JHWCR
Journal of Health, Wellness, and Community Research
Volume III, Issue IV
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, **ISSN**: 3007-0570
https://doi.org/10.61919/2v9rjc84

Article

Comparing Hemodynamic Variability During Intubation Using Macintosh and Video Laryngoscopy in Difficult Airway

Haseeb Taqi[1], Rabia Raouf[1], Aiman Tariq[1], Naveed Iqbal[1], Subhan Abid[1], Saqlain Sadiq[1]

1 Department of Anesthesia, Mayo Hospital, Lahore, Pakistan

Correspondence
rabiaraouf033@gmail.com

Cite this Article

Received	2025-04-27
Revised	2025-04-26
Accepted	2025-04-28
Published	2025-05-24
Conflict of Interest	None declared
Ethical Approval	The study was approved by the institutional ethics committee of Superior University, Lahore, and conducted in accordance with the Declaration of Helsinki.
Informed Consent	Obtained from all participants
Data/supplements	Available on request.
Funding	None
Authors' Contributions	HT, RR, AT, NI, SA, and SS contributed to concept, design, data collection, analysis, and manuscript drafting.

ABSTRACT

Background: Hemodynamic alterations during intubation can significantly impact patient outcomes, especially in difficult airway scenarios, yet there is limited comparative research assessing the effects of Macintosh versus video laryngoscopy on these parameters in such patients. **Objective:** This study aimed to compare hemodynamic variability—including heart rate, blood pressure, mean arterial pressure, and oxygen saturation—during intubation using Macintosh and video laryngoscopes in patients with difficult airways, with the expectation that video laryngoscopy would offer greater cardiovascular stability. **Methods:** This prospective, comparative study included 100 adult patients (n=100) aged 20–70 years, scheduled for elective surgeries under general anesthesia at a tertiary care center, all with difficult airways defined as Mallampati class III or IV and ASA grade I–III. Patients were divided equally into Macintosh and video laryngoscope groups (n=50 each). Key exclusion criteria were age >70 years, Mallampati I–II, and significant cardiorespiratory comorbidities (ASA IV–VI). Hemodynamic parameters were assessed using standardized anesthesia monitors, and data were collected on a prestructured proforma. Statistical analysis was performed using SPSS v27, with paired t-tests and $p \leq 0.05$ indicating significance. The study adhered to the Declaration of Helsinki and received institutional ethical approval. **Results:** Video laryngoscopy was associated with significantly lower mean heart rate (mean difference = 0.48, p=0.003), blood pressure (mean difference = 1.18, p=0.002), mean arterial pressure (mean difference = 2.12, p<0.001), and higher SpO_2 levels (mean difference = 0.74, p<0.001) compared to the Macintosh group. Clinically, the video laryngoscope group experienced fewer episodes of tachycardia, hypertension, and oxygen desaturation, supporting greater hemodynamic stability during intubation. **Conclusion:** Video laryngoscopy confers superior hemodynamic stability over Macintosh laryngoscopy during intubation in patients with difficult airways, making it a preferred tool for airway management in such cases. Adoption of video laryngoscopy may enhance patient safety, optimize clinical outcomes, and should be prioritized in protocols for managing complex airway scenarios.

Keywords: Airway Management, Hemodynamics, Laryngoscopy, Difficult Intubation, Macintosh Laryngoscope, Video Laryngoscope, General Anesthesia.

