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A PROSPECTIVE RANDOMIZED STUDY COMPARING THE HEMODYNAMIC RESPONSE TO INTUBATION USING C-MAC VIDEO LARYNGOSCOPE VERSUS MACINTOSH LARYNGOSCOPE IN PATIENTS POSTED FOR ELECTIVE SURGERY UNDER GENERAL ANESTHESIA

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ABSTRACT

Background: Laryngoscopy and tracheal intubation are often associated with tachycardia, hypertension and, arrhythmia. The major stimuli to cardiovascular change during laryngoscopy and tracheal intubation are the forces exerted by the laryngoscope blade on the base of the tongue while lifting the epiglottis. Direct laryngoscopy remains the gold standard technique as an effective means to securing the airway. Video laryngoscopes have quickly gained popularity as an intubation device in a variety of clinical scenarios and settings, as well as in the hands of airway experts and non-experts. Video laryngoscopy utilizes video camera technology to visualize airway structures and facilitate endotracheal intubation. C-MAC Video laryngoscope blade is similar to the Macintosh, with the additional advantage of a video camera. The distal end of the blade incorporates a small digital camera and a high-power light-emitting diode. The video laryngoscopes are found to be associated with lesser hemodynamic response to laryngoscopy and intubation.

Objectives: The main aim of our study is to compare the hemodynamic response to intubation using C-MAC video laryngoscope and Macintosh laryngoscope. The primary objectives of the study are to assess and compare the hemodynamic parameters such as Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) using C-MAC video laryngoscope and Macintosh laryngoscope. The secondary objectives of the study are to compare the intubation time, the number of attempts, glottis view and, airway morbidity using CMAC video laryngoscope and Macintosh laryngoscope.

Methodology: A prospective randomized, comparative study with a total of 66 American Society of Anaesthesiologists Physical Status (ASA PS) 1 patients of age group between 20 and 50 years was divided into two groups C(C-MAC) and M(Macintosh). Group allocation was achieved by a computer-generated randomization list. Patients were wheeled into the operation theatre on the day of surgery and connected to a multi-para monitor with Electrocardiogram (ECG), non 1 invasive blood pressure (NIBP), Oxygen saturation (SPO2) and, End-tidal carbon dioxide (ETCO2) and, all baseline parameters of HR, SBP, DBP were recorded. Laryngoscopy was performed with C-MAC video laryngoscope in group C and with Macintosh laryngoscope in group M. The HR, SBP, DBP and SPO2 were recorded at the time of introduction of laryngoscope (T0), one minute after intubation (T1), three minutes after intubation (T2), five minutes after intubation (T3). The time taken for intubation was recorded as the time between the introduction of the laryngoscope blade between the canines and the appearance of the first ETCO2 trace in the monitor. The laryngoscope view is graded according to the Cormack Lehane grading. Any injury to the oral mucosa or the tooth will be noted after securing the airway. Data were analyzed using the chi-square test and student t-test.

Results: The mean Heart Rate at 1 minute, 3 minutes, 5 minutes after intubation were 77.2±7.9 beats/min, 75.9±7.2 beats/min, 73.5±8.3 beats/min in the C-MAC group and 95±11.3 beats/min, 89.4±10.9 beats/min, 81±10.5 beats/min in the Macintosh group respectively. The mean systolic blood pressure at 1 min,3 mins,5 mins after intubation were 120±9.3 mm Hg,113.2±6 mm Hg, 113.2±8 mm Hg in the C-MAC group and 130.5±15.6 mm Hg, 128.5±13.2 mm Hg, 125.9± 6.8 mm Hg in Macintosh group respectively. The diastolic blood pressure at 1 min, 3 mins, 5 mins after intubation were 72.2±6.3 mm Hg, 72.7±7.8 mm Hg, 70.6±8.2 mm Hg in the C-MAC group and 96.2±9.1 mm Hg,93.2±8.5 mm Hg, 91.9±9.5 mm Hg in the Macintosh group respectively. There was a statistically significant difference with a lesser increase in HR, SBP and DBP in patients intubated with C-MAC video laryngoscope. The Cormack-Lehane grading 1 was observed in 32 patients and grade 2 was observed in 1 patient in the C-MAC group and grade 1 was observed in 21 patients and grade 2 was observed in 12 patients in the Macintosh group. This conveys that the C-MAC group showed a better glottic view when compared to the Macintosh group. The mean time taken for intubation was 20.3±3.6 seconds in the C-MAC group compared to 31.2±6.0 seconds in the Macintosh group. The first attempt success rate was 100 percent in both the C-MAC group and the Macintosh group. Mucosal trauma was recorded in one participant in the Macintosh group and none in the CMAC group.

