Randomized controlled study comparing the hemodynamic response to laryngoscopy and endotracheal intubation with McCoy, Macintosh, and C-MAC laryngoscopes in adult patients

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Abstract

Background and Aims: Earlier studies have shown that the type of laryngoscope blade influences the degree of hemodynamic response to endotracheal intubation. The aim of the study was to evaluate the hemodynamic response to oral endotracheal intubation with C-MAC laryngoscopy and McCoy laryngoscopy compared to that of Macintosh laryngoscopy in adult patients under general anesthesia.
Material and Methods: This is a prospective randomized parallel group study. Ninety American Society of Anesthesiologists I patients were randomly allotted into three groups. Group A - Macintosh laryngoscopy (control group). Group B - laryngoscopy with McCoy laryngoscope. Group C - laryngoscopy with C-MAC video laryngoscope. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were monitored at baseline (just before induction), just before intubation (T0), 1 min (T1), 3 min (T3), 5 min (T5), and 10 min (T10) after intubation. Intergroup comparison of study parameters was done by unpaired sample t-test for normal data and Mann-Whitney U-test for skewed data. For within-group comparison, the repeated measures of ANOVA for normal data and Friedman followed by Wilcoxon signed rank test for skewed data were performed.
Results: In C-MAC group, the HR was significantly higher than the Macintosh group at 3 min after intubation, whereas SBP, DBP, and MAP were significantly higher at 1 min. McCoy group showed a similar response compared to Macintosh group at all time intervals.
Conclusion: C-MAC video laryngoscope has a comparatively greater hemodynamic response than Macintosh laryngoscope.

Key words: Anesthesiology, arteries, blood pressure, ephedrine, hypertension, laryngoscopy

Introduction

Both laryngoscopy as well as endotracheal intubation individually contribute to the hemodynamic pressor response following endotracheal intubation.[1] It has also been shown that the type of laryngoscopic blade influences the degree of hemodynamic response.[2,3] Videolaryngoscopes have shown varying results such as Pentax AWS® (Pentax Corporation, Tokyo, Japan) has an attenuated response, whereas Glidescope® (Saturn Biomedical System Inc., Burnbaby, Canada) has shown similar hemodynamic response compared to Macintosh laryngoscopy and endotracheal intubation.[4,5] However, there are no studies evaluating the hemodynamic response of C-MAC® video laryngoscope (KARL STORZ GmbH & Co. KG, Tuttlingen, Germany) for endotracheal intubation. Hence, we compared the hemodynamic response to oral endotracheal intubation using McCoy and C-MAC laryngoscopy with that

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of conventional Macintosh laryngoscopy in adult patients posted for elective surgery under general anesthesia. One recent study[6] has shown that C-MAC® videolaryngoscopy needed less duration of laryngoscopy for successful intubation compared to Macintosh laryngoscopy even in lateral position. Duration of laryngoscopy is an expected variable to affect the degree of hemodynamic response to endotracheal intubation. Hence, we hypothesized that the McCoy or C-MAC laryngoscopy produces an attenuated hemodynamic response to laryngoscopy and oral endotracheal intubation compared to Macintosh laryngoscopy.