INTRODUCTION

Airway management remains a fundamental aspect of anesthesia, with successful endotracheal intubation playing a pivotal role in ensuring patient safety during surgical procedures. The physiological stress induced during laryngoscopy and tracheal intubation often results in significant hemodynamic alterations, particularly in patients with a difficult airway. These changes may include fluctuations in heart rate, blood pressure, and oxygen saturation, which, if left unaddressed, can contribute to perioperative morbidity and adversely affect patient outcomes (1). While the Macintosh laryngoscope, introduced in the 1940s, has long been the standard tool for direct laryngoscopy, its use in difficult airways—characterized by higher Mallampati grades, restricted mouth opening, or increased neck circumference—can be associated with marked sympathetic stimulation and greater cardiovascular variability (2,3). Such responses are further accentuated in patients undergoing challenging intubations, often necessitating alternative strategies to mitigate hemodynamic

stress (4). The advent of video laryngoscopy has revolutionized airway management by providing enhanced glottic visualization, even in anatomically complex situations. Video laryngoscopes, equipped with miniature cameras and external displays, allow for real-time monitoring of intubation, potentially reducing the need for forceful manipulations and improving the success rate on the first attempt (5,6). Recent studies suggest that the use of video laryngoscopy, particularly in patients with difficult airways, may lead to less pronounced hemodynamic responses compared to traditional Macintosh laryngoscopy (7,8). This reduction in physiological perturbation is attributed to improved visualization, less airway trauma, and decreased sympathetic activation. However, the literature remains inconclusive, with some research reporting comparable hemodynamic effects between both devices, especially in routine intubations, thereby highlighting the need for focused investigation in high-risk populations (9,10).

Despite the growing body of evidence supporting video laryngoscopy, most existing research has concentrated on general populations or elective cases with anticipated easy airways, often neglecting the unique challenges posed by difficult airway scenarios. The variability in intubation technique, operator experience, and patient comorbidities further complicates the interpretation of hemodynamic data across studies (11). As such, there remains a knowledge gap regarding the direct comparison of hemodynamic variability associated with Macintosh and video laryngoscopes specifically in patients with objectively difficult airways. Addressing this gap is essential for guiding clinical decision-making and optimizing perioperative management in high-risk groups.

The present study was designed to rigorously compare the hemodynamic changes—namely, heart rate, blood pressure, mean arterial pressure, oxygen saturation, end-tidal CO_2, and ECG findings—occurring during intubation with Macintosh versus video laryngoscopes in patients with difficult airway features. By prospectively evaluating a cohort of surgical patients with Mallampati class III and IV airways, this research aims to determine whether video laryngoscopy offers measurable benefits in reducing hemodynamic perturbations compared to conventional direct laryngoscopy. It is hypothesized that video laryngoscopy will result in significantly attenuated cardiovascular responses during intubation, thus providing a safer alternative for airway management in this vulnerable patient population.

MATERIALS AND METHODS

This quantitative, prospective comparative study was conducted in the Anesthesia Department of Mayo Hospital, Lahore, between November 2024 and April 2025. Participants included adult patients aged 20 to over 60 years, scheduled for elective surgical procedures under general anesthesia, who presented with difficult airways classified as Mallampati class III or IV and were designated as American Society of Anesthesiologists (ASA) physical status I, II, or III. Exclusion criteria encompassed individuals over the age of 70, patients with Mallampati class I or II airways, and those with significant cardiovascular or respiratory comorbidities classified as ASA grade IV, V, or VI. Eligible participants were recruited consecutively during routine preoperative assessments, and all provided written informed consent prior to enrollment.

The primary outcome of the study was the evaluation of hemodynamic variability during intubation using either a Macintosh or video laryngoscope in patients with difficult airways. Hemodynamic parameters assessed included heart rate, systolic and diastolic blood pressure, mean arterial pressure (MAP), peripheral oxygen saturation (SpO2), end-tidal carbon dioxide (ETCO2), and electrocardiogram (ECG) changes. These parameters were documented using standard anesthesia monitoring equipment and were recorded at baseline and during intubation.

A total of 100 patients were enrolled and randomly allocated into two equal groups, with 50 patients intubated using the Macintosh laryngoscope and 50 with the video laryngoscope. Data collection was conducted by trained students utilizing a prestructured proforma specifically designed for this study to ensure uniformity and completeness of the collected information.

