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COMPARING HEMODYNAMIC RESPONSES TO INTUBATION IN HYPERTENSIVE PATIENTS: CLEARVUE® VIDEO LARYNGOSCOPE VERSUS MACINTOSH DIRECT LARYNGOSCOPE

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ABSTRACT

Introduction: The ClearVue® video-laryngoscope (CVL) is believed to alleviate the stress response associated with intubation by providing superior laryngeal views, minimizing oropharyngo-laryngeal stimulation, and potentially reducing the pressor response.
Objective: This study aims to assess and compare how effective and safe intubation is when using a CVL versus a Macintosh direct laryngoscope (MDL) in patients with high blood pressure who are having surgery.
Methods: This prospective, randomized, interventional study was conducted on 140 hypertensive patients on antihypertensive medication undergoing elective surgery under general anesthesia (GA), who were allocated into two groups, CVL group (n = 70) and MDL group (n = 70). Hemodynamic parameters, including mean arterial pressure (MAP), mean heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP), were monitored at baseline, induction, and at various intervals post-intubation (1, 2, 3, 4, 5, and 10 minutes). Other metrics, such as intubation time, intubation attempts, ease of intubation, and associated complications, were documented.
Results: Significant differences in heart rate were observed between the groups, right at intubation and at 1, 2, and 3 minutes post-intubation (p-values: 0.011; 0.028; 0.002; 0.003). SBP showed significant differences at intubation and during the first four minutes post-intubation (p-values < 0.001 except for the fourth minute, p = 0.001). DBP and MBP also showed significant differences at various intervals post-intubation (p-values < 0.001 to 0.025 and < 0.001 to 0.020, respectively). No significant difference in airway complications was noted.
Conclusion: The CVL offers advantages over MDL in patients with controlled hypertension, specifically in reducing hemodynamic changes during intubation without increasing airway complications. At the same time, MDL offered less intubation time overall than CVL.

Keywords: Blood pressure; ClearVue® video-laryngoscope; Hemodynamic response; Macintosh laryngoscope

ABSTRAK

Pendahuluan: Video-laringoskop ClearVue® (CVL) diharapkan dapat mengurangi stres saat intubasi dengan memberikan pandangan yang lebih jelas pada laring, mengurangi rangsangan di area mulut dan tenggorokan, serta mungkin menurunkan tekanan darah.
Tujuan: Penelitian ini ingin menilai dan membandingkan seberapa efektif dan aman intubasi yang dilakukan dengan CVL dan laringoskop langsung Macintosh (MDL) pada pasien hipertensi yang menjalani operasi.
Metode: Studi prospektif, acak, dan intervensional ini dilakukan pada 140 pasien hipertensi yang menggunakan obat antihipertensi dan menjalani operasi elektif dengan anestesi umum. Pasien dibagi menjadi dua kelompok yaitu, grup CVL (n = 70) dan grup MDL (n = 70). Parameter hemodinamik, seperti tekanan darah rata-rata (MAP), denyut jantung rata-rata (HR), tekanan darah sistolik (SBP), dan tekanan darah diastolik (DBP), diperiksa pada awal, saat induksi, dan pada beberapa waktu setelah intubasi (menit ke-1, 2, 3, 4, 5, dan 10). Parameter lain seperti waktu intubasi, jumlah percobaan intubasi, kemudahan intubasi, dan komplikasi yang terkait juga didokumentasikan.
Hasil: Terdapat perbedaan signifikan pada denyut jantung antara kedua kelompok pada saat intubasi dan menit ke-1, 2, dan 3 setelah intubasi (nilai p: 0,011; 0,028; 0,002; 0,003). SBP menunjukkan perbedaan signifikan pada saat intubasi dan selama empat menit pertama pasca-intubasi (nilai p < 0,001, kecuali menit ke-4, p = 0,001). DBP dan MBP juga menunjukkan perbedaan signifikan pada berbagai interval pasca-intubasi (nilai p < 0,001 hingga 0,025 dan < 0,001 hingga 0,020, secara berturut-turut). Tidak ditemukan perbedaan signifikan dalam komplikasi jalan napas.
Kesimpulan: CVL lebih menguntungkan daripada MDL untuk pasien dengan hipertensi terkontrol, terutama dalam mengurangi perubahan hemodinamik selama intubasi tanpa menambah komplikasi jalan napas.

