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HAEMODYNAMIC CHANGES DURING LARYNGOSCOPY: A CLINICAL REVIEW AND OBSERVATIONAL ANALYSIS

Anaesthesiology

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ABSTRACT

Background: Laryngoscopy and tracheal intubation often trigger a strong sympathoadrenal response, causing marked rises in heart rate and blood pressure, which in high-risk patients may lead to serious cardiovascular events. Video laryngoscopes like the C-MAC can minimise airway manipulation and potentially blunt these haemodynamic surges compared to the Macintosh blade. **Objectives:** To compare haemodynamic responses to C-MAC and Macintosh laryngoscopes during elective surgery. **Methods:** This clinical review and observational analysis included 100 adult patients, randomly assigned to C-MAC (Group A, n=50) or Macintosh (Group B, n=50). HR, systolic BP (SBP), diastolic BP (DBP), and mean arterial pressure (MAP) were recorded at baseline, pre-laryngoscopy, during laryngoscopy, during intubation, and at 1, 2, 3, 4, and 5 minutes post-intubation. Data were analysed using appropriate statistical tests, with $p<0.05$ considered significant. **Results:** Demographic and baseline haemodynamic parameters were comparable between groups ($p>0.05$). During laryngoscopy and intubation, Group B exhibited significantly higher HR and MAP at all measured intervals compared to Group A ($p<0.05$ to $p<0.01$). The greatest surges occurred during laryngoscopy and at 1 minute post-intubation, with C-MAC demonstrating consistently attenuated cardiovascular responses. **Conclusion:** C-MAC videolaryngoscopy significantly reduces haemodynamic surges associated with laryngoscopy and intubation compared to the Macintosh blade. However, patient characteristics, anaesthetic depth, and operator technique remain influential factors.

KEYWORDS

Laryngoscopy; Video Laryngoscope; C-MAC; Macintosh; Haemodynamic Response

INTRODUCTION

Laryngoscopy and tracheal intubation are vital procedures but provoke a pronounced sympathoadrenal response, triggering rapid rises in heart rate, systolic/diastolic blood pressure, and mean arterial pressure. These changes typically last a few minutes but substantially raise the risk of myocardial ischemia, arrhythmia, or stroke—especially in patients with hypertension, coronary artery disease, or raised intracranial pressure (1,2). Globally, millions of laryngoscopies are performed annually. In India, rising cardiovascular comorbidity magnifies peri-intubation risk. Innovations like video laryngoscopes (e.g., C-MAC) promise improved glottic views and reduced force, possibly blunting haemodynamic reflexes (3,4). Recent clinical findings highlight the ongoing debate over the influence of device choice on haemodynamic stability during laryngoscopy (5,6). Trials over the past three years have reported varied outcomes, with some demonstrating better cardiovascular control through specific drugs or alternative laryngoscope designs, while others found no measurable difference when anaesthetic depth and technique were standardised (7,8). Notably, recent evidence suggests that factors beyond equipment selection—such as pharmacological strategy, patient condition, and operator expertise—may play a decisive role in determining the magnitude of the pressor response during intubation (3). This study aimed to evaluate whether advancements in laryngoscope technology contribute to better haemodynamic stability during intubation or if patient and procedural factors remain more influential. It adopts a dual approach: a focused review of recent literature on haemodynamic responses during laryngoscopy, emphasising comparisons between different laryngoscope designs, and an observational analysis comparing Macintosh and C-MAC blades. Heart rate, blood pressure, and mean arterial pressure were measured at defined intervals before, during, and after intubation, integrating published evidence with clinical data to draw meaningful conclusions.

MATERIALS AND METHODS

Study Design

The study design was a clinical review and observational analysis aimed at evaluating haemodynamic changes during laryngoscopy and comparing the responses between Macintosh and C-MAC laryngoscopes.

Clinical Review

A literature search was carried out in PubMed, Scopus, Web of Science, and Google Scholar for articles published from January 2022 to March 2025. The search terms included haemodynamic changes, laryngoscopy, video laryngoscope, Macintosh, and C-MAC.

Inclusion Criteria

- Adult patients undergoing laryngoscopy and intubation
- Documentation of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP)
- Randomised controlled trials, observational studies, and meta-analyses in peer-reviewed journals

Exclusion Criteria

- Paediatric studies
- Case reports, editorials, and conference abstracts

Observational Analysis

Participants

Adult patients (≥18 years) of ASA physical status I–II undergoing elective surgery under general anaesthesia were enrolled after preoperative evaluation. Exclusion criteria included anticipated difficult airway, more than two intubation attempts, uncontrolled systemic disease, or airway trauma during the procedure.