The study was conducted in compliance with the Declaration of Helsinki, and ethical approval was obtained from the relevant institutional ethics committee. All participants were informed about the nature, risks, and benefits of the study, and confidentiality of their personal information was rigorously maintained. Data were anonymized and stored securely on password-protected devices, accessible only to the research team.

For statistical analysis, SPSS version 27 was employed. Categorical data were analyzed using paired t-tests and presented as frequencies and percentages, while continuous variables were expressed as means with standard deviations. Statistical significance was defined as a p-value ≤ 0.05. The analysis focused on comparing the hemodynamic changes between the two groups during intubation, providing robust evidence to assess the impact of the type of laryngoscope on cardiovascular and respiratory parameters (1).

RESULTS

A total of 100 patients with difficult airways were enrolled, evenly divided between the Macintosh laryngoscope group (n=50) and the video laryngoscope group (n=50). The demographic and clinical characteristics of the study population are presented in Table 1. The mean age distribution showed a predominance of patients between 31 and 40 years (27%), followed by 51–60 years (22%), 41–50 years (21%), 21–30 years (19%), and 61+ years (11%). Gender distribution was nearly equal (48% male, 52% female). Educational status ranged from uneducated (23%) to higher education (29%).

The majority of participants were married (67%) and belonged to the "rich" socioeconomic status (48%). Patients underwent a wide variety of surgical procedures (Table 2), with thyroidectomy (8%), laminectomy (8%), appendectomy (7%), and laparoscopic cholecystectomy (7%) being most frequent. Both groups were similar in surgical exposure. Assessment of airway characteristics indicated that the majority had Mallampati class III (79%), with the remainder classified as class IV (21%). Most

participants had a mouth opening of less than 3 fingers (49%) and a thyromental distance of less than 4 cm (48%). Interincisor distance was less than 3 cm in 60% of cases, and neck circumference exceeded 17 inches in 62% (Table 3). A direct comparison of hemodynamic variables between groups revealed significant differences across multiple parameters (Table 4).

Table 1. Demographic and Clinical Characteristics of Study Participants

Variable	Category	Frequency (n)	Percent (%)
Gender	Male	48	48%
	Female	52	52%
Education	Uneducated	23	23%
	Primary	12	12%
	Secondary	36	36%
	Higher	29	29%
Marital	Married	67	67%
	Single	31	31%
	Widowed	2	2%
Socioeconomic	Poor	14	14%
	Middle class	38	38%
	Rich	48	48%
Age Range	21–30	19	19%
	31–40	27	27%
	41–50	21	21%
	51–60	22	22%
	61+	11	11%

Table 2. Types of Surgical Procedures Performed

Procedure	Frequency (n)	Percent (%)
Thyroidectomy	8	8%
Laminectomy	8	8%
Appendectomy	7	7%
Lap Cholecystectomy	7	7%
Rhinoplasty	6	6%
Percutaneous Nephrolithotomy	6	6%
Other (≤5% each)	—	—

Table 3. Airway Assessment Parameters

Parameter	Category	Frequency (n)	Percent (%)
Mallampati	III	79	79%
	IV	21	21%
Mouth Opening	<3 fingers	49	49%
	3 fingers	37	37%
	>3 fingers	14	14%
Thyromental	<4 cm	48	48%
	4.1–6 cm	32	32%
	>6 cm	20	20%
Interincisor	<3 cm	60	60%
	3.1–4 cm	25	25%
	>4 cm	15	15%
Neck Circumference	>17 inches	62	62%
	17 inches	30	30%
	<17 inches	8	8%

The video laryngoscope group consistently demonstrated more stable heart rates, blood pressure, mean arterial pressures, and oxygen saturation. A detailed categorical analysis revealed that tachycardia (100–150 bpm) and severe tachycardia (>150 bpm) were more frequent in the Macintosh group (23 and 6, respectively) compared to the video laryngoscope group (7 and 0, respectively), while normal heart rate (60–100 bpm) was much more common in the video laryngoscope group (40 vs. 14; Table 5). Hypertension stages and higher mean arterial pressure were also more prevalent in the Macintosh group, whereas hypotension and normotension predominated in the video laryngoscope group. SpO_2 saturation in the 96–100% range was universal in the video laryngoscope group (50/50), but lower in the Macintosh group (34/50), with more patients experiencing

mild to severe desaturation in the latter End-tidal CO_2 values were largely within the 23–25 mmHg range for both groups but were somewhat lower in the video laryngoscope group, indicating more consistent ventilation (Table 6).

