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Original Article

Haemodynamic Response to Four Different Laryngoscopes

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Abstract

Objective: In this prospective randomized study, we aimed to evaluate the effect of tracheal intubation with four different laryngoscopes [Macintosh direct laryngoscope-classic laryngoscope (CL), McCoy (MC), C-Mac video-laryngoscope (CM) and McGrath video-laryngoscope (MG)] on haemodynamic responses in patients with a normal airway.

Methods: One hundred and sixty patients were included. Succeeding haemodynamic measurements were performed immediately after intubation (T2) and for 5 min with 1-min intervals (T3-T4-T5-T6-T7). The primary outcome was the heart rate (HR) and systolic blood pressure (SBP) change triggered by the four different laryngoscopes. The intubation time, the number of intubation attempts, need for stylet or additional manipulation, glottic view and traumatic complications caused by intubation procedure were recorded as secondary outcomes.

Results: HR values significantly increased with the completion of laryngoscopy and intubation at T2 for the CL, MC and CM groups. Lesser fluctuation in HR and SBP was observed in the MG group. Intubation time was significantly shorter in the MG group ($p<0.001$). There was no statistically significant difference between the groups regarding the number of intubation attempts, need for stylette and glottic view. Fewer patients in the MG and CM groups experienced a moderate and severe sore throat than in the other two groups. Shorter intubation time and lesser sore throat incidence were observed in the MG group.

Conclusion: MG offers less haemodynamic stimulation than CL, MC, and CM. Our findings showed that tracheal intubation with MG is advantageous in preventing cardiovascular stress responses with short intubation time and less sore throat incidence.

Keywords: Haemodynamic response, laryngoscope, tracheal intubation

Introduction

During laryngoscopy, the stimulation of the supra-glottic area leads to an increase in the plasma catecholamine concentration due to the activation of the sympathoadrenal system (1). The transition of the endotracheal tube (ETT) through the vocal cords and inflation of the tube cuff at the infra-glottic region is also responsible for the phenomenon, but this contribution is less important than the abnormal force administered during laryngoscopy to the base of the tongue to lift the epiglottis (2). Thus, following laryngoscopy and endotracheal intubation, pathophysiological undesired effects, such as an increase in heart rate (HR) and intravascular, intraocular and intracranial pressure as well as rhythm disturbance and bronchoconstriction frequently occur (3). Haemodynamic changes vary among patients and may be exaggerated in certain populations. Although healthy and young patients generally tolerate these responses well, patients with limited coronary reserve may experience myocardial ischaemia, acute heart failure or serious arrhythmia (4).

The prevention or reduction of this aggravated sympathoadrenal response provoked by laryngoscopy and endotracheal intubation is an important issue for the anaesthesia practice. This practice concerns a group of medication to blunt the response, but the choice of an alternative intubation laryngoscope can also be significant. Alternative laryngoscopes are used to facilitate laryngoscopy and to improve the glottic view in cases of a difficult airway. These laryngoscopes can provide this ameliorating effect with less suspension and distension force, which will probably result in less haemodynamic changes during laryngoscopy.

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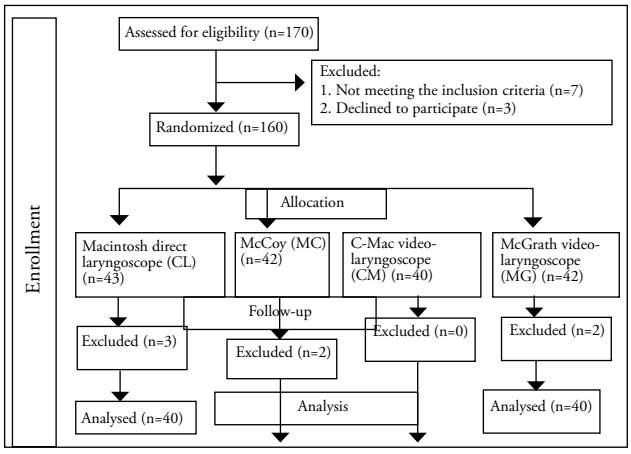