Kata kunci: Tekanan darah; Video-laringoskop ClearVue®; Respons hemodinamik; Laringoskop Macintosh

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INTRODUCTION

Laryngoscopy and endotracheal intubation are critical skills for anesthesiologists, especially for unconscious and critically ill patients. However, these procedures can stimulate the sympathetic nervous system, leading to increased catecholamine levels and adverse cardiovascular effects like arrhythmia, hypertension, and tachycardia. The hemodynamic changes during laryngoscopy and intubation are influenced by factors such as oropharyngo-laryngeal stimulation and the force and duration of laryngoscopy. These responses typically begin within 5 seconds, peak within 1-2 minutes, and return to baseline within 5 minutes.

Hypertensive patients are particularly vulnerable to exaggerated catecholamine release, which can increase myocardial oxygen demand and decrease oxygen supply, potentially causing severe cardiovascular events like cardiac arrhythmias, myocardial infarction, pulmonary edema, and cerebrovascular hemorrhage (1–3). Patients with high blood pressure often have hardening of the arteries and poor blood flow in the throat nerves, making their airway tissues more likely to get hurt during intubation (4).

The Macintosh laryngoscope has long been the gold standard for laryngoscopy and intubation (5), requiring precise alignment of the oral, pharyngeal, and laryngeal axes and significant force (about 5.4 kg) to expose the glottis. However, newer devices like video laryngoscopes (VL) require significantly less force (0.5-1.4 kg), offering superior laryngeal visualization without the need for such alignment. This reduces oropharyngo-laryngeal stimulation and mitigates the pressor response.

Laryngoscopy and intubation-related stress response can be minimized by several medications such as beta-blockers, clonidine, lignocaine, propofol, and opioids, but nowadays different intubating skills are available, like video laryngoscopy and fiber-optic intubation.

Drugs such as beta-blockers, clonidine, lignocaine, propofol, and opioids are effective in reducing the stress response associated with laryngoscopy and intubation. Modern intubation techniques, such as video laryngoscopy and fiber-optic intubation, enhance patient safety and comfort by reducing the associated stress response, highlighting the importance of adopting these advanced methods (6).

METHODS

This prospective, randomized, interventional study was conducted at Swai Man Singh Medical College, Jaipur, India, from August to October 2023. This research has obtained approval from the office of the ethics committee, Swai Man Singh Medical College and attached hospitals, Jaipur (No. 403/MC/EC/2023, dated April 21st, 2023) and the trial was registered under the Clinical Trial Registry (CTRI) of India with registration number CTRI/2023/06/053510. Informed written consent was obtained from all patients considered for inclusion in the study.

Inclusion criteria included patients of either sex, aged 30 to 60 years, with controlled hypertension (blood pressure (BP) < 140/90 mm Hg) on antihypertensive medications and classified as American Society of Anesthesiologist (ASA) Grade II, planned for scheduled surgery under general anesthesia (GA) involving endotracheal intubation.

Criteria for exclusion included the presence of an anticipated difficult airway or intubation (inter-incisor gap < 2.5 cm, Mallampati Grade (MPG) grading 3 & 4), obesity (body mass index (BMI) > 30 kg/m^2), history of coronary artery disease, cervicospinal disease, gastroesophageal reflux, chronic respiratory, kidney, and liver diseases, pregnancy, drug allergy, and patients requiring rapid sequence induction (RSI).

Patients were divided into 2 groups using a computer-generated random number sequence list: CVL group (n = 70), intubated with ClearVue® video laryngoscope, and MDL group (n = 70), intubated with Macintosh direct laryngoscope.

All patients underwent evaluation by a cardio-physician to optimize their medication for hypertension and exclude other cardiovascular conditions. At the pre-anesthetic check (PAC) clinic, selected patients were instructed to fast for 8 hours, continue their antihypertensive medications on the preceding night and the morning of surgery with a small amount of water, and take 0.25 mg of Alprazolam the night before surgery. A comprehensive preanesthetic assessment was conducted, including a detailed airway assessment. Measurements such as Modified Mallampati scores (MMP), thyromental distances, and inter-incisor distances were recorded, along with the patients' antihypertensive medication regimens.