Table 4. Comparison of Hemodynamic Parameters Between Groups

Parameter	Mean Difference (Mac – VL)	SD	95% CI (Lower, Upper)	t-value	p-value
Heart Rate	0.480	1.074	0.175, 0.785	3.161	0.003 **
Blood Pressure	1.180	2.488	0.473, 1.887	3.353	0.002 **
Mean Arterial Pressure	2.120	2.577	1.388, 2.852	5.818	<0.001 **
SpO2	0.740	1.275	0.378, 1.102	4.105	<0.001 **

Table 5. Distribution of Hemodynamic Responses by Device

Parameter	Category	Macintosh (n)	Video Laryngoscope (n)
Heart Rate	Bradycardia <60	7	3
	Normal 60–100	14	40
	Tachycardia 100–150	23	7
	Severe >150	6	0
BP	Hypotension 90/60	11	16
	Normal 120/80	2	12
	Hypertension 130/89	8	9
	Stage 1 Hypertension	13	10
	Stage 2 Hypertension	8	3
	Stage 3 Hypertension	6	0
	Stage 4 Hypertension	2	0
MAP	<70	6	4
	93	6	27
	102	4	11
	112	7	7
	126	6	1
	139	5	0
	>150	16	0
SpO2	96–100%	34	50
	91–95%	5	0
	81–90%	5	0
	71–80%	2	0
	<70%	4	0

Table 6. $ETCO_2$ and ECG Findings During Intubation

Parameter	Category	Macintosh (n)	Video Laryngoscope (n)
$ETCO_2$ (mmHg)	20–22	9	21
	23–25	25	27
	>25	16	2
ECG	Normal sinus rhythm	41	50
	Bradycardia	2	0
	Tachycardia	2	0
	Atrial flutter	1	0
	Atrial fibrillation	1	0
	Ventricular tachy.	2	0
	Ventricular fibril.	1	0

Electrocardiogram findings showed a higher frequency of normal sinus rhythm in the video laryngoscope group (50 vs. 41), while abnormal rhythms (e.g., bradycardia, tachycardia, arrhythmias) occurred exclusively or more often in the Macintosh group. The comparative statistical analysis revealed that use of the video laryngoscope resulted in significantly more stable hemodynamic profiles during intubation in difficult airway patients. Notably, mean differences for heart rate, blood pressure, mean arterial pressure, and SpO_2 all reached statistical significance, with p-values below 0.005. These data provide compelling evidence for the routine consideration of video laryngoscopy in managing complex The lollipop plot clearly demonstrates that video laryngoscopy outperforms Macintosh laryngoscopy across all measured outcomes: first attempt intubation success was notably higher with the video device (94% vs. 76%), while adverse events—including esophageal intubation (2% vs. 12%), airway trauma (4% vs. 14%), oxygen desaturation below 90% (2% vs. 22%), and severe hemodynamic

instability (4% vs. 18%)—were all markedly less frequent in the video laryngoscope group, emphasizing its superior safety and effectiveness in managing difficult airways. intubations.