Grouping

Patients were randomly assigned to:
- **Group A:** C-MAC video laryngoscope
- **Group B:** Macintosh direct laryngoscope

Anaesthetic Protocol

All patients fasted for at least 8 hours. Standard monitoring (ECG, SpO_2, and NIBP) was applied. Premedication included an anticholinergic and an opioid. Following preoxygenation for 3 minutes, anaesthesia was induced with an intravenous hypnotic agent and muscle relaxation achieved with a non-depolarising neuromuscular blocker. Anaesthesia was maintained with oxygen, nitrous oxide, and a volatile anaesthetic agent.

Measurements

Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at:
- Baseline (pre-induction)
- Before laryngoscopy
- During laryngoscopy
- During intubation
- 1, 2, 3, 4, and 5 minutes post-intubation

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Student's t-test or Mann–Whitney U test was used for continuous data, and Chisquare or Fisher's exact test for categorical data. A p-value <0.05 was considered statistically significant.

RESULTS

In the current study, the demographic characteristics of both groups were comparable, with no statistically significant differences in age, gender distribution, weight, ASA physical status, or Mallampati classification (p>0.05 for all parameters). This indicates that both groups were well matched at baseline, minimising the influence of demographic variability on the observed haemodynamic responses (see Table 1).

Table 1: Demographic Characteristics of the Study Population

Variable	Parameter	Group A: C-MAC (n=50)	Group B: Macintosh (n=50)	p value
Age (years)	Mean ± SD	41.8 ± 10.4	42.6 ± 9.8	0.68
Gender	Male	28	30	0.68
	Female	22	20	
Weight (kg)	Mean ± SD	66.2 ± 8.9	67.0 ± 9.2	0.62
ASA	I	32	34	0.68
	II	18	16	
Mallampati	I	29	27	0.69
	II	21	23	

At baseline, prior to induction, both groups had similar HR, SBP, DBP, and MAP values, with no statistically significant differences (p>0.05). This suggests a uniform pre-anaesthetic cardiovascular status, providing a valid basis for subsequent haemodynamic comparison during airway manipulation (see Table 2).

Table 2: Baseline Haemodynamic Parameters

Parameter	Group A: C-MAC Mean ± SD	Group B: Macintosh Mean ± SD	p value
Baseline HR (bpm)	78.4 ± 6.5	78.8 ± 6.2	0.78
Baseline SBP (mmHg)	122.6 ± 7.8	123.2 ± 7.5	0.70
Baseline DBP (mmHg)	77.2 ± 6.3	77.5 ± 6.1	0.81
Baseline MAP (mmHg)	92.3 ± 5.4	92.7 ± 5.2	0.74

Immediately before laryngoscopy, haemodynamic parameters (HR, SBP, DBP, MAP) remained comparable between groups (p>0.05). This confirms that any differences observed during and after laryngoscopy were unlikely to be influenced by pre-existing disparities in cardiovascular variables (see Table 3).

Table 3: Pre-Laryngoscopy Haemodynamic Parameters

Parameter	Group A: C-MAC Mean ± SD	Group B: Macintosh Mean ± SD	p value
Pre-laryngoscopy HR	80.5 ± 6.8	81.2 ± 6.5	0.59
Pre-laryngoscopy SBP	124.4 ± 8.1	125.1 ± 7.9	0.66
Pre-laryngoscopy DBP	78.5 ± 6.5	78.9 ± 6.4	0.72
Pre-laryngoscopy MAP	93.5 ± 5.6	94.0 ± 5.5	0.64

During laryngoscopy and intubation, Group B (Macintosh) exhibited significantly higher HR and MAP values compared to Group A (C-MAC) at all measured intervals (p<0.05 to p<0.01). The most pronounced haemodynamic surges occurred during laryngoscopy and within the first minute after intubation, with the C-MAC consistently demonstrating attenuated cardiovascular responses. These differences persisted for up to 5 minutes post-intubation, although the magnitude decreased over time. This pattern suggests that the C-MAC laryngoscope may be associated with reduced sympathetic stimulation compared to the Macintosh blade (see Table 4).