Conclusion: CMAC video laryngoscope provoked or elicited lesser hemodynamic response after intubation like lesser increase in HR, the lesser elevation of SBP, DBP and also better CL grading, lesser intubation time and lesser incidence of trauma in comparison to Macintosh laryngoscope.

INTRODUCTION

Laryngoscopy and endotracheal intubation are essential components of general anaesthesia, ensuring airway protection and adequate ventilation during surgical procedures. However, these interventions stimulate the sympathetic nervous system and produce transient cardiovascular responses, including increased heart rate, elevated blood pressure and increased myocardial oxygen demand.[1] The magnitude of this response depends on the intensity and duration of laryngoscopy, the force applied to the airway structures, the depth of anaesthesia and the patient's underlying cardiovascular status.

The conventional Macintosh laryngoscope has been widely used for direct laryngoscopy and tracheal intubation because of its established effectiveness, familiarity and widespread availability. Nevertheless, obtaining an adequate glottic view may require considerable lifting force and manipulation of the upper airway, potentially contributing to sympathetic stimulation and haemodynamic fluctuations.[2] Although these changes are generally transient in healthy individuals, they may have clinical significance in patients with hypertension, coronary artery disease and other cardiovascular risk factors.

Technological advances in airway management have led to the development of video laryngoscopes, which incorporate a camera near the blade tip to provide an indirect view of the glottis. The C-MAC video laryngoscope facilitates visualization of the laryngeal inlet on an external monitor and may improve intubation conditions in selected patients.[3] Its design may reduce the need for extensive alignment of the oral, pharyngeal and laryngeal axes; however, improved visualization does not necessarily translate into a reduced haemodynamic response.

Evidence from international studies indicates that video laryngoscopy can improve glottic visualization, although its effect on cardiovascular responses varies according to device design, airway anatomy and intubation technique.[4] Therefore, the C-MAC video laryngoscope should be evaluated not only for its visualization advantages but also for its influence on heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure during intubation.

In the Indian context, a randomized study conducted by Buhari and Selvaraj at Sri Ramachandra University, Chennai, compared Macintosh, McCoy and C-MAC laryngoscopes in adult patients undergoing general anaesthesia. The investigators observed a greater haemodynamic response with C-MAC than with the conventional Macintosh laryngoscope at selected post-intubation time points, highlighting the need for further evaluation in different clinical settings.[5] A subsequent Indian study also investigated the haemodynamic effects of these devices in patients undergoing elective surgery, contributing to the growing evidence base for optimizing airway management.[6] More recently, a randomized trial published in 2026 among patients undergoing coronary artery bypass grafting reported comparable haemodynamic profiles with C-MAC and Macintosh laryngoscopes, despite better glottic visualization with C-MAC.[7]

Despite these investigations, differences in patient characteristics, anaesthetic techniques, operator experience and haemodynamic measurement intervals limit direct comparisons between studies. A prospective randomized comparison under standardized anaesthetic conditions can help determine whether either laryngoscope offers a clinically meaningful advantage in attenuating the pressor response to intubation. The present study is therefore designed to compare the haemodynamic responses associated with C-MAC video laryngoscopy and conventional Macintosh laryngoscopy in patients undergoing elective surgery under general anaesthesia, with particular emphasis on peri-intubation changes in heart rate and blood pressure. The findings may help guide the selection of an appropriate laryngoscope for routine airway management and contribute to safer anaesthetic practice in both Indian and international clinical settings.

AIM

The main aim of our study is to compare the hemodynamic response to intubation using C-MAC video laryngoscope and Macintosh laryngoscope.

OBJECTIVES

The primary objectives of the study are to assess and compare the hemodynamic parameters such as Heart rate, Systolic blood pressure, Diastolic blood pressure using C-MAC video laryngoscope and Macintosh laryngoscope.

The secondary objectives of the study are to compare the intubation time, the number of attempts, glottis view and airway morbidity using CMAC video laryngoscope and Macintosh laryngoscope.

MATERIALS AND METHODS

Study Area

The study was conducted at MIOT International Hospital, Chennai, after obtaining approval from the Institutional Ethics Committee.

