Comparison of Glottic View and Haemodynamic Stress Response Associated with Laryngoscopy using the Macintosh, McCoy and Miller Blades in Adult Patients

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ABSTRACT

Introduction: Laryngoscopy induces haemodynamic response which has implications for patients with cardiovascular illnesses. We devised this study to compare the laryngoscopic view of the glottis obtained with the Macintosh, McCoy and Miller blades, and corresponding haemodynamic changes.
Material and Methods: 105 ASA grade I and II patients randomly divided into three groups were intubated using Macintosh, McCoy and Miller blade respectively. Cormack and Lehane grade of glottic view obtained, heart rate, systolic and diastolic blood pressure at baseline, immediately before induction, following induction, and at 1, 3 and 10 minutes after intubation were noted. Epi Info 7.2 was used for statistical analysis. Chi square and ANOVA tests were applied to compare haemodynamic parameters.
Results: 18 patients (51.4%) were CL grade I and 17 (48.6%) were CL grade II in Macintosh, 24 (68.6%) were CL grade I and 11 (31.4%) were CL II in McCoy and, 32 (91.4%) were CL I and 3 (8.6%) were CL II in Miller group. Rise in heart rate following intubation was greatest with Miller blade, followed by Macintosh and least with McCoy, and was statistically significant ($P< 0.01$). Rise in both, systolic and diastolic blood pressure following intubation was highest with the Miller blade, followed by Macintosh and least with McCoy, and the difference compared with baseline values was statistically significant ($P<0.01$).
Conclusions: Miller blade provides best visualization of larynx but McCoy blade produced least haemodynamic response, hence the latter is preferable when less haemodynamic response is desired.

Keywords: Laryngoscope Blade, Macintosh, McCoy, Miller, Cormack and Lehane Grading, Haemodynamic Response

INTRODUCTION

Laryngoscopy followed by endotracheal intubation is an important part of administration of general anaesthesia. The aim of laryngoscopy is to obtain good visualization of the vocal cords to facilitate smooth endotracheal intubation so that period of apnoea during intubation can be minimized. Direct laryngoscopic view is best attained in 'sniffing the morning air' position obtained by placing a pillow under the occiput of the patient. This brings the laryngeal and pharyngeal axes into closer alignment. Subsequent extension of the head at the atlanto-occipital joint aligns the oral axis with pharyngeal and laryngeal axes.[1] To improve view of the glottis and reduce haemodynamic response to intubation, laryngoscopic blades of different shapes have been designed and studied.

In 1941, Robert Miller first described the straight laryngoscope blade. RR Macintosh developed the first curved laryngoscope blade in 1943, which was found to be much easier to use. In 1993, the McCoy or flexitip blade modification of standard Macintosh blade was introduced. The tip of this blade is hinged and has a lever attached to the proximal end. With the tip of the blade in the epiglottic vallecula, pressing on the lever causes the tip to act on the hyoepiglottic ligament which lifts the epiglottis out of view to expose more of the glottis.

Many factors are known to influence laryngoscopic view of vocal cords. These include forward displacement of mandible, prominent or absent teeth and backward displacement of the tongue. Various types of laryngoscopic blades have been designed to improve view of the vocal cords.[2,3]

Furthermore, laryngoscopy and endotracheal intubation trigger haemodynamic stress responses; one due to sympathetic stimulation, releasing catecholamines that leads to tachycardia and hypertension which increases the myocardial oxygen demand, and the other due to vagal stimulation leading to parasympathetic activation that manifests as bradycardia and hypotension. Both of these can be catastrophic in patients with known history of ischemic heart disease.[4,5]

Thus, it is desirable that blades used for laryngoscopy trigger minimal stress response and at the same time, facilitate good laryngoscopic view for smooth endotracheal intubation.

We designed a randomized prospective study to compare the glottic view and haemodynamic response elicited by

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How to cite this article: Sarika Samel, Bhaskar Murlidhar Patil, Abhinob Roy. Comparison of glottic view and haemodynamic stress response associated with laryngoscopy using the macintosh, McCoy and miller blades in adult patients. International Journal of Contemporary Medical Research 2019;6(9):I11-I16.

DOI: http://dx.doi.org/10.21276/ijcmr.2019.6.9.50

using Macintosh, Miller and McCoy laryngoscopes for endotracheal intubation in general anaesthesia for elective surgery.

MATERIAL AND METHODS

A prospective, randomized study was done on total 105 patients studied for one year.

The identity and other details of enrolled patients were kept confidential. After institutional Research Ethics Committee approval, male and female patients of ASA grade I and II posted for surgery under general anaesthesia, were selected for participation in the study.

In a study by Patil AP et al, Macintosh blades were compared to Flexitip blades with respect to stress response, laryngoscopic view and external manipulation, and the authors found the mean heart rate and standard deviation of the Macintosh blade group were 84.8 and 10.829 respectively at 10 minutes after intubation, while the mean and standard deviation of the McCoy blade group were 77.26 and 9.15 respectively at 10 minutes after intubation.[6] Applying the formula of difference between means, minimum exact sample size calculated was, 28 in each group. We took 35 as the sample size of each group. This calculation was done using the online 'OpenEpi Open Source Calculator - SS mean' tool that could be accessed at https://www.openepi.com/SampleSize/SSMean.htm.

