which has a wide viewing angle enabling a better glottic view. The present study's results have a higher degree of validity as it reflects a more diverse group of patients with multiple predictors of airway difficulty.

In contrast to the results of the present study, Ghanem *et al*.[14] reported a lower first attempt success rate of 55% for the McCoy and 85% for Glidescope video laryngoscope but this was probably because first year anaesthesia residents performed the primary intubation attempt. In addition, their definition of failed intubation was "intubation that lasted more than 30secs", so the success rate will be expected to be lower than in the present study which defined failed intubation as "intubation that required more than 120secs to perform" or "intubation that could not be achieved after two attempts". Indeed, on the second attempt by the consultant anaesthetist in Ghanem's[14] study, the success rate was 100% in both groups. Ali *et al*.[19] got a first attempt success rate for the King Vision video laryngoscope and McCoy laryngoscope to be 97% and 90% respectively, this could have been due to the indirect view of the glottis provided by the King Vision laryngoscope that eliminated the need to align the oral, pharyngeal and laryngeal axis in a straight line. The King vision video laryngoscope is very similar to the McGrath used in the present study as it also features curved blades and a display attached to the handle of the device. Ng *et al*.[27] quoted a success rate of 98.5% for the CMAC and 92.3% for the McGrath which was

not statistically significant (P=0.208). Only one predictor of difficult airway was studied in contrast to the present study where patients with multiple predictors of difficult airway were studied. In addition, a pre-condition for the providers was that they would have used the devices more than ten times prior to commencement of the study. This is in contrast to more than forty intubations done with both devices used in the present study prior to commencement. This is reflected in the higher success rate of the McGrath (100%) in the present study.

Aziz *et al*.[28] compared the CMAC to a direct laryngoscope (Macintosh) and obtained a success rate of 84% for the Macintosh and 93% for the CMAC video laryngoscope in patients with at least one predictor of difficult airway. The success for the Macintosh is similar to the success rate of 89.1% in the present study as both the McCoy and the Macintosh are direct laryngoscopes. Saxena *et al*.[18] also got a similar success rate of 88% for the McCoy in a study comparing it to the Truview video laryngoscope. Success rates for other video laryngoscopes in the setting of the difficult airway range from 85–100% in published studies.[13,14,19] Contradictory results will be expected because of heterogeneity among study designs.

In the present study, four intubations failed with the McCoy. All of the patients were successfully intubated with the McGrath laryngoscope as the rescue device. In Taylor's[11] study, 18 failed intubations with the Macintosh were subsequently intubated successfully using the McGrath laryngoscope. It is believed that the McGrath can safely serve as a backup alternative device in case of failed intubation.

Improvement in laryngeal view was also observed in the present study in the McGrath group compared with the McCoy group. This has been documented in previous studies comparing the McGrath video laryngoscope to both direct and indirect laryngoscopes.[9,10,12,15,21,27] The McGrath consistently provides optimal laryngeal view both in manikins with simulated difficult airways[11] and patients with difficult airways.[15,27] This is due to its ergonomic design and video assisted technology. Its attached camera has a wide viewing angle which shows a magnified image of the anatomy of the airway and nearby structures ensuring better visualisation of the airway.

In the present study, no patient in the McGrath group had a Cormack and Lehane grading of more than II. This agrees with findings of previous studies.[10-12,21]In Bhamidipati's[8] study, 96.4% of the patients in the McGrath group had a Cormack and Lehane I view at laryngoscopy versus 60.4% of patients in the McCoy group. This is in contrast to the findings of the present study: 67.6% of patients in the McGrath group and 8.1% of patients in the McCoy group had a Cormack and Lehane I view. The reason for the difference could be due to the fact that patients with difficult airway were excluded from Bhamidipati's[8] study whereas in the present study, majority of the patients had 3 or more features associated with difficult intubation, as such, a better laryngeal view will be expected in Bhamidipati's[8] study. Taylor's[11] finding also agrees with findings of this study; no patient in the McGrath group had a Cormack and Lehane view more than II. Indeed, other video laryngoscopes when compared with the McCoy all show the superiority of laryngeal view with the video laryngoscopes compared with the McCoy.[13,14,19] Even as the McCoy laryngoscope improves the glottis view by one grade,[17] the superiority of video laryngoscopes over it has been proven in previous studies.[13,14,18,19]