Figure 1. Flow diagram of the study

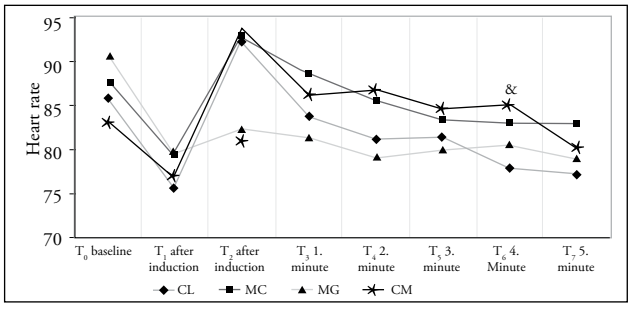

Figure 2. Heart rate changes during the study period
(Only intergroup significances are showed)
*p<0.001 compored to CL, MC and CM, &p<0.01 compared to MG and CM
CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

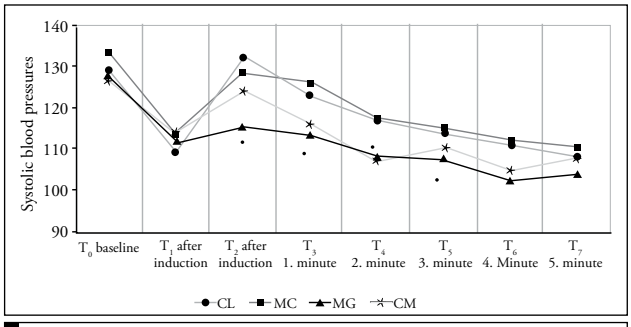

Figure 3. Systolic blood pressure changes during the study period
(Only intergroup significances are showed)
*p<0.001 compared to CL, MC and CM
CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

In this prospective randomised study, we aimed to evaluate the effect of tracheal intubation with four different laryngoscopes [two direct: Macintosh direct laryngoscopes-classic laryngoscope (CL) and McCoy (MC) and two indirect: C-Mac (CM) and McGrath (MG) video-laryngoscopes] on haemodynamic responses in patients with a normal airway.

Methods

This prospective randomised study was approved by the ethics committee of Istanbul University, Istanbul Faculty of Medicine (Date: 31/07/2014, No: 1191), and informed written consent was obtained from all patients. Hundred and seventy patients (aged, 18-65 years) with American Society of Anesthesiologists (ASA) I-II status requiring general anaesthesia with endotracheal intubation undergoing otologic and rhinologic surgery were enrolled. Patients with ASA status >II, a history or suspect of difficult airway (Mallampati >2, intraoral lesion, mouth opening <3 cm, thyromental distance <6 cm), hypertension, diabetes mellitus and treatment known to affect blood pressure or HR were excluded.

After entering the operating room, all patients were equipped with a 20G IV cannula, sedated with midazolam 0.05 mg kg^{-1} and monitored with ECG, non-invasive blood pressure, peripheral oxygen saturation and Bispectral Index (BIS). Baseline systolic blood pressure (SBP), HR and SpO_2 values were recorded as T_0. Standard anaesthetic technique including propofol 2-3 mg kg^{-1} and fentanyl 1.5 mcg kg^{-1} was applied to all patients. A BIS level of 45-55 was targeted and maintained during anaesthetic induction and the entire study period. When this level was obtained, 0.6 mg kg^{-1} rocuronium was administered to facilitate endotracheal intubation. Patients were ventilated by a facemask with 100% oxygen for 3 min following neuromuscular blockage, and the second measurement was performed as T_1 at this point.

Patients were randomly allocated to the CL, CM, MC or MG groups. The randomisation was made by computer generated numbers. The ETT size for female and male patients was predetermined as 7.0 and 7.5 mm, respectively. Size 3 and 4 laryngoscope blades were used for female and male patients, respectively. Intubation stylette was used if requested by the participant in case of intubation failure at the first attempt. All intubation procedures were performed by the same and experienced anaesthesiologist, who was familiar and trained (performed at least 20 intubations prior to the study) with all four laryngoscopes. Endotracheal cuff pressure was standardised to 25 cmH_2O via a manometer. Succeeding haemodynamic measurements were performed immediately after intubation (T_2) and for 5 min in 1-min intervals (T_3, T_4, T_5, T_6, and T_7). The study period was completed at the 5th min after endotracheal intubation.