Material and Methods

With the Institute Ethics Committee's approval (CSP-MED/14/FEB/12/34 dated 13-03-2014) and informed consent from all patients, this prospective randomized parallel group study was carried out. The procedures followed were in accordance with the ethical standards of the Institutional Research Ethics Committee standards and with that of the Helsinki Declaration of 1975, as revised in 2000. We included ninety American Society of Anesthesiologists (ASA) I patients of 18-40 years of age posted for elective surgery under general anesthesia. Pregnant women, patients undergoing emergency surgery and those with airway abnormalities, and anticipated difficult airway (Mallampati Class III and IV, thyromental distance <6 cm, inter-incisor distance <3 cm, and cervical instability) were excluded from the study. In addition, the patients in whom laryngoscopy lasted for more than 30 s and if more than one intubation attempt was needed were also excluded. The study population was randomly allocated into three groups, namely Group A (n = 30) — laryngoscopy with Macintosh laryngoscope (blade size 3) — control group, Group B (n = 30) - laryngoscopy with McCoy laryngoscope (blade size 3), and Group C (n = 30) — laryngoscopy with C-MAC video laryngoscope (D-blade). Randomization was done by computer-generated random numbers and concealed by sealed envelope technique. This was done by a separate anesthesiologist who was not involved in performing laryngoscopy or data collection during the study. Laryngoscopy and intubation were performed by a single senior anesthesiologist in all cases, who was familiar and experienced in intubation using both McCoy and C-MAC laryngoscope. Endotracheal tubes of size 8.5 mm ID in males and 7.5 mm ID in females were used. The endotracheal tubes were loaded with stylet shaped in a hockey stick fashion in all patients. Standard intubating pillow was used during intubation. Standard monitoring was done with electrocardiogram — II and V leads, noninvasive blood pressure, and pulse oximetry (Phillips IntelliVue MP50., Philips Healthcare, Netherlands). After preoxygenation for 3 min with 100% oxygen, anesthesia was induced with midazolam 1 mg, fentanyl 2 mcg/kg, and thiopentone 5 mg/kg intravenously, and maintained with sevoflurane 2% in 100% oxygen. After checking for mask ventilation vecuronium 0.1 mg/kg was administered intravenously. At the end of 3 min, tracheal intubation was done. $EtCO_2$ was maintained below 40 mmHg to avoid the effects of hypercarbia on the hemodynamic variables during the study period. No other medications were administered or procedures performed during the 10 min data collection period after endotracheal intubation. The study parameters monitored were heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP). The above parameters are measured at the following intervals: Baseline (BL - before induction), just before intubation (T0), and 1 min (T1), 3 min (T3), 5 min (T5), and 10 min (T10) after intubation. The first reading of all the parameters after connecting the monitor inside the operating room and before preoxygenation was taken as BL reading. All the study parameters were collected and documented by the same observer who is blinded for the type of laryngoscope used. Other parameters measured are duration of laryngoscopy with a stop clock by an independent observer.

Duration of laryngoscopy was defined as the time from the insertion of laryngoscope into the oropharynx till the appearance of first $EtCO_2$ curve. Intubation response was defined as: The hemodynamic changes in terms of HR, SBP, DBP, and MAP that occurs immediately and within 10 min after oral endotracheal intubation. Significant hemodynamic response that would warrant intervention is defined in the study as a change in HR or blood pressure with a 20% change from BL. Decrease in blood pressure or HR was treated with injection ephedrine 6 mg intravenous boluses.

Sample size calculation was done based on a pilot study done by us prior to the study with ten patients in each group comparing the hemodynamic response to laryngoscopy and oral endotracheal intubation with Macintosh, McCoy, and C-MAC videolaryngoscope. SBP was taken as the primary outcome. Comparison of Macintosh and C-Mac group needed a sample size of 25 in each group to detect an effect size of 10 mmHg in the systolic pressure at a standard deviation (SD) of 12.8 with a power of 80% and alpha error of 0.05 whereas comparison of Macintosh and McCoy group needed a sample size of about 23 patients in each group to detect an effect size of 13.6 mmHg in systolic pressure at a SD of 16 with a power of 80% and alpha error of 0.05. Hence, we included thirty patients allowing for 15% dropouts. Sample size calculation based on the data of previous study[7] comparing the hemodynamic response with Macintosh and McCoy laryngoscopy also arrived at a similar sample size.

The collected data were analyzed with SPSS for Windows, Version 16.0 (SPSS Inc., Chicago, IL, USA). To describe about the data descriptive statistics, mean and SD were used. The normality of the data was verified with Shapiro-Wilk's test. HR, DBP, and demographic data had a normal distribution whereas SBP and MAP had a skewed distribution. The demographic data were analyzed by one-way analysis of variance. To find the significant difference between the bivariate samples in independent groups, the unpaired sample *t*-test was used for normal data and Mann-Whitney U-test for skewed data. For the repeated measures, the repeated measures of ANOVA with adjustment for multiple comparisons to control the Type I error, with Bonferroni test was used for normal data and Friedman followed by Wilcoxon signed rank test for skewed data. In all the above statistical tools, the $P < 0.05$ was considered significant level. Those patients who needed intervention with ephedrine were excluded from the study, since the subsequent readings would be affected by its administration.

No changes in the study design was done after the commencement of the study. No dropouts from the study population occurred during the course of the study.

Results

The demographic data in terms of age, weight, and height was similar in all groups [Table 1]. There was no statistically significant difference in the BL values of all the study parameters among the three groups.

