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Efficacy of Video Laryngoscopes Having Different Field of View in Adult Patients Undergoing Orotracheal Intubation: A Randomized Controlled Trial

Hira Tariq Chaudhary[1]

[1]Department of Anesthesia, Doctors Hospital and Medical Centre, Lahore, Punjab, Pakistan.

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Correspondence to: Hira Tariq Chaudhary, Post Graduate Resident, Department of Anesthesia, Doctors Hospital and Medical Centre, Lahore, Punjab, Pakistan.
Email: Heer27.ht@gmail.com

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ABSTRACT

Background: Airway obstruction and failed tracheal intubation are major contributors to morbidity and mortality in surgical and critical care settings. Orotracheal intubation remains a cornerstone of airway management in both elective and emergency situations. Among various video laryngoscopes (VLs), the McGrath and C-MAC devices are widely used, but comparative data on their performance remains inconclusive from Pakistan. **Aim:** To compare the efficacy of McGrath and C-MAC video laryngoscopes in adult patients undergoing elective orotracheal intubation. **Methodology:** This single-center, randomized controlled trial was conducted in the Doctors Hospital and Medical Centre, Lahore from 20 March 2025 to 20 June 2025. Patients were classified as American Society of Anesthesiologists (ASA) physical status I to IV, and scheduled for elective surgery requiring orotracheal intubation. Patients were randomly allocated to either the McGrath group (n = 50) or the C-MAC group (n = 50). The intubation was performed using standardized induction protocols. Primary outcome was the first-pass intubation success rate. Secondary outcomes included number of attempts, glottic view, ease of intubation, hemodynamic responses, and occurrence of complications. Data were analyzed using SPSS version 28.0 (IBM Corp), with significance set at $p < 0.05$. **Results:** First-attempt success was significantly higher in the C-MAC group (92%) compared to the McGrath group (70%) ($p = 0.006$). Ease of intubation was also superior in the C-MAC group, with 86% of cases rated as ≥8 on the NRS versus 60% in the McGrath group ($p = 0.003$). Although overall success rates (C-MAC 98%, McGrath 92%) and complications (C-MAC 2%, McGrath 10%) differed, these were not statistically significant. Glottic visualization was marginally better with the C-MAC (Grade 1 view in 88% vs. 80%), but the difference was not significant ($p = 0.218$). Hemodynamic parameters remained within safe ranges in both groups, with no significant intergroup variation. **Conclusion:** it demonstrated that the C-MAC video laryngoscope is associated with a significantly higher first-pass intubation success rate and greater ease of intubation compared to the McGrath in adult patients undergoing elective orotracheal intubation. Further research is warranted to assess their performance in difficult airway and emergency settings.

INTRODUCTION

Maintaining a patent airway is fundamental to successful perioperative care and emergency medicine, as complications or inadequate airway control can result in significant illness and death in anesthesia and critical care patients (Kriege et al., 2024). Immediate and accurate airway management is crucial since prolonged hypoxia, brain damage, cardiac arrest and mortality often result from difficulties with securing the airway (Sansone et al., 2023). Unexpected difficult intubation is linked to a significant proportion of anesthesia complications, occurring in 1.5–8.5% of elective surgical patients and more frequently in emergency settings (Kreutziger et al., 2019). This makes refining the approaches and devices employed for successful endotracheal intubation of great significance in minimizing unnecessary airway mishaps (Kriege et al., 2023).

Difficult airway management is especially problematic in high-stress settings like ICUs, EDs and trauma centers, where the risk of complications during emergency intubation is well above 30% (Erkoç et al., 2022). Various clinical situations, including restricted positioning, cervical spine restraint, craniofacial injuries, obesity and atypical anatomies, predispose patients to encounter difficulties during laryngoscopic airway management (Kaur et al., 2020). Complications such as esophageal intubation, dental trauma, mucosal injury, aspiration and hypoxia occur more often in cases when the airway is

challenging to manage (Sukmono et al., 2022). Given these difficulties, it is crucial to have dependable airway equipment that increases tray-to-glottis times and success rates on the initial trial.

