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Comparison of hemodynamic responses to orotracheal intubation with Tuoren video laryngoscope and Macintosh direct laryngoscope in adult hypertensive patients

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ABSTRACT

Background: Laryngoscopy and intubation lead to unfavorable hemodynamic responses. Many studies have already compared direct laryngoscope (DL) and different types of video laryngoscopes (VLs). While some of those reported favorable response with use of VL, others have depicted an unfavorable response with VL. **Aims and Objectives:** Hence, the present study was carried out to compare the hemodynamic response to laryngoscopy between use of Macintosh DL and Tuoren VL in controlled hypertensive patients during elective surgery. **Materials and Methods:** A total of 122 patients were recruited for this interventional study. Patients were allocated into two groups to have their intubation with Tuoren VL (Group V, n=61) or Macintosh DL (Group D, n=61). The mean arterial pressure (MAP) at 1 min after intubation was the primary outcome. Other outcome measures were to compare heart rate (HR) at different time points, procedure time (glottis exposure time and intubation time), and number of attempts. **Results:** The use of DL led to considerably higher MAP at 1, 3, and 5 min after laryngoscopy and intubation compared with VL. However, comparable HRs were found between the two groups at such time points. Glottis visualization time and intubation time were considerably higher using VL compared with DL. The mean total procedure time was considerably lesser with DL over VL (mean, 29.5 vs. 38.5 s, respectively, <0.001). **Conclusion:** Tuoren video laryngoscope can be a better alternative to Macintosh direct laryngoscope in view of considerably lesser rise of mean arterial pressure and comparable heart rate during laryngoscopy and intubation in hypertensive patient.

Key words: Direct laryngoscope; Heart rate; Hemodynamic response; Laryngoscopy; Mean arterial pressure; Video laryngoscope

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INTRODUCTION

Laryngoscopy for endotracheal intubation leads to sympathetic stimulation and unfavorable hemodynamic responses such as tachycardia, increase in blood pressure, and arrhythmia.[1] Although this exaggerated sympathetic response is tolerated by healthy patients, these hemodynamic responses can increase oxygen consumption considerably to worsen myocardial ischemia in hypertensive patients.[2]

Various studies[3-14] have already compared direct laryngoscope (DL) with different types of video laryngoscope regarding hemodynamic changes. However, a variable result has been mentioned in the literature. Some studies[3-8] have concluded that the use of a conventional Macintosh DL results in a considerable increase in heart rate (HR) after intubation in comparison with different types of video laryngoscope (VL). There are other studies[9-14] where it has been found that the use of VL resulted in comparable hemodynamic

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response in comparison with DL. A recent study[15] has reported about greater hemodynamic response during the use of C-MAC VL while compared with Macintosh DL.

A variable and diverse result of VL over DL in the literature indicates that further study is required to consolidate the evidence. Different types of VL already appeared in the market with the intent of ergonomic advantages, better view of glottis, lesser procedure time, and lesser hemodynamic response. Recently, Tuoren VL is being used as the first line in anticipated difficult laryngoscopy in some geographical areas in India. It is claimed to cause reduced damage to the mouth and pharynx due to its special design and curvature. However, this VL has not been used in any clinical study to evaluate the hemodynamic response. Only one study[16] exists where Tuoren VL has been compared with King Vision VL to evaluate intubation time, view of glottis, and success rate in a simulated COVID-19 scenario. This was considered as the lacunae in the literature that has kindled the present researcher to evaluate the Tuoren VL regarding its effect on hemodynamic responses. Hence, the present study was carried out to compare the hemodynamic response to laryngoscopy with Macintosh DL and Tuoren VL in controlled hypertensive patients posted for routine surgery. It was hypothesized that the use of VL would attenuate the hemodynamic response to laryngoscopy and tracheal intubation as compared with the DL.