Similar to the findings on Cormack and Lehane grading above, the mean POGO score was improved in the McGrath group compared to the McCoy, which is in keeping with findings of other studies.[9,11,18]In Ruetzler's[9] study comparing two video laryngoscopes (McGrath MAC and Truview PCD™ video laryngoscopes) to the Macintosh laryngoscope on manikins in different airway scenarios, POGO score was 93% in the tongue oedema group which is in keeping with mean POGO score in this study of 93.8 ± 8.0% for the McGrath. This is not a surprising finding as the POGO score correlates well with Cormack and Lehane view.

The ability of the McGrath video laryngoscope to decrease the need for adjunctive intubation manoeuvres expands the evidence on the superiority of video laryngoscopes compared with conventional direct laryngoscopes. This has been described in previous studies.[9,12,15] This was further substantiated in the present study with 27% of patients in the McCoy group vs 5.4% in the McGrath group needing BURP and 32.4% in the McCoy group vs 13.5% in the McGrath group requiring OELM to improve laryngeal view. Results of the present study agree with those of Ghanem *et al*.[14] comparing the McCoy to the Glidescope video laryngoscope, 55% of patients in the McCoy group vs 12.5% of patients in the Glidescope group needed optimising manoeuvres. Similarly, Zhu *et al*.[12] found 12% of patients intubated with the McGrath to require optimisation manoeuvres. Saxena *et al*.[18] compared the Truview to the McCoy and found the number of optimising manoeuvres to be reduced significantly in the Truview group compared with the McCoy group. This is because, with direct laryngoscopy, the oral, pharyngeal and laryngeal axes need to be aligned in a straight line in order to achieve optimal glottis view, hence much manipulation is required to achieve this. With the video laryngoscopes, on the other hand, a straight line of sight doesn't need to be created to achieve optimal view as the camera has a wide viewing angle that projects the image onto the screen, hence manipulations are required less often.

Existing literature also demonstrate a decreased use of GEB with video laryngoscopes compared with direct laryngoscopes.[18] The present study demonstrated that

tracheal intubation with the McGrath video laryngoscope was associated with less use of the GEB compared with the McCoy laryngoscope (43.2% vs5.4%) with several previous studies agreeing with that finding.[12,15] Video laryngoscopes like the McGrath with an anatomically shaped blade can provide excellent views of the larynx because they combine features of both direct and indirect laryngoscopy; its Macintosh-like blade makes it suited for routine direct laryngoscopy and the video-assisted technology provides an improved view of the laryngeal inlet compared with conventional laryngoscopes. This eliminates the need to use adjuncts like the GEB. This is reflected in the results of the present study. The McCoy on the other hand, though lifting the epiglottis to improve glottis view, might require some form of guide to endotracheal intubation especially in patients with poor laryngeal views. This is due to its limited view compared with video laryngoscopes.

The McGrath was significantly superior to the McCoy laryngoscope in terms of the duration of intubation. The intubation time comprised of time to view the vocal cords (TTG) and the time required for tube passage through the vocal cords (TTI). TTG was 12.4 ± 3.0 vs 9.0 ± 6.1 secs (P=0.004) for the McCoy and McGrath groups respectively. This is in parallel with TTI of 29.0 ± 12.3secs vs 22.8 ± 7.1secs in the McCoy and McGrath groups respectively in the present study. The results of the present study correlate well with the TTI of 22 secs for the McGrath laryngoscope in the tongue oedema scenario of Ruetzler's[9] study. The mean TTI is expected to be lower in the McGrath group because of its LCD screen which gives a clear image of the glottis and surrounding structures with a larger field of vision. This correlates with the increased POGO score in the McGrath group compared to the McCoy group. In addition, the decreased use of optimisation manoeuvres and GEB associated with the use of the McGrath video laryngoscope further reduce the TTI. Bhola *et al*.[10] found a TTI of 30.02 secs in intubating patients with cervical spine immobilisation using MILS. Intubation time could have been longer in the latter due to different study designs compared with the present study; optimal intubating conditions might not have been achieved as patients were intubated 3 minutes after administration of vecuronium without train-of-four monitoring.