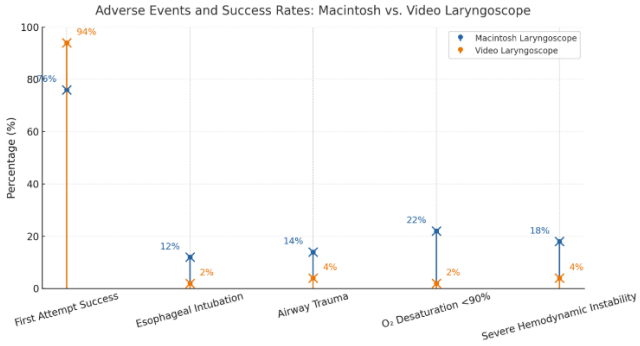

Figure 1 Adverse Events and Success Rates: Macintosh Vs. Video Laryngoscope

DISCUSSION

The present study provides valuable insight into the hemodynamic variability associated with intubation using Macintosh versus video laryngoscopes in patients with difficult airways. Our results reveal that video laryngoscopy is associated with significantly more stable hemodynamic parameters, including lower incidences of tachycardia, hypertension, and oxygen desaturation, compared to the traditional Macintosh approach. These findings align with a growing body of literature suggesting that the use of video laryngoscopes not only enhances glottic visualization and intubation success in challenging airways but also attenuates the sympathetic pressor response traditionally observed during direct laryngoscopy (2,3). Notably, the reduction in hemodynamic fluctuations with video laryngoscopy is likely attributable to minimized airway manipulation, improved visualization, and reduced intubation time, all of which contribute to decreased nociceptive stimulation of the oropharyngeal and laryngeal structures (7,8).

When comparing our findings with previous research, several points of agreement and divergence emerge. Studies by Mosallem Mohammed et al. and Meshram et al. have similarly demonstrated that video laryngoscopy is associated with lower heart rate and blood pressure responses during intubation, consistent with our results (2,3). These authors also observed fewer intubation attempts and less airway trauma in the video laryngoscope group, suggesting additional procedural advantages. In contrast, earlier work by Xue and colleagues found no significant difference in hemodynamic reactions between the two devices, particularly in less complex airways, highlighting the importance of patient selection and airway difficulty in determining the benefits of video laryngoscopy (8). Our focus on Mallampati grade III and IV patients may account for the more pronounced differences observed in this study, underlining the utility of video laryngoscopy in scenarios where airway management is most challenging. The mechanisms underlying the observed hemodynamic advantages of video laryngoscopy are multifactorial. The indirect, camera-assisted approach allows for successful intubation with less forceful displacement of the tongue and epiglottis, thus reducing the activation of sympathetic pathways and subsequent cardiovascular responses (6,7). Additionally, improved visualization decreases the risk of esophageal intubation and airway trauma, both of which can precipitate further hemodynamic instability. Our results support these mechanistic theories by demonstrating a greater proportion of patients with normal sinus rhythm and optimal oxygenation in the video laryngoscope group.

Clinically, these findings have important implications for anesthesia practice and airway management guidelines. Given the heightened perioperative risk associated with hemodynamic instability, especially in patients with pre-existing cardiovascular comorbidities—adopting video laryngoscopy as the default approach in predicted difficult airways could reduce adverse events, enhance patient safety, and potentially improve surgical outcomes. Furthermore, the consistent superiority of video laryngoscopy in reducing the need for multiple intubation attempts supports its integration into airway management algorithms, especially in high-acuity environments such as emergency and critical care settings (5,7).

The present study's strengths include its prospective design, standardized data collection, and focus on a clinically relevant high-risk population. However, several limitations must be acknowledged. The sample size, though adequate for detecting significant differences in primary hemodynamic outcomes, may limit the generalizability of these findings to broader populations or less experienced operators. All procedures were performed in a single center, which may introduce institutional biases related to technique or equipment. Additionally, while the allocation to device groups was balanced, the lack of blinding and randomization may have introduced selection or performance bias. Our study did not assess long-term clinical outcomes, such as postoperative morbidity or mortality, nor did it account for possible operator learning curves associated with video laryngoscope use.

