

Comparative evaluation of hemodynamic responses to laryngoscopy and endotracheal intubation using Macintosh, McCoy, and C-MAC laryngoscopes in adult patients undergoing general anaesthesia

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Abstract:

Background: Laryngoscopy and endotracheal intubation provoke significant hemodynamic changes due to sympathetic stimulation. Various laryngoscopes, such as Macintosh, McCoy, and C-MAC, differ in design and degree of glottic stimulation, influencing cardiovascular responses.

Aim: To compare the hemodynamic responses to laryngoscopy and intubation using Macintosh, McCoy, and C-MAC laryngoscopes in adult patients undergoing elective surgeries under general anaesthesia.

Methods: This randomized, single-blinded study was conducted on 120 ASA I–II adults (aged 18–60 years) undergoing elective surgeries at GSL Medical College, Andhra Pradesh. Participants were divided into three groups (n=40 each): Group A – Macintosh, Group B – McCoy, and Group C – C-MAC. Standard induction agents were used, and hemodynamic parameters heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at baseline, before intubation, and 1, 3, 5, and 10 minutes after intubation. Data were analyzed using SPSS v21.0; $p < 0.05$ was considered significant.

Results: All groups showed transient hemodynamic increases post-intubation, most pronounced with Macintosh and least with C-MAC. The McCoy group demonstrated intermediate values. C-MAC produced significantly lower rises in heart rate and blood pressure ($p < 0.001$).

Conclusion: C-MAC video laryngoscope provides superior hemodynamic stability compared with Macintosh and McCoy laryngoscopes during intubation.

Keywords: Hemodynamic response; Laryngoscopy; Endotracheal intubation; McCoy; C-MAC.

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Introduction

Endotracheal intubation (ETI) remains the gold standard for airway management during general anaesthesia and critical care, providing airway protection, relief of obstruction and prevention of aspiration. The process of laryngoscopy and intubation (L&I) is widely recognised to elicit a pronounced hemodynamic response, characterised by tachycardia, hypertension, arrhythmias and even major cardiovascular or cerebrovascular events in at-risk patients. This reflexive surge is mediated through the hypothalamo–pituitary–adrenocortical (HPA) axis and the sympatho-adreno-medullary (SAM) system, leading to release of catecholamines and cortisol. Since the early description of this pressor response in 1977, the anaesthesia

community has sought techniques to attenuate this response safely [1].

Historically, the conventional Macintosh laryngoscope blade remained the standard for direct laryngoscopy. With the advent of the McCoy laryngoscope (lever-blade modification) and the indirect-laryngoscopy video device C-MAC video laryngoscope, newer opportunities to reduce force on the glottic structures have emerged. Studies comparing these blades suggest that reduced mechanical stimulation may lessen the hemodynamic stress. For example, in a randomized study of 150 adults, the McCoy blade produced markedly less hemodynamic alteration compared to Macintosh and C-MAC devices [2].

However, other investigations show comparable responses between Macintosh and C-MAC in normal airways [3], and reviews suggest haemodynamic response remains substantial regardless of blade type [4]. Given the relative paucity of studies directly comparing all three devices under uniform conditions, our study aims to evaluate the hemodynamic responses systolic and diastolic blood pressure, mean arterial pressure and heart rate associated with Macintosh, McCoy and C-MAC laryngoscopy in adult elective surgery patients undergoing general anaesthesia and oral endotracheal intubation.

Methods

This randomized, single-blinded study was conducted in the department of Anesthesiology, GSL Medical College; after obtaining approval from the Institutional Ethics Committee. The study period extended over 16 months, from October 2024 to January 2026. Adult patients aged between 18 and 60 years, classified as ASA I or II and scheduled for elective surgeries under general anaesthesia requiring endotracheal intubation, were enrolled after obtaining informed consent. Both male and female patients were included. Exclusion criteria comprised patients with incomplete data, acute systemic illnesses such as cardiac, pulmonary, hepatic, or renal disease, malignancy, emergency surgeries, airway abnormalities, or anticipated difficult intubation. Patients requiring more than one intubation attempt or laryngoscopy lasting more than 30 seconds were also excluded. Exclusion criteria were verified using patient history and previous medical records.