The primary outcome of the study was HR and SBP changes triggered by the four different laryngoscopes. Furthermore, the intubation time, the number of intubation attempts, need for stylette or additional manipulation, glottic view (Cormack–Lehane) and traumatic complications caused by intubation procedure were recorded as secondary outcomes. Intubation time was defined as the interval starting with the entrance of the blade to the mouth and ending with the passage of the tip of ETT through the vocal cords. Finally,

patients were assessed for a sore throat at the second postoperative hour using an established 4-point scale (5). According to this scoring system, sore throat was graded as none: 1, mild (less severe than with a cold): 2, moderate (obvious to an observer): 3 and severe (aphonia): 4.

Patients requiring more than two attempts to achieve successful intubation and those in whom the BIS level exceeded 60 at any stage during the study period were excluded from the statistical analysis of data.

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS Inc.; Chicago, IL, USA) version 17.0.

Sample size calculation

After conducting a pilot study of ten patients using CL, an increase of 15±20 mmHg in SBP after intubation was observed. Based on this result, we assumed that 39 patients would be required in each group when predicting that this increase will be reduced by at least 30% with other laryngoscopes (assuming α=0.05 and β=0.1).

Therefore, we *a priori* decided to include 170 patients, in case of dropouts.

Distribution of each quantitative dataset was assessed for kurtosis and skewness, with –1.5 to +1.5 accepted as the normal distribution. Normally distributed quantitative data are presented as mean±SD.

Continuous data are presented as mean±SD and categorical data as the number of cases and percentage. Quantitative data were analysed using analysis of variance (ANOVA) for intergroup and repeated-measure ANOVA for intragroup comparison. Tukey's or Dunnett's test was utilised for post-hoc comparison. Qualitative data were compared using chi-square test. A p value of <0.05 was considered statistically significant.

Results

Hundred and seventy patients requiring general anaesthesia with endotracheal intubation for otologic and rhinologic surgery were recruited for this study. Three patients refused to participate, and 167 consenting patients were finally enrolled. In seven patients, successful intubation was achieved with more than two attempts; therefore, they were excluded from the study. The targeted BIS level was obtained and maintained in all patients, no patient was excluded because of proper anaesthetic depth failure. Data from the remaining 160 patients were included in the statistical analysis as shown in the flow diagram (Figure 1).

Demographic and basal haemodynamic data of patients are presented in Table 1. There were no statistically significant differences between the four laryngoscope groups with respect to age, sex, ASA status distribution, height, weight and basal haemodynamic parameters (Table 1). Morbidities co-existing in patients categorized ASA II were cigarette smoking without COPD, mild asthma or mild obesity.

Heart rate data analysis revealed that after anaesthetic induction (T_1), there was a significant drop in HR in all patients compared with baseline values, as seen in Figure 2. HR values significantly increased with the completion of laryngoscopy and intubation at T_2 for the CL, MC and CM groups but persisted without a significant change for the MG group. HR values returned to T_1 (after-induction) level at T_6 for CL, at T_7 for CM and at the end of the study period for MC. HR did not show any significant difference at any measurement time for MG and showed a stable profile during the entire study period. The intergroup comparison showed that the MG group had a significantly lower HR value at T_2 compared with that of other groups, whereas the MC group had a significantly higher HR at T_6. All inter- and intragroup comparisons of HR data are shown in Table 2, and in Figure 3, only intergroup comparisons are presented.