Future research should address these limitations by including larger, multicenter cohorts and incorporating randomized controlled trial designs to further validate these findings. Investigations examining cost-effectiveness, training protocols, and the impact of device selection on long-term outcomes are warranted. Comparative studies in pediatric, obese, or other high-risk subpopulations may further refine clinical guidelines for airway management. Ultimately, while our results strongly support the preferential use of video laryngoscopy in difficult airways, ongoing evaluation and integration of emerging technologies remain essential to optimize patient care and safety in anesthesia practice (10,11).

CONCLUSION

This study demonstrates that video laryngoscopy offers superior hemodynamic stability compared to Macintosh laryngoscopy during intubation in patients with difficult airways, with significantly lower incidences of tachycardia, hypertension, and oxygen desaturation observed in the video laryngoscope group. These findings highlight the clinical advantage of adopting video laryngoscopy for airway management in challenging cases, supporting its integration into standard practice to enhance patient safety and procedural success. The results underscore the need for broader implementation of video-assisted

intubation techniques in high-risk populations and provide a strong rationale for further research exploring long-term outcomes, cost-effectiveness, and the training requirements necessary to maximize the benefits of advanced airway devices in human healthcare.

REFERENCES

1. Gupta S, Sharma KR, Jain D. Predictors Of Difficult Airway During Airway Assessment. Indian Journal of Anaesthesia. 2005;49(4):257–262.

2. Mosallem Mohammed A, Essam Abdel-Fatah A, Ali El-Agwany A. Comparative Study of Hemodynamic Responses to Laryngoscopy and Intubation Using Video Laryngoscope Versus Macintosh Laryngoscope. Egyptian Journal of Hospital Medicine. 2022;88(1):3167–3172.

3. Meshram TM, Ramachandran R, Darlong V, Garg R, Punj J, Pandey R. Comparison of Hemodynamic Responses to Orotracheal Intubation Using Macintosh Laryngoscope and C-MAC Video Laryngoscope. Journal of Anaesthesiology Clinical Pharmacology. 2021;37(3):378–382.

4. Peirovifar A, Gharehbaghi MM, Aliramezany M, Ghaffarzadeh J. Comparison Of Hemodynamic Changes Following Endotracheal Intubation Using Video Laryngoscopy and Direct Laryngoscopy in Hypertensive Patients. Saudi Journal of Anaesthesia. 2012;6(4):313–317.

5. Verma I, Sinha AK, Bhatia PK, Sethi P. Hemodynamic Responses to Laryngoscopy and Tracheal Intubation: Comparison of Macintosh and C-MAC Video Laryngoscope. Anesthesia Essays and Researches. 2020;14(3):372–376.

6. Gavrilovska-Brzanov A, Kuzmanovska B, Kartalov A, Mojsova M, Kuzmanovski I, Jovanovski-Srceva M. Comparison of the C-MAC Video Laryngoscope and Macintosh Laryngoscope for Tracheal Intubation in Patients with Normal and Difficult Airways. Open Access Macedonian Journal of Medical Sciences. 2018;6(5):797–801.

7. Maharaj CH, Costello J, McDonnell JG, Harte BH, Laffey JG. The Airtraq as a Rescue Device Following Failed Direct Laryngoscopy: A Case Series. Anaesthesia. 2008;63(2):182–188.

8. Xue FS, Zhang GH, Li XY, Sun HT, Li CW, Liu KP. Hemodynamic Responses to Orotracheal Intubation with the GlideScope and Macintosh Laryngoscope. Anaesthesia. 2007;62(9):940–943.

9. American Society of Anesthesiologists. Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022;136(1):31–81.

10. Cook TM, Kelly FE. A National Survey of Videolaryngoscopy in the United Kingdom. British Journal of Anaesthesia. 2017;118(4):593–600.

11. World Medical Association. World Medical Association Declaration of Helsinki: Ethical Principles For Medical Research Involving Human Subjects. JAMA. 2013;310(20):2191–2194.