Table 4: Haemodynamic Changes During and After Laryngoscopy

Time Interval		HR – C-MAC Mean ± SD	HR – Macintosh Mean ± SD	p (HR)	MAP – C-MAC Mean ± SD	MAP – Macintosh Mean ± SD	p (MAP)
During Laryngoscopy		92.4 ± 7.2	96.8 ± 7.5	0.001**	104.5 ± 6.8	109.2 ± 6.9	0.001**
During Intubation		94.1 ± 7.4	98.6 ± 7.8	0.002**	106.2 ± 6.9	110.5 ± 7.1	0.001**
Post-intubation	1 min	91.8 ± 7.1	96.0 ± 7.3	0.003**	103.0 ± 6.7	107.4 ± 6.8	0.002**
	2 min	88.4 ± 6.9	92.2 ± 7.0	0.005**	100.1 ± 6.5	103.8 ± 6.6	0.004**
	3 min	84.9 ± 6.7	88.1 ± 6.8	0.006**	96.5 ± 6.3	99.2 ± 6.4	0.007**
	4 min	82.2 ± 6.5	85.0 ± 6.6	0.009**	94.0 ± 6.1	96.3 ± 6.2	0.011*
	5 min	80.1 ± 6.3	82.6 ± 6.4	0.015*	92.4 ± 5.9	94.5 ± 6.0	0.018*

*Significant at p<0.05, **Highly significant at p<0.01

DISCUSSION

In the current study, the demographic characteristics between the C-MAC and Macintosh groups were comparable, with no statistically significant differences in age, gender, weight, ASA status, or Mallampati classification (p>0.05 for all variables) (see Table 1). This matching minimises potential confounding and ensures that observed haemodynamic changes can be more reliably attributed to laryngoscope type rather than baseline variability. Similar baseline comparability in demographic data has been reported by Kumari et al.(7), Rajasekhar et al. (9), and Aggarwal et al.(10), where no significant difference in age, weight, or ASA class was found between C-MAC and Macintosh groups, allowing for valid intergroup haemodynamic comparison. Likewise, Paul and Nathroy (11) and Chandra et al. (12) demonstrated demographic parity, reinforcing that uniform patient distribution strengthens study validity. In contrast, Mogahed et al. (13) reported a slight but statistically significant weight difference between groups, which they acknowledged could influence haemodynamic variability.

At baseline, both groups in our study exhibited similar HR, SBP, DBP, and MAP values (p>0.05), confirming uniform pre-anaesthetic cardiovascular status (see Table 2). This finding aligns with the results of Kumari et al. (7), Rajasekhar et al. (9), and Aggarwal et al. (10) where baseline haemodynamic parameters did not differ significantly between Macintosh and C-MAC groups. Similarly, Chandra et al. (12) found no variation in pre-induction haemodynamic status, underscoring effective randomisation and anaesthetic standardisation. Conversely, Mogahed et al. (13) noted slightly higher baseline HR in their Macintosh group, which they attributed to preoperative anxiety and varying induction times.

Immediately prior to laryngoscopy, haemodynamic parameters remained statistically comparable between groups (see Table 3). This suggests that differences observed later were a direct consequence of laryngoscopy and intubation rather than pre-existing instability. This stability before airway manipulation is consistent with findings from Kumari et al. (7), Rajasekhar et al. (9), and Aggarwal et al. (10), all of whom reported no significant intergroup variation in pre-laryngoscopy haemodynamic measurements. Paul and Nathroy (11) also demonstrated similar values before laryngoscopy, supporting the view that device-induced differences manifest during active airway manipulation. However, in the study by Mogahed et al. (13), minor but statistically significant increases in HR were noted in the Macintosh group before laryngoscopy, possibly due to delayed instrumentation.

During laryngoscopy and intubation, our study found that Group B (Macintosh) exhibited significantly higher HR and MAP values at all intervals from laryngoscopy until five minutes post-intubation (p<0.05 to p<0.01), with the greatest surges during laryngoscopy and within the first minute thereafter (see Table 4). The C-MAC consistently attenuated these responses, suggesting reduced sympathetic stimulation. These findings are in agreement with Aggarwal et al. (10), who demonstrated significantly lower HR and MAP with C-MAC compared to Macintosh during laryngoscopy and intubation. Kumari et al. (7) and Rajasekhar et al. (9) similarly reported blunted cardiovascular responses with video laryngoscopes, attributing the effect to improved glottic visualisation and reduced lifting force on airway structures. Chandra et al. (12) also found reduced pressor responses with C-MAC, particularly in the first two minutes post-intubation.

In contrast, Mogahed et al. (13) and Haidry and Khan (14) found no significant difference in haemodynamic surges between C-MAC and Macintosh when anaesthetic depth was carefully standardised, indicating that anaesthetic management may modulate device-related differences. Similarly, McCoy et al.^19 reported that device type was less influential than factors such as intubation duration, operator skill, and patient airway anatomy.

CONCLUSION

C-MAC videolaryngoscopy attenuates haemodynamic responses to laryngoscopy and intubation more effectively than the Macintosh blade, particularly in the immediate post-intubation period. Although the differences were statistically significant, they were influenced by patient, procedural, and anaesthetic variables. Meticulous standardisation of technique and anaesthesia remains critical in minimising pressor responses, regardless of the device used.

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