Eligible participants were randomly allocated into three equal groups ($n = 40$ each) using the shuffled opaque sealed-envelope method to ensure allocation concealment. Randomization lots were labelled Group A, Group B, and Group C, corresponding to the Macintosh, McCoy, and C-MAC laryngoscopes respectively. The study was single-blinded patients were unaware of the device used, while the investigator performing intubation knew the laryngoscope type. Blinded studies were chosen to enhance objectivity and scientific validity. Group A patients underwent laryngoscopy with a Macintosh blade size 3, serving as the control group. Group B patients were intubated with a McCoy laryngoscope (size 3), and Group C with a C-MAC video laryngoscope (D-blade). All intubations were performed by the same experienced anaesthesiologist to avoid inter-operator variability.

Premedication consisted of diazepam 5 mg orally the night before surgery. In the operating room, patients were pre-oxygenated with 100% oxygen for 3 minutes and connected to non-invasive monitors for continuous pulse rate and blood pressure measurements. Anaesthesia was induced using

midazolam 1 mg IV, fentanyl 2 $\mu\text{g}/\text{kg}$ IV, thiopentone 5 mg/kg IV, and maintained with isoflurane 2%. After confirming adequate mask ventilation, vecuronium 0.1 mg/kg IV was administered to facilitate muscle relaxation. Laryngoscopy and intubation were performed at the end of 3 minutes following vecuronium administration using the assigned laryngoscope. Endotracheal tube sizes were standardized 7.5 mm for males and 6.5 mm for females. End-tidal carbon dioxide (EtCO_2) was maintained around 40 mm Hg to avoid hyperventilation, and no additional drugs or procedures were performed during the 10-minute data-collection period following intubation.

Demographic data (age, sex, BMI, ASA grade) and clinical parameters systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and heart rate (HR) were recorded at baseline, before intubation, and 1, 3, 5, and 10 minutes post-intubation. The duration of laryngoscopy and any side effects were documented. Data were compiled in Microsoft Excel and analyzed using SPSS version 21.0. Continuous variables were expressed as mean \pm standard deviation, categorical variables as frequencies and percentages. Statistical comparisons were made using one-way ANOVA and paired t-tests where appropriate, with $p < 0.05$ considered statistically significant.

Results:

A total of 120 adult patients were successfully enrolled and analyzed 40 in each group. The three groups were comparable regarding demographic characteristics such as age, sex, BMI, and ASA physical status ($p > 0.05$), ensuring baseline homogeneity. Hemodynamic responses to laryngoscopy and intubation differed significantly among the devices. Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) increased markedly in all groups following intubation; however, the magnitude of rise was least with the C-MAC video laryngoscope and greatest with the conventional Macintosh blade.

At 1 minute post-intubation, mean heart rate increased by 36.3% in the Macintosh group, 22.3% with McCoy, and only 13.2% with C-MAC ($p < 0.001$). Similarly, SBP and MAP elevations were significantly lower in C-MAC compared to McCoy and Macintosh groups ($p < 0.001$). Hemodynamic values gradually returned toward baseline within 5–10 minutes in all groups. The McCoy laryngoscope demonstrated an intermediate attenuation effect, attributed to its hinged tip minimizing upward lifting force. C-MAC laryngoscope showed the least hemodynamic disturbance due to reduced mechanical stimulation and better glottic visualization. No adverse events such as

arrhythmias, desaturation, or airway trauma were recorded in any patient.

Discussion

The demographic distribution shows no statistically significant differences between the three groups in terms of age, gender, BMI and ASA physical status, suggesting a well-balanced randomization and comparable baseline populations. This is important, because when baseline characteristics are similar across intervention groups, observed differences in outcomes (here, haemodynamic responses) are more likely attributable to the interventions rather than to underlying patient differences. Several prior studies emphasise the necessity of comparable groups to reduce confounding: for example, in the study by Lakhe et al., baseline demographics were reported as similar in patients undergoing laryngoscopy/intubation [5]. Similarly, Gavrilovska-Brzanov et al. reported no differences in demographic or airway evaluation parameters between groups in their intubation haemodynamic response trial [6]. The reporting of age, sex, BMI and ASA class is standard practice and enables readers to judge external validity and applicability of findings. Furthermore, some authors have linked demographic variables—such as advancing age or higher BMI—with greater sympathetic responses during intubation, so ensuring balance prevents these becoming confounders [7]. In the present study the close matching of demographic factors strengthens the internal validity of the comparisons between the blade/laryngoscope groups, meaning the observed haemodynamic differences are less likely to be influenced by baseline patient-characteristic differences.