Systolic blood pressure values showed a parallel profile with HR data. Thus, a significant decrease in SBP after induction occurred for all groups followed by a significant increase after intubation, except for the MG group. The elevated SBP induced by laryngoscopy-intubation lasted 4 min for the CL group, returned to after-induction values at the 2nd min for the MC group and at the 3rd min for the CM group. Patients in the MG group did not experience any SBP elevation caused by laryngoscopy. SBP data are showed in Table 3. Intergroup SBP changes during the study period are presented in Figure 3.

Intubation time was found significantly different between the groups, being significantly shorter in the MG group (p<0.001) There was no statistically significant difference between the studied laryngoscopes regarding the number of intubation attempts, need for stylet and glottic view according to the Cormack-Lehane scale. Finally, fewer patients from the MG and CM groups experienced a moderate and severe sore throat than those from the other two groups (Table 4).

Discussion

In this randomised study that evaluated the intensity of the haemodynamic response to laryngoscopy using four different laryngoscopes, lesser fluctuation in HR and SBP was observed with MG. Shorter intubation time was solely related to MG, yet diminution in the sore throat was shared with CM. This is the first study comparing four laryngoscopes from two different categories (two direct laryngoscopes and two indirect video-laryngoscopes) regarding their influence on the haemodynamic response to laryngoscopy in patients with a normal airway.

Endotracheal intubation requires the elevation of the epiglottis and exposure of the glottic opening, which can be obtained by a forward and upward movement of the laryngoscope blade to lift the base of the tongue. Although the passage of the tip of ETT through the vocal cords is also responsible for the stress response caused by the intervention, the manifest haemodynamic alterations are mainly provoked by this combined oropharyngeal manipulation and is independent of the shape of blades (straight or curved) in case of direct laryngoscopes (6). By this point of view, Kaplan and Schuster emphasized the importance of pharmacologic reduction of this aggravated cardiovascular response considering that two different laryngoscopes caused similar consequences. (6) In our study, we focused on the effect of different devices on the laryngoscopy-induced haemodynamic response rather than pharmacologic manipulations.

Haemodynamic response associated with laryngoscopy and intubation is transient and ends within minutes; however, it can be harmful to some group of patients. Thus, several methods are in use in anaesthesia practice to blunt this phenomenon, including different premedication and induction regimes, augmenting the speed of anaesthetic agent administration and various systemic agents (beta blockers, lidocaine, etc.) (7). The rationale of using standardised sedation 10 min before the operating room access and BIS-guided standardised (agent and speed of injection) anaesthetic induction described by our protocol was to circumvent possible interference between anaesthetic regime application and the intensity of haemodynamic response to laryngoscopy intubation.

There is a considerable amount of clinical data in anaesthesia literature investigating the most suitable medical method to limit the laryngoscopy-induced haemodynamic response (8). However, limited studies have focussed on the non-pharmacological side of the challenge and few data exist exploring the influence of the choice between different laryngoscopes and alternative intubation laryngoscopes on unwanted haemodynamic events (9). However, with the evolution of alternative intubating laryngoscopes in the market designed for difficult airways, clinical investigations are growing based on the opinion that different laryngoscopes may produce different haemodynamic responses.

We compared two direct laryngoscopes and two video-laryngoscopes, thus four different techniques, and observed haemodynamic consequences. CL and MC were compared in Haidry and Khan's study (10), and MC group was found to have significantly lower HR and SBP augmentation following laryngoscopy. Their results are different from our data that showed a similar haemodynamic profile between the CL and MC patients. Although their intergroup data comparison shows statistical significance, parallel haemodynamic profile (augmentation after laryngoscopy and return to baseline value) is apparent and this phenomenon is similar to our data evaluation. The discrepancy between their findings and our findings may arise from their different induction regimen and neuromuscular blocking protocol (10). Some other studies did not show any difference between CL and MC (11, 12).