On studying each group separately, in Group A (Macintosh), there was no statistically significant increase in any of the study parameters at all study intervals after intubation compared to the BL value [Tables 2 and 3]. Whereas in Group B (McCoy), there was a statistically significant increase in HR response at 1 min interval (T1) from BL value with $P = 0.003$, and at other time intervals, there was no significant rise from BL in any of the study parameters [Tables 2 and 3].

There was a statistically significant increase in the HR at 1 min (T1) ($P = 0.001$) and 3 min (T3) ($P = 0.004$) interval from the BL HR in Group C. Whereas there was a statistically significant increase in DBP ($P = 0.01$) and MAP ($P = 0.03$) at T1 interval compared to the BL in Group C (C-MAC). At other time intervals, there is no rise but a significant fall in the values compared to the BL value [Tables 2 and 3].

Table 2 compares the changes in HR and SBP of Group B and Group C with that of Group A. The difference in HR at 3 min interval (T3) after intubation between Group A and Group C was statistically significant $t(58) = 2.782$, $P = 0.008$. The HR was significantly higher in Group C compared with Group A at 3 min (T3) interval. At other time intervals, there is no significant difference in HR on comparing Group B and Group C with that of Group A.

There was a significant difference in SBP observed when comparing Group A with Group C $U = 294$, $P = 0.01$, and $r = 0.42$ at 1 min (T1) after intubation. At other intervals, there was no statistically significant difference in SBP on comparing Group B and Group C with that of Group A.

Table 3 compares the changes in mean DBP and mean artery pressure of Group B and Group C with that of Group A. There is a statistically significant difference in DBP observed between Group A and Group C, $t(58) = 2.301$, $P = 0.03$ at 1 min interval (T1) after intubation. At other time intervals, there are no statistically significant changes in DBP on comparing Group B and Group C with that of Group A.

There is a statistically significant difference in mean artery pressure observed on comparing Group A with Group C; $U = 320$, $P = 0.04$, and $r = 0.35$ at 1 min interval (T1) after intubation. At other intervals, there are no statistically significant changes in MAP on comparing Group B and Group C with that of Group A.

Discussion

We found that C-MAC laryngoscope has higher hemodynamic response to tracheal intubation compared to conventional Macintosh laryngoscopy and intubation in these ASA I patients. While comparing the Macintosh with McCoy laryngoscopy, we found that there is no significant difference in terms of hemodynamic response to orotracheal intubation between the two laryngoscopic methods. Some of the previous studies have shown that there is no difference in hemodynamic response between McCoy laryngoscope and conventional Macintosh laryngoscopy.[8-11] One study[7] comparing McCoy and Macintosh laryngoscope found that the McCoy group had less hemodynamic response when fentanyl was not included as premedicant, but there was no difference when fentanyl was used as premedicant.

In our study, both the Macintosh and McCoy group did not show any significant increase in the study parameters, but there was a decreasing trend after intubation. This can be attributed to the difference in the inclusion criteria compared to other studies, namely the ASA status and the age group. Unlike earlier studies, we included only the ASA I patients belonging to 18-40 years of age group in our study.

Table 1: Comparison of demographic data among groups

Parameter (*n* = 30)	Mean ± SD			*P*
	Group A	Group B	Group C	
Weight (in kg)	62.0±11.6	61.9±11.3	67.8±13.9	0.113
Height (in cm)	157.8±5.1	159.7±8.4	164.1±8.4	0.06
Age (in years)	28.6±6.8	33.1±5.8	32±5.8	0.15

n = Number of patients, SD = Standard deviation

Table 2: Comparison of mean heart rate and systolic blood pressure of Group B and Group C with Group A