The HR data depict a clear and expected pattern of sympathetic activation following laryngoscopy and endotracheal intubation. All three groups began with comparable baseline HRs, thereby providing a reliable starting point for observing procedural impact. The rise in HR at 1-minute post-intubation was greatest in Group A and lower in Groups B and C suggesting that the choice of laryngoscope blade and the resulting force exerted during airway manipulation can influence autonomic responses. This aligns with earlier findings showing that direct laryngoscopy exerts significant hemodynamic stress due to mechanical lifting of the epiglottis and tongue base, with documented HR rises of ~20–27 % and BP increases of ~30–50 % [5]. The subsequent measurements at 3 min and 5 min demonstrate a gradual decline toward baseline, yet the Macintosh group retains higher HR values longer than the other groups. This temporal profile is consistent with studies which demonstrate that the magnitude and duration of tachycardia after intubation correlate with the mechanical stimulus applied [4, 5]. In the McCoy and C-MAC groups, the attenuated HR rise likely reflects reduced

upward lifting force and less pharyngo-laryngeal pressure during glottic exposure a concept supported by literature wherein devices designed to minimise blade lifting or indirect visualization result in blunted hemodynamic responses [8]. Clinically, the differences in HR response among laryngoscope types in this table suggest that selecting a device that minimises mechanical stimulation may contribute to better cardiovascular stability, particularly in patients with limited cardiac reserve.

The SBP data demonstrate a distinct, graded pressor response across the three laryngoscope groups, with the greatest increase seen in the Macintosh group, intermediate in the McCoy group, and lowest in the C-MAC video laryngoscope group. The comparable baseline SBP values across all groups confirm successful randomization and comparability of the cohorts, thereby enabling attribution of SBP variations primarily to the device used rather than underlying patient differences. The one-minute peak SBP elevation aligns with physiologic understanding that the stimulation of laryngoscopy and tube passage produces a sympathetic surge mediated via the hypothalamic–pituitary–adrenocortical and sympathoadreno-medullary axes [9, 10].

Notably, the slower return toward baseline in the Macintosh group suggests that more aggressive mechanical lifting force and longer duration of glottic exposure may sustain the sympathetic response. This is consistent with meta-analytic data showing that devices which reduce the upward lifting force or shorten laryngoscopy time — such as the Airway Scope compared to Macintosh — achieved significantly less MBP increase at 60 seconds after intubation (weighted mean difference ~–11.5 mmHg) in pooled trials [11]. In addition, a recent comparative study found that the McCoy blade induced significantly smaller SBP rises than Macintosh (e.g., 10.3% vs 22.9% in one series) when used for laryngoscopy, supporting the notion that modifications to the blade tip reduce haemodynamic stress [12].

The MAP changes across the three laryngoscope groups showed several important observations arise. First, the baseline MAP values are comparable among the groups, indicating successful randomization and a fair starting point for comparison. Following laryngoscopy and intubation, the MAP in Group A shows the highest rise at 1 minute post-intubation, followed by Group B, with Group C showing the smallest increase. This gradation suggests that the device used influences the magnitude of sympathetic-adrenergic activation following airway manipulation. The peak response at 1 minute is consistent with known physiology — arterial pressure elevations begin within seconds of glottic manipulation, peak around 1-2 minutes, and tend to decline by 3-5 minutes [13]. Additionally,

the return of MAP values toward baseline by the 5-10 minute mark reflects the transient nature of the pressor response, as corroborated in prior reports [5].

The smaller MAP rise seen with McCoy and especially C-MAC may relate to reduced mechanical stress on oropharyngeal and glottic structures less lifting force or indirect visualization may limit afferent vagosympathetic stimulation and thus blunt the haemodynamic surge. Supporting this, a study showed that shorter intubation time and decreased mechanical lift correlate with lower MAP changes [14]. Clinically, for patients with cardiovascular comorbidities, such attenuated MAP responses may translate into lower risk of complications like myocardial ischaemia or intracranial bleeding triggered by marked pressure surges. One recent study of hypertensive patients confirmed that video-laryngoscopes produced significantly lower MAP responses versus Macintosh in that high-risk cohort [15].

Conclusion: The present randomized single-blinded study demonstrated that the type of laryngoscope significantly influences the hemodynamic response during laryngoscopy and endotracheal intubation. Among the three devices compared, the C-MAC video laryngoscope produced the least elevation in heart rate, systolic, diastolic, and mean arterial pressures, followed by the McCoy and Macintosh laryngoscopes. This attenuation is attributed to reduced mechanical stimulation and improved glottic visualization. Therefore, C-MAC video laryngoscope offers superior cardiovascular stability and may be preferred in patients at risk of exaggerated pressor responses, particularly those with hypertension, coronary artery disease, or cerebrovascular comorbidities undergoing elective general anesthesia.

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