Certain alternative laryngoscopes and video systems were also previously compared with CL to investigate haemodynamic

Table 1. Demographic data and baseline haemodynamic parameters

	CL (n=40)	MC (n=40)	MG (n=40)	CM (n=40)
Age (year)	34.2±13.12	32.4±11.12	34.7±12.44	35.9±12.9
M/F	19/21	21/19	23/17	14/26
ASA status	33/7	30/10	35/5	33/7
(I/II)				
Height (cm)	165.25±8.5	169.6±8.7	164.7±7.9	165.4±9.5
Weight (kg)	69.69±13.4	73.68±14.06	69.02±11.02	65.82±13.46

Data are presented as mean ± standard deviation (SD). CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

Table 2. Heart rate data

	CL (n=40)	MC (n=40)	MG (n=40)	CM (n=40)
T_0 Baseline	85.85±19.12	87.9±12	90.72±12.23	83±16.8
T_1 After induction	75.57±13.9$^{\#}$	79.35±12.4$^{\#}$	79.5±11.17$^{\#}$	76.8±11.95$^{\#}$
T_2 After intubation	93.22±14.74*	92.25±12.7*	82.32±10.3$^{\&}$	93.65±15.5*
T_3 1stmin.	83.7±13.9*	88.42±11.43*	81.5±10.9	86.22±14.34*
T_4 2ndmin.	81±12.8*	85.55±9.37*	79.72±11.2	86.6±13.45*
T_5 3rdmin.	81.3±14.9*	83.47±9.58**	80±10	84.57±12.56*
T_6 4thmin.	77.9±11.2	83±10.1	80.45±10.5	85±10.9*$^{¥}$
T_7 5thmin.	77.12±10.8	82.82±10.36	79.05±11.27	80.12±14.9

$^{\#}$p<0.05 compared with T0, *p<0.01 compared with T1, **p<0.05 compared with T1, $^{\&}$p=0.004 compared with CL, MC and CM, $^{¥}$p=0.021 compared with CL, MC and MG.
Data are presented as mean ± standard deviation (SD). CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

Table 3. Systolic blood pressure data

	CL (n=40)	MC (n=40)	MG (n=40)	CM (n=40)	p
T_0 Baseline	128.9±13.6	133.37±14.47	127.4±12	126.7±17.8	0.179
T_1 After induction	109±16.8[&]	113.3±16.4[&]	111.52±16[&]	113.7±16.8[&]	0.572
T_2 After intubation	132±18.3[#]	128.4±22.5[#]	115.42±20.7*	124±18.44[#]	<0.01 Compared with CL and McCoy
T_3 1st min.	123±14.7[#]	125.77±20.5[#]	113.5±14.4*	116.5±19	<0.05 Compared with McCoy
T_4 2nd min.	117±13.5[#]	117.25±18.17	108.12±15.63*	107±11.3*[#]	<0.05 Compared with CL and McCoy
T_5 3rd min.	114±13.37[#]	115±17.6	107.27±14.76	110±15	0.093
T_6 4th min.	111±12.5	112±16.4	102.37±15*[#]	104.6±12.6*[#]	<0.05 Compared with CL and McCoy
T_7 5th min.	108±12	110±17.3	104.17±14[#]	107.6±16[#]	0.362

[&]p<0.01 compared with T0, [#]p<0.01 compared with T1. Times comparison were shown with & and #. Group comparisons were shown with *. Data are presented as mean ± standard deviation (SD). CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

Table 4. Laryngoscopy and intubation data

	CL (n=40)	MC (n=40)	MG (n=40)	CM (n=40)	p
Intubation time (s)	24±8.2	26.7±8.5	12.8±7.6	20.37±9.7	<0.0001*
Intubation attempt (1/2)	34/6	35/5	35/5	35/5	0.982
Cormack–Lehane (1/2/3)	17/20/3	15/22/3	21/17/2	18/18/4	0.873
Need for stylet/manipulation	4/14	1/9	0/9	2/8	0.095
Sore throat	16	9	2	5	0.006**

*Tukey's post-test: MG and CM significantly shorter than CL and MC, **Tukey's post-test: MG and CM significantly shorter than CL and MC. Continuous data are presented as mean ± standard deviation and categorical data as the number of cases and percentage. CL: Macintosh direct laryngoscope-classic laryngoscope; MC: McCoy laryngoscope; MG: McGrath video-laryngoscope; CM: C-Mac video-laryngoscope

responses caused by airway manipulation. A study on lightwand intubating laryngoscope versus direct laryngoscopy (with and without intubation) revealed that the lightwand group had the same haemodynamic profile as the classical laryngoscopy without intubation (13). Another video-laryngoscope (GlideScope) was compared with Macintosh laryngoscope in Xue et al.'s study (14), but no difference was found concerning haemodynamic responses caused by laryngoscopy. Their result correlates with our CM group data, and we believe that this is a consequence of a similar blade design of the two laryngoscopes.