Study Design

A prospective, randomized, two-group comparative study was conducted to compare the haemodynamic responses to tracheal intubation using the C-MAC video laryngoscope and the Macintosh direct laryngoscope in patients undergoing elective surgery under general anaesthesia.

Study Population

The study included 66 patients scheduled for elective surgery under general anaesthesia. The patients were randomly

allocated into two groups, with 33 patients in each group.

- Group C: Patients underwent intubation using the C-MAC video laryngoscope.
- Group M: Patients underwent intubation using the Macintosh direct laryngoscope.

Inclusion Criteria

- Patients aged 20–50 years of either sex.
- Patients classified as American Society of Anesthesiologists Physical Status (ASA PS) I.

Exclusion Criteria

- Patients with ASA PS II or higher.
- Patients with anticipated difficult airways, including Modified Mallampati Class III or IV, mouth opening less than 2 cm, sternomental distance less than 7 cm, buck teeth, or restricted neck movements.
- Patients with a body mass index (BMI) greater than 40 kg/m^2.
- Patients at risk of aspiration.

Sample Size Calculation

The sample size was calculated using MedCalc Statistical Software, version 19.1.3, based on the comparison of means. The calculation used a type I error of 5%, a type II error of 20%, and a statistical power of 80%. Based on the reference study by Archana K. N. et al., the expected difference in means was 6.5, with standard deviations of 7.7 and 10.6 in the two groups. The calculated sample size was 33 patients per group, giving a total sample size of 66 patients.

Sampling Technique

Eligible patients were enrolled after obtaining written informed consent. Group allocation was performed using a computer-generated randomization list. The patients were assigned to either the C-MAC video laryngoscope group or the Macintosh laryngoscope group.

Pre-Anaesthetic Evaluation

All patients underwent a pre-anaesthetic evaluation on the day before surgery. A detailed medical history was obtained, and the presence of systemic diseases was assessed. Airway assessment was performed using the Modified Mallampati classification. Routine investigations were carried out according to the clinical condition and surgical requirements. Patients were advised to fast for eight hours before surgery. The anaesthetic procedure was explained to each patient in their vernacular language, and written informed consent was obtained.

Operation Theatre Preparation

The anaesthesia workstation was checked, and its self-test was performed to ensure proper functioning and exclude leaks. Alternative ventilation equipment was kept ready. Macintosh laryngoscope blades of sizes 3 and 4, a size 3 C-MAC video laryngoscope blade, appropriately sized endotracheal tubes, bougies, stylets, suction apparatus and emergency drugs were prepared before induction.

Anaesthetic Procedure

On the day of surgery, patients were transferred to the operation theatre and connected to a multiparameter monitor. Electrocardiography, non-invasive blood pressure, peripheral oxygen saturation (SpO_2) and end-tidal carbon dioxide ($EtCO_2$) were monitored. Baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and SpO_2 were recorded.

Intravenous access was established using an 18G or 20G cannula. Patients were premedicated with midazolam 0.05 mg/kg and fentanyl 2 µg/kg intravenously. Anaesthesia was induced with propofol 2 mg/kg, followed by vecuronium 0.08 mg/kg for neuromuscular relaxation. Bag-mask ventilation was continued for four minutes. Anaesthesia was maintained with isoflurane at a dial setting of 0.8–1%, using an air–oxygen mixture in a 1:1 ratio.

Laryngoscopy and Endotracheal Intubation

Laryngoscopy and endotracheal intubation were performed using the assigned device. Patients in Group C underwent intubation with the C-MAC video laryngoscope, whereas patients in Group M underwent intubation with the Macintosh direct laryngoscope. All procedures were performed by an experienced laryngoscopist with more than four years of experience.

Haemodynamic Monitoring

Heart rate, systolic blood pressure, diastolic blood pressure and SpO_2 were recorded at the baseline, at the time of laryngoscope introduction (T0), and at one minute (T1), three minutes (T2) and five minutes (T3) after intubation. The recorded parameters were compared between the two groups to assess the haemodynamic responses associated with each laryngoscope.

Assessment of Intubation Parameters

An independent observer recorded the intubation time and the number of intubation attempts. Intubation time was defined as the interval between the introduction of the laryngoscope blade between the incisors and the appearance of the first $EtCO_2$ trace on the monitor.