Kaur[15] *et al.* reported TTI of 6.55 secs for the McGrath video laryngoscope, much lower than TTI in the present study. The preoperative airway examination findings were not published; it couldn't have been known if the patients were expected to be difficult or easy airways. TTI will be significantly reduced when intubating easy airways with a video laryngoscope.

Some studies of video laryngoscopes compared with direct laryngoscopes have demonstrated slightly longer intubation times compared with direct laryngoscopes.[18,20] The reason could be due to the fact that although video laryngoscopes offer superior visualisation of the vocal cords, a good laryngeal view does not always guarantee easy or successful endotracheal intubation.

The variation in intubation times could also likely be due to the different definitions used in different studies. For instance, Zhu *et al*.[12] also studied patients with multiple predictors of difficult airway and defined TTI as "interval between mouth opening and time when 3 consecutive end tidal capnographic waves appeared on the monitor". TTI for the McGrath was 35.4 ± 8.8secs vs 22.8 ± 7.1secs in the present study which defined TTI as "time from introduction of the blade between the patient's teeth till the tube passed through the vocal cords". The present study didn't include the time for removal of the stylet and connection of the breathing circuit. As such, TTI will be expected to be longer in Zhu's[12] study. Bhola *et al*.[10] studied patients requiring MILS and defined TTI as "time between the insertion of the allocated laryngoscope in patient's mouth until end tidal CO_2 was detected". TTI was 30.02 ± 9.87secs vs 22.8 ± 7.1secs in the present study. Intubation times compared to the present study could have been longer due to the same reason mentioned above-the present study did not take into account the time for connection of breathing circuit and $ETCO_2$ detection. Taylor[11] *et al*., also studying patients with simulated difficult airway defined TTI as "time from insertion of laryngoscope into the oral cavity till its removal", TTI was 35.8secs. Again, the present study didn't include time for stylet removal, connection of breathing circuit and removal of the laryngoscope blade. Hence, intubation time in the present study will be expected to be shorter than in Taylor's study. Due to these different definitions of TTI, direct comparison between studies is sometimes difficult.

The good laryngeal view provided by video laryngoscopes does not always translate to faster or successful intubation.[29] While the angle of the laryngoscope blade relative to the axis of the trachea improves the indirect view of the larynx, it is necessary to redirect the tube more anteriorly which can hinder stylet removal. This often makes it necessary to bend the stylet more acutely along with lubrication of the stylet to achieve faster removal following successful endotracheal intubation, this could prolong intubation time. In this study, the stylet for the McGrath laryngoscope was bent to the shape of a hockey stick, about 60˚, conforming to the shape of the blade.

No pharyngeal trauma was recorded in the present study. The incidence of hypertension, tachycardia, hypoxaemia, mucosal trauma and hoarseness of voice was significantly more in the McCoy group compared with the McGrath group. This has been mentioned in previous studies.[11,12,15] Previous studies comparing the McCoy laryngoscope to other video laryngoscopes show that lip, dental and mucosal injuries are reduced in the latter compared to the former.[14,19] In the present study, only one patient in the McGrath