Attaining appropriate alignment of the oral, pharyngeal and laryngeal axes during direct laryngoscopy can be challenging and it is commonly encountered in practice (Abhyankar et al., 2023). Direct laryngoscopy often encounters challenges due to variations in trainees' abilities, patient conditions and environmental factors (Akbas et al., 2019). Video laryngoscopes (VLs) utilise a camera fixed to their blade tips, projecting continually updated views of the glottis onto an external monitor that enables intubation without visualization by the operator (Zhu et al., 2019). VLs have been shown to enhance glottic observation, increase the likelihood of successful first intubation and reduce the chance of complications during routine and challenging procedures (Gupta et al., 2021). Moreover, VLs enable better training and oversight by offering simultaneous visualization to all involved professionals. A growing variety of VLs has led to studies comparing their effectiveness in different clinical settings (Gupta et al., 2022).

The McGrath is popular because of easy-to-carry frame featuring a pliable probe and an embedded LCD screen (Kriege et al., 2021). It was developed to provide optimal views of the larynx in various scenarios and without needing complicated patient repositioning or extensive voice box adjustments (Korkut et al., 2019). It is widely used in emergencies and in field scenarios due to its lightweight and simple manipulation. The insertion of the endotracheal tube is more likely to be successful when using a rigid stylet or shaping the tube with care, especially for novice operators (De Jong et al., 2021). The C-MAC video laryngoscope incorporates a conventional Macintosh blade and uses a camera placed in the tip (Korkut et al., 2019). This fusion of traditional methods and modern technology enables the physician to perform almost like direct laryngoscopy while benefiting from the advantages of video visualization. With this laryngoscope, users can convert from direct to video-assisted techniques as necessary (Witkam et al., 2025; Erkoç et al., 2022). The large external monitor, compatibility with both the standard blade and the D-Blade and the high-definition images of the C-MAC have earned it a positive reputation in surgical settings and medical institutions. However, it has been mentioned that its large size and limited mobility might limit its use in some remote and mobile situations (Kreutziger et al., 2019; Kriege et al., 2024).

The existing literature suggests that McGrath and C-MAC video laryngoscopes have advantages as well as drawbacks when used to guide the insertion of a tracheal tube (Zhang et al., 2022). Many aspects including the skills of the operator, the chosen blade and patient-related factors dramatically affect the outcome of tracheal tube insertion (Kreutziger et al., 2019; Sansone et al., 2023). Employing either the McGrath or C-MAC is most appropriate for challenging airways, but neither is uniformly better than the other in every situation. Direct comparisons of video laryngoscope performance under real-world conditions can help identify their unique properties (Akbas et al., 2019; Zhu et al., 2019). These factors have become critical in the design and evaluation of devices used for airway management (Zhang et al., 2022; Gupta et al., 2021). The objective of this study was to evaluate the two types of video laryngoscopes, McGrath and C-MAC, during elective orotracheal intubation in adult patients to determine their attributes under similar conditions.

METHODOLOGY

Study Design and Participants

A randomized controlled trial was carried out in the operation theatres of Doctors Hospital and Medical Centre, Lahore, for a duration of three months. The purpose of the study was to evaluate the performance of both devices in helping healthcare professionals perform orotracheal intubation on adult patients during elective surgery. A total of 100 patients were recruited in the trial and they were equally and randomly allocated to the McGrath and C-MAC groups. A sample size of 100 was determined considering a significance level of 5%, power of 80% and the expected glottic view angles reported in the literature. The McGrath video laryngoscope has a field of view of 60–70° and consistently attains a glottic view angle ranging from 85.1%. The C-MAC provides an angled view of the glottis at 80–90°. Eligible patients were between the ages of 18 and 60 years old, were scheduled for orotracheal intubation and consented to participate in the study. Only patients between the ages of 18 and 60 who were recommended for orotracheal intubation and fitted the following requirements were included in the study: gender, BMI below 40 and ASA classification of I to IV. Those with more than three indicators for difficult airway, those who did not consent, those who suffered failed intubation or patients classified as ASA V were excluded.