An intubation attempt was considered unsuccessful if it exceeded 90 seconds, if oxygen saturation decreased below 90%, or if more than two attempts were required to secure the airway. The laryngoscopist assessed the laryngeal view using the Cormack–Lehane grading system. Any mucosal injury or dental trauma occurring during laryngoscopy and intubation was also recorded.

Statistical Analysis

Data were analysed using appropriate statistical methods. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequencies and percentages. The student's t-test was used to compare continuous variables, while the chi-square test was used to compare categorical variables, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Age group of participants

Group	C	M	P value
Age			
Mean (SD)	31 (7)	33 (8)	*0.305*

The mean age of participants in Group C is 31 years and in Group M is 33 years. The difference in age among either group was statistically insignificant (p=0 .305).

Table 2: Gender distribution among the groups

Group	C	M	P value
Gender n (%)			
Male	23 (69.7)	25 (75.8)	*0.580*
Female	10 (30.3)	8 (24.2)	

In Group C, 23 patients are males, 10 patients are females and in Group M 25 patients are males and 8 patients are females. P value was not significant. The ratio of males to females in group C was 23: 10 and group M was 25:8. The difference between the ratio was found to be 0.580.

Table 3. Procedure wise distribution in study groups:

PROCEDURE	n	(%)
Arthroscopic ACL reconstruction	11	16.7
Endoscopic discectomy	3	4.5
FESS	7	10.6
Lap appendicectomy	11	16.7
Lap cholecystectomy	10	15.2
Lap hernioplasty	11	16.7
Lumbar discectomy	2	3.0
Shoulder arthroscopy	5	7.6
TLH with BSO	6	9.1
Total	**66**	

Table 4: Heart rate variations in group C and group M:

CM			
Heart rate	**Mean ± SD**	**Mean ± SD**	**P Value**
Pre Op	74.8 ± 8.6	76.4 ± 8.5	0.456
0 Minutes	73.5 ± 8.4	73.7 ± 9.5	0.913

1 Minutes	77.2 ± 7.9	95 ± 11.3	**<0.001****
3 Minutes	75.9 ± 7.2	89.4 ± 10.9	**<0.001****
5 Minutes	73.5 ± 8.3	81 ± 10.5	**0.002***
Significantly differed at **0.1% level (P < 0.001), * 0.5% level (P < 0.005)			

The mean HR in both groups was similar during the preoperative period and at the time of induction. At 1 min after intubation, the mean HR was 77.2 ± 7.9 beats/ min in the C group and 95 ±11 .3 beats/min in the M group with statistically significant p values (p<0. 001) in the C MAC group. At 3 mins after intubation, the mean HR was 75. 9±7. 2 beats/ min in the C group compared to 89.4± 10 .9 beats/min in the M group with statistically significant p values(p<0.001) in the C MAC group.
At 5 mins after intubation, the mean HR was 73.5± 8.3 beats/ min in the C group compared to 81±10. 5 beats/min in the M group with statistically significant p values(p 0. 002) in the C- MAC group. Thus a statistically significant difference was seen with a lesser increase in HR noted in the C MAC group.

Table 5: systolic blood pressure changes over time

SBP/ Group	**C**		**M**		**P Value**
	Mean ± SD	**Mean ± SD**			
Pre Op	114.3 ± 8.6	113.9	±	7.6	0.845
0 Minutes	114.1 ± 8.5	112.8	±	8.8	0.544
1 Minutes	120 ± 9.3	130.5	±	15.6	**<0.001***
3 Minutes	113.2 ± 6	128.5	±	13.2	**<0.001***
5 Minutes	113.2 ± 8	125.9	±	6.8	**<0.001***
*** Significantly differed b/w groups at 0.1% level (P < 0.001)**					

SBP at the pre- operative period and at the time of induction was comparable in both groups. No significant difference (p>0.05) in the mean SBP was found in both groups. The mean SBP at 1 min after int ubation was 120±9.3 mm Hg in the C group compared to 130 ±15 .6 mm Hg in the M group with statistically significant p values (p<0.001) in the C group. The mean SBP at 3 mins after intubation was 113.2±6 mm Hg and 128. 5±13.2 mm hg in the C group and M group respectively with statistically significant p values (p<0.001) in the C group.
The mean SBP at 5 min after intubation was 113.2±8 mm Hg and
125. 9±6.8 mm Hg in the C group and M group respectively with statistically significant p values (p<0.001) in the C group. Similar to HR, a statistically significant p value was noted at 1st min (p<0.001), 3 rd min (p<0.001), 5th min
(p <0.001) with a lesser increase in SBP noted in the C-MAC group.