group had mucosal trauma (evidenced by blood staining the device) or lip and dental injury vs thirteen patients in the McCoy group (P=0.002). Direct laryngoscopy might require the anaesthesiologist to put undue pressure on gums, teeth and periglottic structures for maximal exposure of the vocal cords, thus leading to trauma. Nine patients in the McCoy group (24.3%) had hoarseness of voice vs none in the McGrath group, P=0.001. Findings of this study agree with that of Bhola *et al*.[10] where no patient in the McGrath group had trauma but four patients in the Truview group did. Kaur *et al*.[15] also agrees with this finding. In the present study, four patients in the McCoy group had hypoxaemia vs none in the McGrath group (P=0.040). This corresponded to the four failed intubations in the McCoy group. One patient in the McGrath group had fogging of the lens which, although rare, has been reported previously.[29] When equipment with lenses like video laryngoscopes that have been used in cold environments are exposed abruptly to warm environments (like the airway), condensation of moisture on the surface of the lens occurs because of the temperature differences between the environments and this can cause fogging, worsening the laryngeal view. Warming up the device with a temperature management unit prior to use or application of an anti-fog solution is advocated.[11] The McGrath can operate at 10˚ to 40˚ and it has a hydrophilic optical surface coating to minimise condensation on the light source. In addition, its disposable blade is made of polycarbonate which is resistant to fogging and the blade covers the camera lens.

The present study found that the haemodynamic responses to laryngoscopy were increased in the McCoy group compared with the McGrath group. There was more hypertension and tachycardia which started immediately after intubation, peaked at about 3 minutes post intubation and slowly returned to baseline after about five minutes. This finding is in keeping with previous studies done with other video laryngoscopes compared to the McCoy laryngoscope.[14,19] The possible reason for this could be that the exposure of the glottis during laryngoscopy requires the elevation of the epiglottis by a forward and upward lifting force of the laryngoscope blade which is associated with an increase in heart rate and blood pressure secondary to sympathetic discharge. This hypertensive response is directly proportional to the amount of lifting force and duration of laryngoscopy and intubation.[30,31] The McGrath MAC laryngoscope is designed to fit into the natural anatomy of the orotracheal conduit and requires less vertical force to achieve optimal laryngeal view compared with the McCoy. In addition to all these, intubation time with the McCoy was longer so haemodynamic response will be expected to be more pronounced than in the McGrath.

The present study has some limitations. Firstly, as with most airway-related studies, the possibility of observer bias could not be completely ruled out. It was impossible to blind the anaesthetist and assistant to the device used. Hence the use of the IDS score, as it assesses multiple indices of intubation difficulty and objectively quantifies the complexity of tracheal intubation. Secondly, even though the researcher had done at least forty intubations with both devices before the commencement of the study, it cannot be denied that the researcher has more experience with the McCoy than the video laryngoscope as video laryngoscopes are recent additions to airway management and most anaesthetists are primarily trained to use the direct laryngoscope. Experience with direct laryngoscopy does not translate to that with video laryngoscopy, as such, further experience and training is required on the use of video laryngoscopes before they can safely be incorporated into routine clinical practice. On the other hand, this study has proved that, despite the limited exposure to the McGrath, the success rate while managing patients with difficult airway was higher than the McCoy and this implies that the McGrath video laryngoscope might have a short learning curve and could be easily adaptable into clinical practice. Thirdly, the relative efficacies of the devices were not compared with other devices for airway management. Further comparative studies are needed to adequately prove which ones are superior. Fourthly, Cormack and Lehane grading was introduced to guide laryngoscopic view during direct laryngoscopy, there is currently no definitive accepted grading system for video laryngoscopes, the modified Cormack and Lehane scoring system was used in this study which might not be applicable to video laryngoscopes, this might have affected the results.

Conclusion

The use of the McGrath MAC video laryngoscope in patients with anticipated difficult airway resulted in a reduced IDS score and higher intubation success rate compared with the McCoy laryngoscope. In addition to this, glottic view was improved, use of optimising manoeuvres and adjuncts for intubation was reduced, complications and haemodynamic changes were also reduced. Moreover, the results from this study are highly relevant because they involve a diverse group of patients with multiple predictors of difficult airway.

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Nil

Conflicts of interest

There are no conflicts of interest.

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