Some other studies have made multiple comparisons between alternative laryngoscopes and CL and showed no benefit for the attenuation of haemodynamic response induced by laryngoscopy (15). Siddiqui et al. (16) compared Glidescope and Trachlight versus CL and obtained a similar haemodynamic response with all the three laryngoscopes. Finally, McGrath, Truview PCD and Macintosh were investigated by Tempe et al. (15) and did not show significant differences between laryngoscopes. These results are parallel to our data for CM but disagree with data for our MC group that was advantageous to attenuate laryngoscopic haemodynamic response. This contradictory finding may be the result of different properties of the medical status of study populations. They studied a group of patients undergoing coronary artery bypass grafting (CABG) procedure and who were already preoperatively medicated by some vasoactive agents. We believe that this long-lasting use of these agents (Ca-channel antagonists, beta blockers, etc.) may blunt the intensity of the haemodynamic response.

Another issue is that prolonged intubation time may exacerbate hypertension and tachycardia by augmenting the period to be subject to physical forces executed by laryngoscopes (17). In our study, we observed that the time from laryngoscopy to the end of intubation was shorter with video-laryngoscopes, particularly the shortest with MC. Parallel to our result, Shin et al. (18) have reported a similar decrease in intubation time with MC and CM compared with direct laryngoscopy in a normal airway. We believe that this shorter time required to accomplish the intervention plays a key role in the beneficial haemodynamic profile of MG. The difference between two video systems concerning intubation time can be originated from blade length, which is approximately 3-cm shorter in MG than in CM in no. 4 blades. In that case, choosing a smaller CM blade size may help to overcome these limitations, but smaller and lighter form of the MG handle should be considered as another factor that allows for an easier manipulation. Finally, close position of the screen to the blade ameliorates the performance of the operator.

Previous reports have demonstrated that several contributing factors, including age, sex, large tracheal tube, aspiration and intracuff pressure, play a role for the sore throat after orotracheal intubation (19). In the present study, none of these factors differed among the groups. Our results showed that MG and CM offer a significant advantage over direct laryngoscopes to reduce the incidence of a postoperative sore throat.

Our study has some limitations. First, we studied these four laryngoscopes according to our department's facilities. Currently, there are several options in this area; thus, it is not possible to compare all these groups of laryngoscopes in a single centre study. Second, the arterial blood pressure was not invasively monitored because of the ethic committee's consideration. Finally, our study population comprised patients with ASA I-II with a normal airway; therefore, our results cannot be extrapolated to other patient groups with concomitant medical problems or anticipated difficult airway.

Conclusion

McGrath video-laryngoscope offers a lesser haemodynamic stimulation than CL, MC, and CM in patients with ASA I-II with a normal airway. Additionally, we obtained a shorter intubation time and lesser sore throat incidence with MG. Based on our findings, we propose that tracheal intubation with MG is advantageous in preventing cardiovascular stress responses with short intubation time and less sore throat incidence.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Istanbul University School of Medicine (Date: 31/07/2014, No: 1191).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - D.A., E.Ç.; Design - D.A., E.Ç.; Supervision - E.Ç., T.Ö.S.; Resources - D.A., A.Ö.; Materials - D.A., A.A., A.Ö.; Data Collection and/or Processing - D.A., T.Ö.S.; Analysis and/or Interpretation - D.A., E.Ç.; Literature Search - E.Ç., T.Ö.S.; Writing Manuscript - D.A.; Critical Review - E.Ç.

Conflict of Interest: The authors have no conflicts of interest to declare.

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