Randomization and Perioperative Protocol

Each patient was randomly assigned to either the McGrath or the C-MAC group after giving their informed consent. Clinical and demographic information was obtained before surgery. This data included age, gender, BMI, ASA classification and the results of the airway assessment. Only after ensuring that all participants achieved an end-tidal oxygen level of at least 70% were they given 100% oxygen for preoxygenation. After the patients had been prepared, anesthesia was induced with intravenous drugs. Once induction drugs were administered, oxygenation was achieved with a bag-environmental compensation thereby mitigating an excessive rise in the patient's end-tidal carbon dioxide and ensuring their safety. Once the patient was fully relaxed and breathing adequately, the presence of neuromuscular blockade was checked using a peripheral nerve stimulator. The anesthetists began laryngoscopy after confirming full muscle relaxation and ensuring a zero train-of-four response. Patients were randomly assigned to receive either McGrath or C-MAC video laryngoscopy for intubation. The anesthetist chose to use either blade size 3 or 4 to provide the best view of the larynx for successful intubation.

Outcome Measures and Data Collection

The primary outcome of interest was the time needed to achieve successful intubation, measured from the moment

the allocated video laryngoscope was inserted into the patient's mouth until the endotracheal tube position was confirmed by measuring end-tidal carbon dioxide. If more than a single attempt at intubation was needed, bag-and-mask ventilation was used in between. An attempt was considered a failure if the trachea was not intubated after three attempts with the allocated device and the anesthetist would then perform an alternative airway management technique. Intubation time was stopped when the anesthetist decided there was no longer a possibility for successful intubation and elected to pursue an alternative airway management technique. The Cormack and Lehane glottic view scale was used to rate the quality of the view of the vocal cords on the video laryngoscope screen (Cormack and Lehane, 1984). Additional secondary outcomes included the number of tries until successful placement, the percentage of successful intubation in each group and how easy it was to intubate each patient. Ease of intubation was assessed by the anesthetist based on an ordinal ranking system from 0 for the hardest case to 10 for the easiest case. Heart rate and blood pressure were continuously checked throughout the intubation process to detect any changes. Any complication that occurred such as hypoxia (oxygen saturation below 90%) or signs of oropharyngeal or dental injury, was noted.

Statistical Analysis

All the data was entered and analyzed in SPSS version 28.0 (IBM). Mean and standard deviation were calculated for quantitative variables such as age and BMI. Frequency and percentage were calculated for qualitative variables such as gender, attempts, and first-pass attempts(efficacy). Statistical significance was determined by inferential statistical tests including the Chi-square test for qualitative variables, and the independent t-test for quantitative variables. If needed, Fisher's exact test was used for small sample sizes or when the expected frequency is less than 5. For all statistical tests, the level of significance was set to $p < 0.05$.

RESULTS

Demographic Outcomes

In the McGrath group, 28 patients (56.0%) were male and 22 patients (44.0%) were female, whereas in the C-MAC group, males accounted for 30 patients (60.0%) and females for 20 patients (40.0%). Overall, the study population comprised a slight male predominance, with 58 males (58.0%) and 42 females (42.0%). The McGrath group had 15 patients (30.0%) aged 18–30 years, 20 patients (40.0%) aged 31–45 years, and 15 patients (30.0%) aged 46–60 years. Similarly, the C-MAC group included 17 patients (34.0%) aged 18–30, 18 patients (36.0%) aged 31–45, and 15 patients (30.0%) aged 46–60. In the McGrath group, 18 patients (36.0%) had a normal BMI, 22 (44.0%) were overweight, and 10 (20.0%) were obese (BMI 30–39.9). In the C-MAC group, 20 (40.0%) were of normal BMI, 21 (42.0%) were overweight, and 9 (18.0%) were obese. The highest proportion of patients in both groups fell within the overweight range (43.0% overall), followed by those with normal BMI (38.0%).