Upon arrival in the operating theatre, the patient's fasting status, written informed consent, pre-anesthetic evaluation, and the antihypertensive medication taken before surgery were verified. Standard monitoring devices, including non-invasive blood pressure (NIBP), SPO2, and echocardiography (ECG) were applied, and baseline hemodynamic parameters such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and SPO2 were documented. An intravenous cannula was also inserted.

The patients were premedicated with intravenous metoclopramide (0.2 mg/kg), midazolam (0.02 mg/kg), glycopyrrolate (0.01 mg/kg), and fentanyl (2 mcg/kg). Pre-oxygenation was performed with 100% oxygen for 3-5 minutes. Hemodynamic parameters were recorded prior to induction, which began with intravenous propofol (2 mg/kg), and then they used atracurium (0.5 mg/kg) to relax the muscles.

Adequate mask ventilation was assured, and laryngoscopy was performed using either the Macintosh or CVL according to the assigned group. Modified Cormack and Lehane grading, intubation time, number of attempts, need for external laryngeal manipulations, and ease of the intubation score were noted. The correct position of the tube was confirmed by 5-point auscultation and $EtCO_2$ readings. Hemodynamic parameters were recorded at specified intervals: during intubation and at 1, 2, 3, 4, 5, 10 minutes post-intubation. Complications, including esophageal intubation, mucosal bleeding, lip and dental injury, episodes of desaturation (SPO2 < 92%), ischemia, and bronchospasm, were also documented.

Anesthesia was maintained with sevoflurane (1.5–2.0%) and a 50:50 mixture of O_2:N_2O, along with a maintenance dose of Inj. Atracurium (0.1 mg/kg). At the conclusion of the surgery, all anesthetic agents were stopped, and reversal was achieved using Inj. Neostigmine (0.06 mg/kg) and Inj. Glycopyrrolate (0.01 mg/kg). Patients were then extubated and transferred to the recovery room.

RESULTS AND DISCUSSION

A total of 140 patients (controlled hypertensives) of either sex, with age group 30 to 60 years, belonging to ASA Grade II and Mallampati Grade 1 & 2, scheduled to undergo elective surgery under general anesthesia requiring oral endotracheal intubation.

There were no statistically significant differences in the demographic parameters (age, sex, weight, ASA grading), airway examination (Inter-incisor gape, Mallampati Grade), CL grading, number of attempts required for intubation, and the difference in complications [Table 1].

We observed a statistically significant difference between Group CVL and Group MDL in terms of external laryngeal manipulation (ELM) with p-value < 0.001 (S). In Group CVL, consisting of all 70 subjects (100%), did not required during intubation. Conversely, in Group MDL, which comprised 25 out of 70 subjects (35.7%) required ELM (non-comparable). All intubations were done on the first attempt in both groups. We observed a statistically significant difference between Group CVL and Group MDL in terms of mean insertion time. It was higher in the case of Group CVL at 18.99 ± 3.40 seconds, while in the case of Group MDL, it was 13.98 ± 2.78 seconds (p = 0.001) (non-comparable).

Table 1. Demographic Data

Parameters	Group CVL (n=70)	Group MDL (n=70)	p-Value
Age (years) (mean ± SD)	44.23 ± 12.63	44.53 ± 12.15	0.714**
Sex			
Male [n (%)]	54 (77.14)	53 (75.71)	1.00*
Female [n (%)]	16 (22.86)	17 (24.29)	
Weight (kg) (mean ± SD)	71.6 ± 11.81	69.21 ± 10.77	0.214**
Height (cm) (mean ± SD)	163.8 ± 11.29	162.2 ± 12.14	0.425**
Mallampati Grade			
MMP l [n (%)]	36 (51.4)	30 (42.9)	0.397*
MMP ll [n (%)]	34 (48.6)	40 (57.1)	
Modified Cormack–Lehane (CL) Grading			
Grade 1 [n (%)]	37 (52.9)	25 (35.7)	
Grade 2a [n (%)]	33 (47.1)	45 (64.3)	0.0397*
Antihypertensive Medication Status			
CCBs [n (%)]	50 (71.4)	49 (70)	0.688**
βBs [n (%)]	2 (2.9)	6 (8.6)	
CCBs + βBs [n (%)]	15 (21.4)	12 (17.1)	
CCBs + TZ [n (%)]	3 (4.3)	3 (4.3)	