Aims and objectives

The aim of the present study was to compare the hemodynamic responses between the uses of Tuoren video laryngoscope and Macintosh direct laryngoscope. Primary outcome measure was to compare mean arterial pressure (MAP) at 1 minute after intubation between the uses of two devices. Other outcome measures were to compare the MAP at 3 minutes post-intubation, MAP at 5 minutes post-intubation, and heart rates at 1 minute, 3 minutes, and 5 minutes after intubation. In addition, the ease of intubation in terms of procedure time (glottis exposure time and intubation time) and number of attempts were observed.

MATERIALS AND METHODS

This was an experimental and single-blind study. In this interventional study, hemodynamic responses between VL and DL were compared. The protocol of the study was placed before the Institutional Ethics Committee (IEC). After approval from IEC (No. 2023/243), and permission from West Bengal University of Health Sciences, the study protocol was prospectively registered with the Clinical Trial Registry of India (CTRI) with trial registration number CTRI/2023/05/053131, registered on May 25, 2023. Thereafter, the recruitment was started in a prospective manner and the study spanned over 12 months approximately (May 2023–May 2024).

From the published literature,[17] the standard deviation of MAP in DL group was around 28. We assumed a considerable difference in MAP to occur between VL and DL group. We considered that the difference in MAP would be about 15 mmHg. Hence, the effect size was taken as 15. The sample size was calculated based on the methods as described in the literature.[18] The power study was set at 80 and the significance level of the study was set at 5 or lower (allowing alpha error of 5%). Thus, a sample size of 55 for each group was required. For both groups, 110 patients were taken following 1:1 group. Considering the possibility of 10% dropout, a total of 122 patients were recruited for the study.

Patients aged between 18 and 65 years of either sex; hypertensive but controlled with medication; American Society of Anesthesiologists (ASA) physical Status I or II, posted for surgeries in the general surgery operating room were selected based on inclusion and exclusion criteria. Patients having uncontrolled hypertension, uncontrolled systemic disorder, documented or anticipated difficult airway, and body mass index >30 kg/m^2 were excluded from the study.

Pre-anesthetic check-up was completed on the day before surgery. Standard baseline investigations were considered as per institutional protocol. The aim of the study, description of the procedure to undergo, and probable adverse events were briefed to patients and their legal guardian in their mother language to obtain their informed consent. They were given the option to opt out from the study at any time. The patients who had given written, informed consent were included in the study.

The group allocation was performed before induction of anesthesia using sequentially numbered opaque sealed envelope method. There were 122 sealed envelopes each containing one piece of paper marked either "V" or "D" (61 papers marked as "V" and another 61 papers marked as "D"). The alphabet displayed ("V" or "D") corresponded to the group allocation of the patient.

- Group-V: Patients were intubated with Tuoren VL
- Group-D: Patients were intubated with Macintosh laryngoscope.

On arrival in the operating room, multichannel monitor was attached to record baseline parameters as per ASA guideline. Intravenous (IV) access was established using 18-G cannula. Pre-oxygenation was done for 3 min. Pre-medication was given, as appropriate for each patient, using fentanyl (2 mcg/kg), glycopyrrolate (4 mcg/kg), and ondansetron (0.1 mg/kg). Induction was performed with propofol 2 mg/kg IV and neuromuscular blockade was done using atracurium 0.5 mg/kg IV for. Patients were ventilated manually with sevoflurane (1–2%) in oxygen adjusted to have 1% end-tidal concentration.

At the end of 3 min of ventilation, the intubation procedure was performed in "sniffing the morning air" position using size 3 and size 4 of channeled blade in group "V" and size 3 and size 4 in Macintosh blade in Group "D." After achieving the best possible view of the glottis region, one anesthesiologist, not otherwise involved with the study, was requested to rate the quality of vocal cord visualization using the Cormack–Lehane grading (grade 1–4)[19] as well as the percentage of glottic opening (POGO) score (0–100%). All intubations were performed by an experienced anesthesiologist whose previous experience included at least 50 intubations with each type of laryngoscope within the past 3 months. Airway was secured with cuffed endotracheal tube of size 7 mm in internal diameter in female and 8 mm ID in male. Vital parameters (HR, ECG, SpO_2, and MAP) were measured serially at 1 min, 3 min, and 5 min after intubation. An independent operator noted the time of intubation, attempt for intubation, and hemodynamic parameters. For the sake of data collection, no procedure was allowed and no medications were administered up to 5 min after intubation, except emergency.