Table 1

Demographic outcomes of participating patients

Gender	McGrath Group (n=50)	C-MAC Group (n=50)	Total (n=100)
Male	28 (56.0%)	30 (60.0%)	58 (58.0%)
Female	22 (44.0%)	20 (40.0%)	42 (42.0%)
Age Category (years)			
18–30	15 (30.0%)	17 (34.0%)	32 (32.0%)
31–45	20 (40.0%)	18 (36.0%)	38 (38.0%)
46–60	15 (30.0%)	15 (30.0%)	30 (30.0%)
BMI Category (kg/m^2)			
<25 (Normal)	18 (36.0%)	20 (40.0%)	38 (38.0%)
25–29.9 (Overweight)	22 (44.0%)	21 (42.0%)	43 (43.0%)
30–39.9 (Obese)	10 (20.0%)	9 (18.0%)	19 (19.0%)

Physical and Intubating Characteristics

Most patients in both groups belonged to ASA II and III classifications, with ASA III being more prevalent in the McGrath group (60%) than in the C-MAC group (44%). Similarly, the majority of patients in both groups were classified as Mallampati Class 3 (96%), with only 4% in Class 4. This distribution indicates a generally similar baseline airway assessment across both groups.

Table 2

Physical and intubating characteristics of participating patients

Baseline Characteristics	McGrath Group (n=50)	C-MAC Group (n=50)
ASA Classification		
I	2	7
II	18	21
III	30	22
Mallampati Class		
3	48	48
4	2	2

Intubation and Hemodynamic Outcomes

The first-attempt intubation success rate was significantly higher with C-MAC (92%) compared to McGrath (70%), with a statistically significant p-value of 0.006, suggesting superior efficacy in prompt airway access. Additionally, fewer patients in the C-MAC group required two or more intubation attempts (8% vs. 30%; $p = 0.006$), indicating better efficiency. Ease of intubation, as rated by the intubating anesthetists on the Numerical Rating Scale (NRS), also favored C-MAC, with 86% of patients in this group scoring ≥8 compared to only 60% in the McGrath group ($p = 0.003$), demonstrating greater operator satisfaction and perceived procedural simplicity. Although overall success rates and complication frequencies were higher in the McGrath group, the differences in these parameters did not reach statistical significance. Likewise, hemodynamic responses—including heart rate and systolic pressure elevations—were somewhat lower with C-MAC but without significant differences.

Table 3

Intubation and haemodynamic outcomes of participating patients

Outcome Parameter	C-MAC (n = 50)	McGrath (n = 50)	p-value
Laryngoscopic View			
Grade 1	44 (88%)	40 (80%)	0.218
Grade 2 or Higher	6 (12%)	10 (20%)	0.218
Number of Attempts			

First Intubation Attempt Successful	46 (92%)	35 (70%)	0.006
Two or More Attempts Required	4 (8%)	15 (30%)	0.006
Overall Successful Intubation	49 (98%)	46 (92%)	0.317
Failed Intubation	1 (2%)	4 (8%)	0.317
Ease of Intubation			
NRS ≥ 8	43 (86%)	30 (60%)	0.003
NRS < 8	7 (14%)	20 (40%)	0.003
Complications			
Complications Reported	1 (2%)	5 (10%)	0.089
No Complications	49 (98%)	45 (90%)	0.089
Cardiac Outcomes			
Heart Rate Increase > 25%	6 (12%)	12 (24%)	0.124
Heart Rate Increase ≤ 25%	44 (88%)	38 (76%)	0.124
Systolic Pressure Increase > 3%	7 (14%)	10 (20%)	0.432
Systolic Pressure Increase ≤ 3%	43 (86%)	40 (80%)	0.432

DISCUSSION

The primary aim of this randomized controlled trial was to compare the efficacy of two widely used video laryngoscopes, the McGrath and the C-MAC in adult patients undergoing elective orotracheal intubation. The study showed that the C-MAC performed better in many important aspects and provided insights that could influence how these innovations are used in clinical practice. It was discovered that the C-MAC achieved considerably greater success in initial intubation attempts (92%) which was significantly better than that of McGrath (70%), as the p-value was equal to 0.006. Our results are consistent with findings from Witkam et al., (2025) that demonstrated a 91.2% rate of first-attempt success with the C-MAC compared to only 75.4% when using the McGrath, suggesting that the C-MAC gives an edge in helping achieve a timely airway. These results could be explained by the similarity in design between the C-MAC's blade and the traditional macintosh laryngoscope, allowing providers to effectively combine direct and video laryngoscopy techniques.