*Results of the chi-square test, it is significant if α < 0.05
**Results of the independent T-test, it is significant if α < 0.05
CCBs: Calcium channel blockers; βBs: β Blockers; ARBs: Angiotensin II receptor blockers; Th: Thiazides; MMP: Modified Mallampati grade; SD: Standard deviation; P < 0.05 is considered significant.

We observed a statistically significant difference between Group CVL and Group MDL in terms of ease of intubation. In the CVL group, all 70 patients underwent intubation effortlessly, while in the MDL group, 45 patients experienced (non-comparable) easy intubation and 25 patients reported satisfactory-grade ease of intubation (non-comparable) [Table 2].

Table 2. Airway Management Observation

Variable	Group CVL (n=70)	Group MDL (n=70)	p-Value
Mean Intubation Time [mean ± SD]	18.99 ± 3.40	13.98 ± 2.78	**<0.001***
Number of Attempts Required	1	1	-
External Laryngeal Manipulation			
Yes [n (%)]	0 (0)	25 (35.71)	**<0.001****
No [n (%)]	70 (100)	45 (64.29)	
Ease of Intubation			
Easy [n (%)]	70 (100)	45 (64.29)	**<0.001****
Satisfactory [n (%)]	0 (0)	25 (35.71)	
Difficult [n (%)]	0 (0)	0 (0)	

*Results of the independent T-test, it is significant if α < 0.05
**Results of the chi-square test, it is significant if α < 0.05

At baseline, before intubation, both CVL and MDL groups exhibited comparable heart rates, with means of 86.51 x/min and 85.86 x/min, respectively. However, upon intubation, there was a notable divergence in heart rate dynamics between the two groups. Following intubation, at the first minute, the heart rate for the CVL group remained relatively stable, showing a minor increase to 86.61 beats per minute, whereas the MDL group experienced a more pronounced elevation to 92.94 beats per minute. This trend continued with successive minutes, with the MDL group showing consistently higher heart rates compared to the CVL group [Figure 1]. Statistical analysis revealed significant differences between the groups at all time points post-intubation up to three minutes, with p-values ranging from 0.011 to 0.003, denoted as statistically significant (S). However, beyond the three minutes, the disparity diminished, with p-values exceeding 0.05, indicating no significant difference in heart rate between the two groups. Overall, these findings suggest that intubation induces a notable transient increase in heart rate, with the response being more pronounced in patients with MDL compared to those with CVL [Table 3].