Parameters	Time interval	Mean ± SD				
		Group A	Group B	*P*	Group C	*P*
HR (beats/min)	BL	88.5±12.8	85.3±13.0	0.39	84.3±9.9	0.23
	T0	82.2±12.9	82.2±12.9	0.34	82.3±9.9	0.90
	T1	90.3±14.0	92.8±11.9	0.62	93.8±12	0.31
	T3	83.9±11.7	88.3±10.8	0.33	92.3±10.2	0.008
	T5	79.1±10.9	81.3±13.5	0.68	85.4±12.9	0.09
	T10	76.4±11.0	78.3±14.4	0.94	75.3±10.9	0.82
SBP (mmHg)	BL	127.2±12.8	125.9±14.3	0.3	126.1±12.8	0.5
	T0	101.1±9.9	104.6±11.4	0.4	104.3±12.0	0.4
	T1	118.1±15.8	122.0±16.6	0.3	128.3±17.7	0.01
	T3	111.1±16.8	111±17.2	0.9	117.9±23.7	0.3
	T5	102.3±10.7	102.5±9.8	0.8	105.7±13.9	0.4
	T10	101±10.4	101.2±10.7	0.9	99.1±10.1	0.5

BL = Baseline, HR = Heart rate, SBP = Systolic blood pressure, SD = Standard deviation

Table 3: Comparison of mean diastolic blood pressure and mean arterial pressure in Group B and Group C with Group A

Parameters	Time interval	Mean ± SD				
		Group A	Group B	*P*	Group C	*P*
DBP (mmHg)	BL	77.9±8.4	76.5±10.6	0.5	77.0±8.6	0.7
	T0	59.1±9.8	66.1±9.7	0.001	65.1±10.8	0.01
	T1	75.8±16.1	76.9±16.1	0.8	86.5±17.7	0.03
	T3	69.1±14.8	70.4±11.6	0.4	74.3±18.3	0.2
	T5	62.8±9.7	65.7±8.9	0.2	68.2±12.5	0.09
	T10	60.5±9.4	63.8±10.4	0.1	61.4±10.8	0.8
MAP (mmHg)	BL	93.7±16.8	91.9±12.6	0.7	91.6±10.9	0.7
	T0	73.0±8.6	77.2±10.4	0.2	75.0±9.5	0.4
	T1	88.6±16.3	92.1±15.5	0.3	98.4±17.7	0.04
	T3	83±13.4	83.2±12.1	0.7	87.1±18.7	0.4
	T5	76.0±10.6	78.3±8.1	0.07	79.2±13.2	0.3
	T10	74.3±10.7	75.7±9.0	0.2	72.4±10.2	0.3

BL = Baseline, MAP = Mean arterial pressure, DBP = Diastolic blood pressure, SD = Standard deviation

A recently published study[12] compares the hemodynamic response to endotracheal intubation with Macintosh and C-MAC videolaryngoscope in cardiac surgical patients. They found no significant change between the two groups in terms of the hemodynamic response to laryngoscopy and endotracheal intubation. This particular study has been done in heterogeneous cardiac surgical patients with varied cardiac pathology coming for CABG, valvular surgeries, etc. The patients were on drugs such as beta blockers which itself would have influenced the degree of hemodynamic response to endotracheal intubation, while our study has shown that C-MAC has an increased hemodynamic response to intubation compared to Macintosh laryngoscopy and endotracheal intubation. The difference in the study population would have contributed to the difference in the outcome between the two studies.

The major limitation was the difficulty in blinding with this study design which could have led to a potential bias in the study. However, we ensured that a separate anesthesiologist not knowing the type of laryngoscopy is involved in data collection. Secondly, the learning curve of the new technique of laryngoscopy with C-MAC videolaryngoscope has not been established and this would have affected the hemodynamic response to endotracheal intubation. Experience of the anesthetist performing the laryngoscopy may affect the outcome. We had one experienced senior anesthesiologist doing all the laryngoscopies.

Another limitation is that we have included only ASA I patients in our study. The authors did this to avoid the potential bias that would happen when a wide variable group such as ASA II patients was included. Such patients may have conditions such as hypertension, diabetes, and hypothyroidism, which can affect the hemodynamic response to oral endotracheal intubation. Furthermore, conducting the entire study in controlled hypertensives will be technically difficult to recruit patients as well as to standardize the confounding factors such as drug therapy. Moreover, the authors felt that attenuation of hemodynamic response to endotracheal intubation is also important in these ASA I patients while providing general anesthesia.

Conclusion

Our study showed that McCoy and Macintosh laryngoscopies have similar hemodynamic response to direct laryngoscopy and endotracheal intubation, but C-MAC video laryngoscopy and endotracheal intubation have an increased hemodynamic response than conventional Macintosh laryngoscopy and intubation in patients undergoing general anesthesia.

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Conflicts of interest
There are no conflicts of interest.

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