An "intubation attempt" was defined as any effort to introduce a laryngoscope blade into the oral cavity and subsequent withdrawal of laryngoscope, irrespective of whether the endotracheal tube was successfully placed in the trachea or not. The inability to intubate within two attempts was termed as "intubation failure." In the case of "intubation failure" by definition, the conducting anesthesiologist was given the liberty to secure the airway using laryngoscope of his/her choice. The period between the insertion of the laryngoscope blade through the incisors and the optimal viewing of the glottis was designated as "glottis visualization time." The period from glottis visualization to the observation of six consecutive square waveforms of the end-tidal CO_2 ($EtCO_2$) tracing on the monitor was considered as "Intubation time." The "procedure time" or "total time required for intubation" was calculated from the time when the laryngoscope blade was introduced up to visualization of six consecutive square wave patterns in the $EtCO_2$ tracing.

Any adverse event such as esophageal intubation, dental injury, or mucosal trauma involving lip or oral cavity was noted. Any episode of hypotension (<20% of baseline), bradycardia (HR <50), hypertension (MAP >20% of baseline), or hypoxemia (SpO_2 <90%) was noted.

The collected data were tabulated in Microsoft Excel and analyzed with SPSS version 22.0. The continuous data (e.g., age, time taken for intubation, MAP, and HR) are presented as mean±standard deviation and analyzed using an independent sample "t' test. The categorical variables (e.g., sex, ASA, MP grade, and number of attempts) are presented as the number of patients and proportions. These are analyzed using Chi-square test. P≤0.05 is considered statistically significant.

RESULTS

The study spanned from June 2023 to May 2024. Data from all 122 patients were available for analysis.

Both groups were comparable in terms of demographic parameters (Table 1).

It was found that a considerable higher MAP was maintained at 1, 3, and 5 min after laryngoscopy and intubation with DL over VL (Table 2). However, HRs were found comparable between the two groups at such time points (Table 2).

Glottis visualization time and intubation time were considerably higher with the use of VL compared with

Table 1: Demographic parameters

Parameters	Group D (n=61)	Group V (n=61)	P-value
Age*	52.2±8.4	52.3±8.5	0.932
Gender (F/M)	25/36	23/38	0.711
ASA (1/2)	0/61	0/61	-
Mallampati Grade 1/2	9/52	4/57	0.142

Group D: Patients intubated with Macintosh laryngoscope, Group V: Patients intubated with Tuoren video laryngoscope, ASA: American Society of Anesthesiologists. Data presented as the number of patients, and Chi-square test applied except marked with (*) that is presented as mean±standard deviation where Student's "t" test has been applied for analysis

Table 2: Comparison of mean arterial pressure and heart rate

Parameters	Group D (n=61)	Group V (n=61)	P-value
Mean arterial pressure			
Baseline	92.7±7.01	90.6±9.7	0.169
1 min	106.7±8.4	101.25±8.6	0.001*
3 min	96.1±8.2	90.9±11.3	0.005*
5 min	89.8±7.9	85.6±9.9	0.011*
Heart rate			
Baseline	87.6±12.5	88.46±11.5	0.679
1 min	102.7±11.9	101.1±10.9	0.434
3 min	94.6±11.4	93.6±11.3	0.600
5 min	90.8±11.5	89.9±10.7	0.649

Continuous data presented as mean±standard deviation. Analyzed using Student's "t"-test. Group A: Combined lateral position with throat pack *in situ*, Group B: Lateral position alone, (*): Statistically significant