Table 6: changes in diastolic blood pressure over time:

CM			
DBP/ Group	**Mean ± SD**	**Mean ± SD**	
Pre Op	75.9 ± 8.2	76.8 ± 7.9	0.648
0 Minutes	74.9 ± 8.7	75.8 ± 8.6	0.671
1 Minutes	72.2 ± 6.3	96.2 ± 9.1	**<0.001***
3 Minutes	72.7 ± 7.8	93.2 ± 8.5	**<0.001***
5 Minutes	70.6 ± 8.2	91.9 ± 9.5	**<0.001***
*** Significantly differed b/w groups at 0.1% level(P < 0.001)**			

P Value
The mean DBP in both the groups was similar during the preoperative period and at the time of induction as there was no statistical difference. At 1 min after intubation, mean DBP was 72. 2±6.3 mm Hg in the C group compared to 96.2± 9.1 mm Hg in the M group with statistically significant p values (p<0.001)

in the C group.
Even at 3 mins and 5 mins after intubation, mean DBP was 72.7± 7.8 mm Hg, 70.6±8.2 mm Hg in the C group compared to 93.2±8.5 mm Hg,
91.9±9. 5 mm Hg in the M group respectively with statistically significant p values(p<0.001) in the C group.

Table 7: CLG in the two groups:

CORMACK LEHANE GRADE			
	Grade n (%)		P value
Group	1	2	
C	32 (97.0%)	1 (3.0%)	**< 0.001***
M	21 (63.6%)	12 (36.4%)	
*** Significantly differed b/w groups at 0.1% level(P < 0.001)**			

Table 8: Comparison of intubation time in both the groups:

INTUBATION TIME(SEC)					
	Group	**Mean**	**SD**	**[95% CI]**	
C		20.3	3.6	19.0	21.6
M		31.2	6.0	29.0	33.3
*** Significantly differed b/w groups at 0.1% level(P < 0.001)**					

The mean t ime taken for intubation was 20. 3±3. 6 seconds in the C MAC group and 31 .2 ±6.0 seconds in the Macintosh group. The time taken for intubation was lower in the C MAC group when compared to the Macintosh group. This was found to be statistically significant with a p value<0. 001.

Table 9: Number of attempts for intubation:

Group		
	C	M
NUMBER OF ATTEMPTS	1	1

Both groups of patients were intubated in the first attempt in our study.

Table 10: Incidence of trauma in both the groups:

Group		
AIRWAY TRAUMA	**C**	**M**
NO	33 (100%)	32 (97%)
YES	0 (0%)	1 (3%)
Total	**33**	**33**

There was a mild incidence of trauma in 1 patient in the Macintosh group when compared to the C MAC group which had no incidence of trauma.

DISCUSSION

The present study compared the haemodynamic response to endotracheal intubation using the C-MAC video laryngoscope and the conventional Macintosh laryngoscope in patients undergoing elective surgery under general anaesthesia. The principal findings were that C-MAC laryngoscopy was associated with a smaller increase in heart rate and blood pressure after intubation, a better Cormack–Lehane laryngoscopic view, and a shorter intubation time. Both groups achieved successful intubation at the first attempt, while airway trauma was observed in one patient in the Macintosh group.
The mean age was 31 years in Group C and 33 years in Group M, with no statistically significant difference (\(p=0.305\)). Similarly, males constituted 69.7% of Group C and 75.8% of Group M, while females constituted 30.3% and 24.2%, respectively (\(p=0.580\)). These findings indicate that the groups were broadly comparable in terms of age and sex, reducing the likelihood that these baseline characteristics explain the observed differences in haemodynamic response. The procedures performed included arthroscopic ACL reconstruction and laparoscopic appendicectomy (16.7% each), laparoscopic

hernioplasty (16.7%), laparoscopic cholecystectomy (15.2%), functional endoscopic sinus surgery (10.6%), and other elective procedures. This variety reflects the use of both laryngoscopes across different surgical settings, although procedure-specific effects should be considered when interpreting the results.