In terms of ease of intubation, our results indicated that 86% of intubating clinicians rated the C-MAC experience ≥8 on a 0–10 Numerical Rating Scale, compared to only 60% for McGrath users (p = 0.003). This corroborates the findings by Zhang et al., (2022), who found significantly better operator satisfaction with the C-MAC due to its wider external screen and ease of endotracheal tube guidance. Furthermore, a study by Sukmono et al., (2022) demonstrated that clinicians reported a lower learning curve and greater procedural comfort with the C-MAC in both simulated and clinical environments. The McGrath, though portable and compact, may impose technical challenges such as the need for a preformed stylet due to its angulated blade design (Sukmono et al., 2022).

Interestingly, while overall intubation success did not differ significantly between the groups (98% for C-MAC vs. 92% for McGrath; p = 0.317), the number of required attempts differed substantially. Only 8% of C-MAC patients needed a second attempt versus 30% with McGrath (p = 0.006). This trend mirrors findings from a recent study (Abhyankar et al., 2023), who observed fewer repeated attempts with the C-MAC among ICU patients, reinforcing its reliability in first-pass success, a critical determinant of patient outcomes, particularly in high-risk settings. Regarding glottic visualization, although not statistically significant in our study (Grade 1 view in 88% C-MAC vs. 80% McGrath; p = 0.218), the C-MAC slightly outperformed the McGrath. This contrasts with Kaur et al., (2020), who reported superior glottic views with McGrath due to its hyper-angulated design, especially in anatomically challenging airways. However, better visualization does not always equate to easier intubation, as the McGrath may complicate tube delivery without proper stylet shaping (Zhang et al., 2022; Kaur et al., 2020). Thus, while McGrath may provide excellent laryngeal views, tube passage may remain a barrier.

The incidence of complications was higher in the McGrath group (10%) compared to C-MAC (2%), although this difference was not statistically significant (p = 0.089). Most of these complications were minor, such as oropharyngeal trauma or brief hypoxia. Similarly, previous studies (Witkam et al., 2025; Yahagi et al., 2025) have also shown that the C-MAC is associated with a lower rate of complications in elective procedures. Advantages like optimum orientation and excellent visibility of immediate surroundings may underpin the low complication risk associated with the Macintosh-style laryngoscope. In this research, McGrath elicited slightly higher increases in heart rate and systolic pressures but these differences were not statistically significant. This result is in line with Ho et al. (2022) who noted that the McGrath laryngoscope can induce greater hemodynamic changes as a result of longer handling and increased airway irritation. The C-MAC's improved overall comfort and speed of placement could yield lower levels of sympathetic activation in future studies with patients at increased cardiac risk (Ho et al., 2022).

Limitations

There are few limitations associated with this study that should be mentioned. The findings of this study cannot be fully applicable to unpredictable emergency and prehospital situations where intubation conditions and time constraints are markedly different. The study involved anesthesia professionals experienced with both devices which limits the understanding of the learning curves involved, particularly for the angled blade of the McGrath. The results may not generalize well to critically ill or unstable patients with difficult airways, where discrepancies in device efficacy could be more apparent. It also did not evaluate the cost-effectiveness of the devices which should be taken into account when deciding on their use in low-resource settings.

CONCLUSION AND RECOMMENDATIONS

This randomized controlled trial demonstrated that the C-MAC video laryngoscope provides statistically superior first-pass success and ease of intubation compared to the McGrath, without significant differences in complication rates or hemodynamic instability. These findings are consistent with several other high-quality studies and

suggest that C-MAC may be the preferred device in routine elective settings, especially when used by practitioners with varying levels of experience. Nonetheless, the McGrath remains a valuable tool, particularly in difficult airway scenarios and prehospital care, where its compactness and visualization advantages may outweigh its technical challenges. Future research should focus on multi-center trials incorporating difficult airway cases and emergency contexts, as well as cost-effectiveness analyses, to inform institutional procurement and training strategies.

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