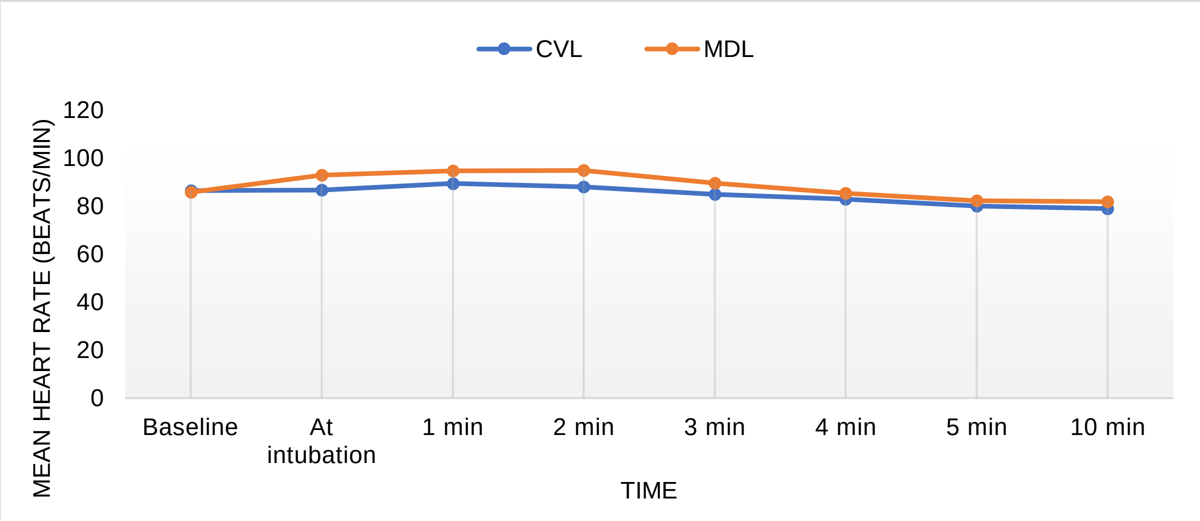

Figure 1. Mean Heart Rate (beats per minute) Over Time Following Intubation Using CVL and MDL
The graph shows the mean heart rate (HR) in beats per minute at various time points: baseline, at intubation, and 1, 2, 3, 4, 5, and 10 minutes post-intubation. The blue line represents the CVL group, while the orange line represents the MDL group.

Similarly, significant differences were noted in systolic blood pressure (SBP) at the time of intubation and during the first four minutes post-intubation, with p-values consistently below 0.001 except for the fourth minute (p = 0.001). Furthermore, DBP showed significant differences at the time of intubation and throughout the first five minutes post-intubation, with p-values ranging from < 0.001 to 0.049. Additionally, MAP [Figure 2] exhibited significant differences between the groups at the time of intubation and during the first four minutes post-intubation, with p-values ranging from < 0.001 to 0.008, and at five-minute p-values of 0.020 (non-comparable). [Table 3]

In our study, we found that the use of CVL resulted in a significantly smaller increase in blood pressure following intubation compared to MDL. The hemodynamic response to intubation results from the stimulation of oropharyngeal structures during laryngoscopy and the tracheal stimulus caused by the insertion of the endotracheal tube. The design of the CVL blade, with its curvature, minimizes the need for precise alignment of the 3 axes (oral, pharyngeal, and laryngeal) during intubation, which in turn decreases the required upward lifting force to 0.5-1.5 kg, compared to 5.4 kg with the traditional Macintosh laryngoscope (7).

Our findings align with a study by Meshram T. M. et al. (5), which compared the Macintosh direct laryngoscope with the GlideoScope video laryngoscope (GVL) in controlled hypertensive patients undergoing orotracheal intubation. They also observed a significant difference in blood pressure (SBP, DBP, MAP) at intubation and at 1-, 2-, and 3-minute post-intubation, although there was no significant difference in heart rate at post-intubation intervals. GVL was associated with a reduced hemodynamic response compared to the Macintosh laryngoscope.

Similarly, our study's findings were consistent with the study by Jain P. et al. (8), which compared the hemodynamic response between direct laryngoscopy and video laryngoscopy in hypertensive patients. They found that video laryngoscopes induced fewer variations in hemodynamic response compared to direct laryngoscopy.

Video laryngoscopy requires less force on the upper airway, leading to a more even distribution of pressure across the blade. In contrast, with the MDL, the force is focused on the distal part of the blade, which is likely to result in a higher hemodynamic response (9,10). Various studies have demonstrated reduced cervical spine movement using video laryngoscopy compared to MDL (11). Video laryngoscopy provides a better view of the glottis, which reduces the need for excessive upward lifting force and makes the procedure easier for novice users (12).