The haemodynamic response to laryngoscopy and tracheal intubation is caused primarily by sympathetic stimulation following manipulation of the upper airway and passage of the endotracheal tube. The magnitude of this response may be influenced by the force and duration of laryngoscopy, the quality of the glottic view, and the number of attempts required. Video laryngoscopes provide an indirect view of the glottis and may reduce the need for extensive alignment of the oral, pharyngeal, and laryngeal axes. These features may help explain the relatively stable haemodynamic measurements observed in the C-MAC group. Studies comparing video laryngoscopy with direct laryngoscopy have similarly investigated whether improved visualisation and reduced airway manipulation can improve intubation conditions and patient safety.[8,9]

In the present study, the mean heart rate at 1 minute after intubation was 77.2 ± 7.9 beats/min in Group C compared with 95.0 ± 11.3 beats/min in Group M ($p<0.001$). At 3 minutes, the corresponding values were 75.9 ± 7.2 and 89.4 ± 10.9 beats/min ($p<0.001$), while at 5 minutes they were 73.5 ± 8.3 and 81.0 ± 10.5 beats/min ($p=0.002$). These findings suggest a smaller post-intubation heart-rate response with C-MAC. However, the results of studies comparing different video laryngoscopes have not been entirely consistent. Buhari and Selvaraj, in a randomized study of 90 patients comparing Macintosh, McCoy and C-MAC laryngoscopes, reported a significantly higher heart rate in the C-MAC group than in the Macintosh group at 3 minutes, demonstrating that the haemodynamic response may vary with the device, technique and study conditions.[8] Altun and colleagues also compared four laryngoscopes in 160 patients and found that heart rate increased after intubation in the Macintosh and C-MAC groups, while the McGrath group showed less haemodynamic fluctuation.[9] These differences highlight that the benefits of video laryngoscopy should not automatically be assumed to be identical across all devices.

A similar pattern was observed in systolic blood pressure in the present study. The baseline SBP was comparable between Group C (114.3 ± 8.6 mmHg) and Group M (113.9 ± 7.6 mmHg; $p=0.845$). At 1 minute after intubation, SBP increased to 120.0 ± 9.3 mmHg in Group C and 130.5 ± 15.6 mmHg in Group M ($p<0.001$). At 3 minutes, the respective values were 113.2 ± 6.0 and 128.5 ± 13.2 mmHg, and at 5 minutes they were 113.2 ± 8.0 and 125.9 ± 6.8 mmHg, with $p<0.001$ at both time points. The smaller rise in SBP in the C-MAC group is consistent with a potentially less pronounced pressor response in this study. Nevertheless, the findings of Buhari and Selvaraj indicate that C-MAC does not invariably attenuate haemodynamic responses compared with Macintosh laryngoscopy.[8] A randomized trial in patients with predicted difficult airways by Aziz and colleagues found that C-MAC improved first-attempt success and laryngeal visualisation, although the duration of laryngoscopy was longer with C-MAC in that particular setting.[10] Collectively, these findings suggest that haemodynamic outcomes depend not only on the laryngoscope but also on the airway characteristics, operator experience and procedural duration.

The diastolic blood pressure results also favoured Group C, with mean DBP values of 72.2 ± 6.3 mmHg at 1 minute, 72.7 ± 7.8 mmHg at 3 minutes and 70.6 ± 8.2 mmHg at 5 minutes. The corresponding values in Group M were 96.2 ± 9.1, 93.2 ± 8.5 and 91.9 ± 9.5 mmHg, respectively, with reported $p<0.001$ at all three intervals. The magnitude of these between-group differences is substantial and should be verified against the original anaesthesia records and statistical output before the results are finalised. In particular, it is important to confirm that the values and time points have been transcribed correctly and that the statistical analysis is appropriate. The findings should therefore be interpreted cautiously until this verification is complete.

The present study demonstrated a markedly better Cormack–Lehane view with C-MAC: grade I was observed in 32 patients (97.0%) in Group C and 21 patients (63.6%) in Group M, whereas grade II was observed in 1 patient (3.0%) and 12 patients (36.4%), respectively ($p<0.001$). This supports the advantage of video-assisted visualisation of the glottis. Aziz and colleagues similarly reported grade I or II views in 139 of 149 C-MAC attempts compared with 119 of 147 direct-laryngoscopy attempts in patients with predicted difficult airways.[10] Although their population differed from the present study, the improved glottic view is consistent with the visualisation advantage observed here.