Table 3: Characteristics of procedure time

Parameter	Group D (n=61)	Group V (n=61)	P-value
Procedure time			
Glottic visualization time (seconds)	11.8±4.6	16.5±6.7	<0.001
Intubation time (seconds)	17.6±6.2	21.2±4.8	<0.001
Total procedure time (seconds)	29.5±9.9	38.5±10.9	<0.001
Number of attempts			
First attempt	55	58	0.298
Second attempt	6	3	

The data about number of attempts is presented as number of patients, and analyzed using the Chi-square test. Others are continuous data and analyzed with t-test

DL use. The mean total procedure time for Group D was considerably lesser during use of DL compared with the use of VL (mean, 29.5 vs. 38.5 s, respectively, <0.001). While comparing the number of intubation attempts between the two groups, it was observed that most of the participants were successfully intubated in the first attempt in both groups (Table 3).

During DL, considerably more number of patients (ten patients) had Grade 3 view compared with VL use. However, POGO scores were comparable between the two groups (Table 4).

Table 4: Laryngoscopic view

Parameters	Group D (n=61)	Group V (n=61)	P-value
POGO score			
100% view	37	38	0.326
50–100% view	18	21	
<50% view	6	2	
Cormack–Lehane grade			
Grade 1	21	37	0.004
Grade 2	30	22	
Grade 3	10	2	
Grade 4	0	0	

Data are presented as the number of patients. Analyzed with Chi-square test

DISCUSSION

In the present study, the use of Tuoren VL has resulted in less hemodynamic changes compared with use of Macintosh DL. The use of VL has resulted in about 5 mmHg less MAP at 1 min after intubation, mean values 101 versus 106 mmHg, respectively. Rise in HR was not significant between the two groups at 1 min, 3 min, and 5 min post-intubation. The procedure time of laryngoscopy and intubation was considerably longer during use of Tuoren VL compared with Macintosh DL. The degree of increase in heart rate was almost similar in both the groups, and thus they remained comparable. It translates in to the fact that use of VL yielded increased heart rate response similar to use of DL. The longer procedure time with VL may contribute this increased heart rate response, thus nullifying the benefit of VL. The observation of the present study is in agreement with a recent study by Mogahed et al.,[7] who found that the use of King Vision VL resulted in considerably less increase in HR and MAP at 2 min and 5 min after intubation compared with use of Macintosh DL.[10]

In three different studies, glidescope was found to be associated with lower hemodynamic fluctuations compared with Macintosh DL in patients with untreated hypertension,[20] parturients undergoing elective cesarean section[21], and patients undergoing orthopedics surgery.[22] Maassen et al.,[23] found that video laryngoscopy was associated with less cardiovascular response such as an increase of rate pressure product from baseline values compared to classic DL in cardiac patients. Similarly, Elhadi et al.,[6] observed that the MAP and HR were significantly less with use of King Vision VL immediately after intubation and 10 min after intubation compared with use of Macintosh DL. Woo et al.,[4] observed a higher HR with use of Macintosh DL over Pentax Airway Scope while systolic and diastolic pressures remained comparable.

Some studies observed comparable hemodynamic responses using the two devices. Pournajafian et al.,[9] observed comparable hemodynamic response between the uses of Glidescope and Macintosh DL. Tempe et al.,[11] also found that the hemodynamic responses with Truview VL, McGrath VL, and Macintosh DL were comparable. Similarly, Kanchi et al.,[24] observed comparable hemodynamic changes between Pentax VL and Macintosh DL in cardiac patients posted for coronary artery bypass graft.

The present study finds that considerably longer procedure time for laryngoscopy and intubation using Tuoren VL compared with Macintosh DL (mean, 38 s vs. 29 s, respectively). This is in line with the study of Parasa et al.,[12] who observed that use of Glidescope yielded a better glottic view at the cost of longer procedure time, more hemodynamic response, and mucosal injury for endotracheal intubation compared with Macintosh DL. Some previous studies have also reported prolonged intubation times with VL as compared to Macintosh DL.[9,24-27] Increased glottis visualization time with use of VL may be attributed to less skill of the performer. Considerably longer intubation time with the VL may be explained by repeated manipulation (depth of insertion) and adjustment of laryngoscope blade position as were required during the use of VL.[12] Kanchi et al.,[24] postulated that if the procedure time for video laryngoscopy and intubation could be reduced, it would be possible to realize the benefit of VL in terms of hemodynamic response. There are other studies that report a contrast picture – demonstrating equal and possibly faster endotracheal intubation with VL.[28,29]