Table 3. Hemodynamic Response to Intubation (mean ± SD)

Hemodynamic Parameters	Timeline							
	Baseline	At Intubation	At 1 min	At 2 min	At 3 min	At 4 min	At 5 min	At 10 min
Heart Rate (x/min)								
CVL group	86.51 ± 12.55	86.61 ± 14.73	89.49 ± 14.09	87.99 ± 12.43	84.93 ± 9.55	82.83 ± 11	80.14 ± 12.76	79 ± 12.18
MDL group	85.86 ± 12.54	92.94 ± 14.22	94.69 ± 13.86	94.89 ± 12.8	89.6 ± 9.01	85.27 ± 11.6	82.36 ± 9.28	81.86 ± 12.54
P-Value	0.757	**0.011**	**0.028**	**0.002**	**0.003**	0.203	0.242	0.174
Systolic Blood Pressure (mmHg)								
CVL group	129.04 ± 5.99	130.51 ± 8.15	131.34 ± 10.53	126.94 ± 19.97	120.64 ± 11.49	118.37 ± 14.51	116.16 ± 9.42	115.84 ± 10.42
MDL group	128.7 ± 5.52	147.81 ± 11.67	151.36 ± 10.93	140.77 ± 13.26	135.76 ± 13.38	127.41 ± 17.5	119.7 ± 12.25	117.57 ± 14.5
P-Value	0.725	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.001**	0.057	0.419
Diastolic Blood Pressure (mmHg)								
CVL group	84.14 ± 3.63	86.89 ± 5.74	87.67 ± 8.57	84.49 ± 8.31	78.96 ± 8.25	76.96 ± 10.42	73.93 ± 9.28	72.87 ± 8.15
MDL group	84.44 ± 3.97	93.14 ± 6.8	95.2 ± 8.35	94.83 ± 6.82	88.19 ± 7.52	80.13 ± 8.85	77.09 ± 7.05	75.4 ± 6.91
P-Value	0.641	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.054	**0.025**	0.050
Mean Arterial Pressure (mmHg)								
CVL group	99.11 ± 3.11	101.43 ± 5.48	102.23 ± 7.9	98.64 ± 10.01	92.85 ± 8.77	90.76 ± 11.53	88 ± 8.71	87.2 ± 8.54
MDL group	99.2 ± 3.5	111.37 ± 6.9	113.92 ± 7.65	110.14 ± 7.62	104.04 ± 7.96	95.89 ± 11.07	91.29 ± 7.72	89.46 ± 8.8
P-Value	0.878	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.008**	**0.020**	0.125
Spo2 (%)								
CVL group	98.96 ± 0.82	98.93 ± 0.82	99.07 ± 0.79	99.03 ± 0.8	99.03 ± 0.76	99.21 ± 0.81	99.03 ± 0.87	99.06 ± 0.8
MDL group	99.13 ± 0.8	98.94 ± 0.81	98.99 ± 0.86	99.17 ± 0.78	98.99 ± 0.81	99.2 ± 0.86	98.97 ± 0.83	99.07 ± 0.84
P-Value	0.213	0.981	0.539	0.286	0.747	0.920	0.692	0.918
Rate Pressure Product								
CVL group	11153.89 ± 1629.7	11297.51 ± 2011.73	11715.46 ± 1816.06	11195.64 ± 2489.21	10277.46 ± 1820.07	9831.94 ± 1970.51	8984.81 ± 1846.2	8758.83 ± 1306.59
MDL group	11040.03 ± 1616.74	13713.87 ± 2259.66	14695.04 ± 2184.54	13397.91 ± 2601.21	12216.9 ± 2229.12	10912.47 ± 2481.97	9876.14 ± 1717.82	9607.97 ± 1739.74
P-Value	0.679	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.005**	**0.004**	0.056