The mean intubation time was 20.3 ± 3.6 seconds in Group C compared with 31.2 ± 6.0 seconds in Group M, and this difference was statistically significant ($p<0.001$). A shorter intubation time may reduce the duration of airway stimulation and could partly explain the smaller post-intubation haemodynamic changes observed in Group C. However, this is a possible explanation rather than proof of a causal relationship. Altun and colleagues found significantly shorter intubation times with the McGrath device, while their findings also demonstrated that performance differed among video laryngoscopes.[9] Thus, the time advantage observed in the present study should be interpreted specifically as a result for the C-MAC system and the operators involved.

All 66 patients in the present study were intubated successfully on the first attempt, with 33 successful first attempts in each group. Consequently, no between-group advantage in first-attempt success could be demonstrated in this sample. In contrast, Aziz and colleagues found first-attempt success in 138 of 149 C-MAC attempts (93%) compared with 124 of 147 direct-laryngoscopy attempts (84%) among patients with predicted difficult airways ($p=0.026$).[10] The difference between their findings and ours may reflect the easier airway profile and high success rate in the present elective surgical population. Regarding complications, airway trauma was not observed in Group C, whereas one patient (3.0%) in Group M experienced trauma. Because only one event occurred, this difference is descriptive and does not establish a statistically significant reduction in trauma with C-MAC.

Overall, the findings of this study suggest that C-MAC video laryngoscopy provided better glottic visualisation, shorter

intubation time and smaller measured post-intubation increases in heart rate and systolic blood pressure than Macintosh direct laryngoscopy. These results support the potential utility of C-MAC during elective intubation, but the small sample size, universal first-attempt success and single airway-trauma event limit conclusions regarding uncommon outcomes. The reported diastolic blood pressure differences particularly require source-data verification. Future studies involving larger samples, standardised operator experience and repeated-measures statistical analysis would help establish whether the observed haemodynamic differences are reproducible and clinically meaningful.

Additional evidence from systematic reviews supports the overall advantage of video laryngoscopy for glottic visualisation, although effects on intubation time and haemodynamic parameters vary. The Cochrane review by Lewis and colleagues reported that video laryngoscopy can improve intubation success and reduce failed intubation in selected adult populations.[11] An updated Cochrane review by Hansel and colleagues also concluded that video laryngoscopes generally improve glottic views and first-attempt success, while outcomes differ according to device design and clinical setting.[12] A systematic review specifically evaluating C-MAC against Macintosh laryngoscopy found better glottic visualisation with C-MAC and less need for external laryngeal manipulation, although overall success rates and intubation time did not differ significantly across all included trials.[13] These findings are relevant to the present study, in which C-MAC produced grade I views in 97.0% of patients compared with 63.6% with Macintosh laryngoscopy.

A more recent comparative study involving 180 adults undergoing elective surgery reported a grade I view in 100% of the C-MAC group compared with 41.7% of the Macintosh group, further supporting the visualisation advantage of C-MAC.[14] However, intubation time is not consistently shorter with every video laryngoscope or in every clinical setting. In a randomized study of patients requiring double-lumen tube insertion for thoracic surgery, the mean intubation times were similar between C-MAC and Macintosh laryngoscopy, despite better laryngoscopic views with C-MAC.[15] Another randomized comparison of C-MAC D-blade and Macintosh laryngoscopy for double-lumen tube insertion also reported comparable intubation times, while some complications were more frequent in the Macintosh group.[16] These results emphasise that device performance may be influenced by tube type, blade design and the complexity of airway instrumentation.

Evidence from other clinical settings further demonstrates that improved glottic visualisation does not invariably translate into shorter intubation time or a smaller haemodynamic response. A randomized study comparing C-MAC with Macintosh laryngoscopy for double-lumen tube placement reported improved laryngoscopic grades and less need for additional laryngeal pressure with C-MAC, but no significant difference in the time required for intubation.[17] Similarly, a randomized trial of Macintosh and C-MAC D-blade laryngoscopy in the lateral position found no statistically significant difference in glottic visualisation time or intubation time between the two devices.[18] Therefore, the shorter intubation time observed in the present study is encouraging but should be considered specific to the study population, device configuration and operator technique.

CONCLUSION

We hereby document that laryngoscopy performed with CMAC video laryngoscope triggered lesser hemodynamic stress responses, offered better laryngoscopic views, lesser time to intubate and less incidence of trauma.

We thus recommend the employment of CMAC video laryngoscope for laryngoscopy not only in normal patients with a good glottic view but also in patients with Systemic hypertension, cardiac diseases, cerebrovascular accidents where CMAC video laryngoscope would aid in reducing hemodynamic stress responses to laryngoscopy.

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