In the present study, during DL, considerably more number of patients (ten patients) had Grade 3 view compared with VL use. However, POGO scores were comparable between the two groups. During DL using Macintosh DL, the Cormack–Lehane grade of laryngoscopic view has been found a valid marker of difficult tracheal intubation. In contrast, during use of indirect glottic visualization systems, a good view of the glottis (Cormack–Lehane Grades I and II) is often obtained in most of cases. However, in such cases, difficulties in tracheal intubation do not rely on glottic view quality, rather it depend on tube manipulations. The duration of these manipulations often longer than the time required to achieve optimal glottis exposure. Hence, the Cormack and Lehane grade of laryngoscopy and the "intubation difficulty scale" appear to be less relevant in comparing indirect glottis viewing systems with the conventional intubation technique and may not be an appropriate measurement tool.[30] In a study, Lascarrou et al.,[31] observed a comparable first-pass orotracheal intubation rates using VL and DL. The authors concluded that improving glottis exposure alone during use of VL may not ensure success in tracheal intubation.[31]

The specific Tuoren VL that was used in the present study has been made available for the use approximately 1 year before the start of the present study. Moreover, the conducting anesthesiologist had the opportunity to gain prior experience and to acquire skill with the use of another type of VL (King Vision) available in the present Institute for past 5 years. However, considerably prolonged intubation time was observed with the use of VL. This indicates about the need for further practice to improve the skill. Greater airway stimulation with elevated pressures can be expected in less experienced hands and this could potentially nullify the beneficial effects of the VL. Moreover, with practice, the procedure time for VL is expected to shorten.

The structure of the blade in Tuoren VL device might help to reduce the hemodynamic response. The design of the Tuoren VL differs from that of the conventional blade in the fact that the former is based on the oropharyngeal anatomy. The wide area of the anatomically designed blade lifts the oropharyngeal structure, thus reducing the amount of force applied per unit area. DL warrants a direct line of sight to align the airway axis (oral-pharyngeal-laryngeal) for optimal glottic visualization. Often, to align these axes, there is a need for manipulations such as head extension, neck flexion, laryngeal manipulation, and other stressful movements. The maximal lifting force applied to the base of the tongue during the use of Macintosh laryngoscope can be as high as 30–50 N.[32,33] However, a much lower force is exerted by the VL and glottic visualization can be achieved without alignment of the anatomical axes. Hence, VL requires the application of less force (5–14 N) to the base of the tongue and, therefore, is less likely to stimulate stress response.[30] Goto et al.[33] used a high-fidelity simulator to evaluate the forces applied to the tongue by the Airway Scope VL and the Macintosh DL during intubation. They found that the Airway Scope facilitated intubation with considerable less force on the tongue compared with the Macintosh laryngoscope (11 N vs. 27 N). It is therefore thought that the Tuoren VL blade facilitated laryngoscopy and intubation with considerably less painful manipulation, thus leading to hemodynamic stabilization during intubation.

Limitations of the study

The present study has some limitations. Although the study has evaluated VL in contrast with DL, the patients with difficult airway were not included in the study. The performance of VL should be further evaluated in difficult airway situation. The study was single-blind. The credentials of performing anesthesiologist were limited only with 50 procedures with each device in past 3 months. It was a single-center study.

CONCLUSION

Tuoren video laryngoscope can be a better alternative to Macintosh direct laryngoscope in view of considerably lesser rise of mean arterial pressure and similar heart rate response during laryngoscopy and intubation in hypertensive patients. Achieving proficiency with specific video laryngoscope with regular practice can shorten the duration of laryngoscopy and has the potential to unveil further advantages.

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