Results of the Independent T-test, it is significant if α < 0.05

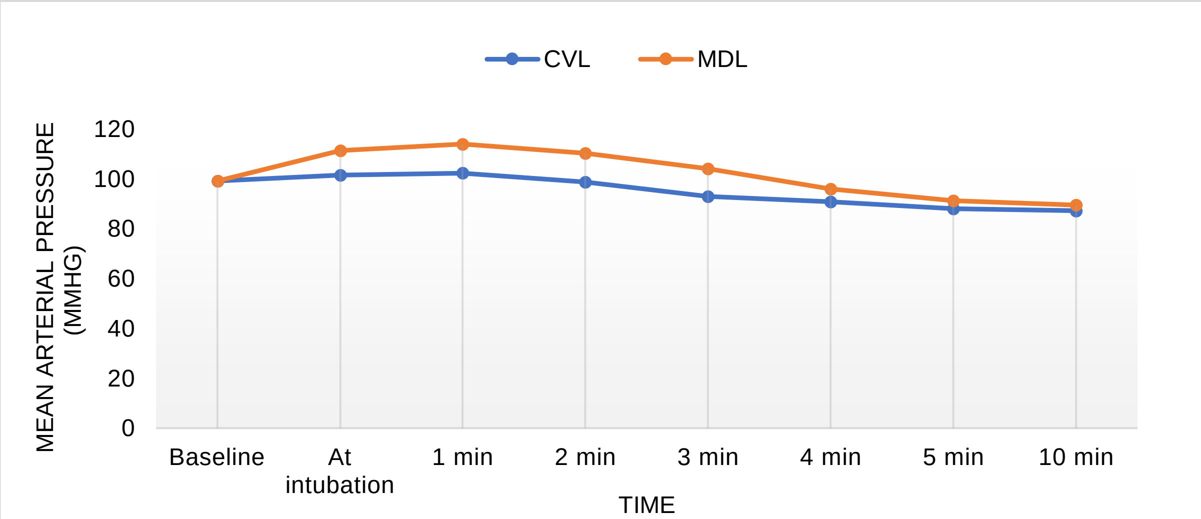

Figure 2. The graph illustrates the mean arterial pressure (MAP)
Measured in millimeters of mercury (mmHg) at various time points: baseline, at intubation, and 1, 2, 3, 4, 5 and 10 minutes post-intubation. The blue line represents the CVL group, and the orange line represents the MDL group.

These studies focused exclusively on controlled hypertensive patients, with all intubations carried out by experienced hands. The anesthesiologist required less upward force to expose the glottis, which helped minimize the hemodynamic responses to laryngoscopy. In our study, the intubation time with CVL (18.99 ± 3.40 seconds) was significantly longer than with MDL (13.98 ± 2.78 seconds). The increased intubation time with CVL is attributed to the need for an intubating stylet to maintain the tracheal tube's curvature in alignment with the CVL blade. The stylet needs to be removed as soon as the tracheal tube reaches the larynx, which may lead to a longer intubation time (13). Furthermore, the blade's anterior curvature may cause the tracheal tube to become caught on the front wall of the upper trachea, requiring tube rotation for the removal of the CVL blade (14).

Samal R. L. et al. (15) compared the Truview video laryngoscope and Macintosh laryngoscope for endotracheal intubation and concluded that the mean intubation time was longer (37.16 ± 8.23 seconds) with video laryngoscopy compared to Macintosh laryngoscopy (29.80 ± 6.75 seconds; P = 0.025). Although intubation times were longer, the use of CVL did not lead to an increased hemodynamic response to tracheal intubation.

CVL minimizes complications during tracheal intubation by exerting less pressure on soft tissue structures and offering improved glottic visualization, thereby reducing the risk of esophageal intubation. The complication rates during laryngoscopy and intubation were comparable between the two groups.

The study's limitations include the involvement of an experienced anesthesiologist in performing tracheal intubations. Additionally, the lack of blinding and no data regarding the duration of hypertension and use of different antihypertensive treatments, so hemodynamic response may be different, included only ASA I and II patients, not including emergency intubation, awake, and obstetric patients, though challenging to implement in such research, could introduce bias. Furthermore, realize that a single proficient operator might introduce some degree of bias into the findings.

CONCLUSION

The CVL offers advantages over MDL in patients with controlled hypertension, specifically in reducing hemodynamic changes during intubation without increasing airway complications. At the same time, MDL offered less intubation time overall than CVL. Further research should compare CVL and MDL to better balance blood pressure control and intubation speed in controlled hypertension.

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Conflict of Interest

The authors state that they have no conflicts of interest to disclose.

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Authors' Contributions

RKV, SM, JS, and RKS were involved in the study's conception and design, data collection and analysis, and drafting and revising the manuscript with significant intellectual contributions. The authors also provided administrative, technical, and material support, conducted the literature review, oversaw the study, coordinated its execution, and approved the final manuscript for submission.

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