According to the blade used for the laryngoscopy for endotracheal intubation, using a web-based randomization tool available at https://www.randomizer.org/, patients were divided into the following groups:

Group I: Laryngoscopy and endotracheal intubation, with Macintosh blade.

Group II: Laryngoscopy and endotracheal intubation, with McCoy ('flexitip').

Group III: Laryngoscopy and endotracheal intubation, with Miller blade.

A day prior to the planned procedure, detailed history of the patient was taken during the preoperative assessment visit. A thorough clinical examination was conducted and necessary investigations were sent and results noted. Airway assessment was done using the Modified Mallampati Score. All patients were kept nil per oral for 8 hours before surgery. Injection ranitidine 150 mg was administered to all patients on the night before surgery.

On the day of planned procedure, routine balanced general anaesthesia was administered to patients. After induction of general anaesthesia, patient was given the 'sniffing position'. In group I, direct laryngoscopy was done using Macintosh blade, and Cormack and Lehane grading recorded. High-volume, low-pressure cuff endotracheal tube was placed in the trachea. Endotracheal tubes of internal diameter 6.5 mm to 7.5 mm for females and 8 mm to 9 mm for males were preferred. Similarly, in group II direct laryngoscopy was done using McCoy blade, and Cormack and Lehane grading recorded. And in group III, direct laryngoscopy was done using Miller blade and Cormack and Lehane grading recorded followed by endotracheal intubation.

Heart rate, systolic and diastolic blood pressure were recorded at baseline, immediately before induction, immediately following induction, and at 1, 3 and 10 minutes after intubation of all patients.

Outcome measures

Cormack and Lehane grade of glottic view obtained with laryngoscopy in each patient was noted.

Heart rate, systolic blood pressure and diastolic blood pressure in Group I, Group II and Group III were measured and recorded:

1. Before shifting patient to operating room (baseline)
2. Just before induction
3. Immediately following induction
4. 1 minute after intubation
5. 3 minutes after intubation
6. 10 minutes after intubation.

STATISTICAL ANALYSIS

Data was entered into a Microsoft Excel 2007 sheet, and analyzed with SPSS version 20.0. Qualitative data like sex of patient, history of coexisting illnesses etc was analyzed. Quantitative data like heart rate, systolic and diastolic blood pressure were recorded at baseline, just before induction, immediately following induction, and at 1, 3 and 10 minutes after intubation and analyzed. Data obtained was processed using Analysis Of Variance (ANOVA) test, inter group comparison, and P value<0.05 was considered statistically significant. Using Research Randomizer (a computer-based random number generator), three sets of random numbers for three blades were generated. Each set contained 35 random numbers. Chi square test was applied as required and the ANOVA test was applied to compare haemodynamic parameters. 95% confidence interval was taken and P values less than 0.05 were considered positive for test of significance.

RESULTS

Table 1 shows the distribution of subjects according to gender, age, ASA grade and MPC grade in all the three groups. There was no statistically significant difference in the distribution of subjects with respect to these parameters in all the three groups ($P = 0.30$). Table 1 also shows CL (Cormack-Lehane) grade in all the three groups. Out of 35 patients intubated with Macintosh, 18 (51.4%) were CL grade I and 17 (48.6%) were CL grade II. Out of 35 patients intubated with McCoy 24 (68.6%) were CL grade I and 11 (31.4%) were CL II. And out of 35 patients intubated with Miller blade, 32 (91.4%) were CL I and 3 (8.6%) were CL II. Thus, visualisation of larynx was best with Miller blade, followed by McCoy and then Macintosh blade, which was found to be statistically significant ($P < 0.01$).

Comparison of heart rates

Table 2 shows comparison of mean heart rate between the groups according to laryngeal blades used for intubation.

At 1 minute and 3 minutes after intubation, heart rate was increased in all the three groups with mean of 93.85 ± 6.28 and 83.51 ± 5.72 for Macintosh; 86.02 ± 7.89 and 80.02 ±

		Laryngeal blade used for intubation			Total
		Macintosh	McCoy	Miller	
Gender	Male	23(65.7%)	17(48.6%)	18(51.4%)	58
	Female	12(34.3%)	18(51.4%)	17(48.6%)	47
	Total	35	35	35	105
		X^2= 2.38, *P*=0.30			
Age	Mean	36.20	35.60	37.51	
	SD	11.51	9.97	10.12	
		P=0.74			
ASA grade	l	25 (71.4%)	32 (91.4%)	28 (80%)	85
	ll	10 (28.6%)	3 (8.6%)	7 (20%)	20
	Total	35	35	35	105
		X^2= 4.57, *P*=0.10			
MPC	l	28 (80%)	20 (57.1%)	23 (65.7%)	71
	ll	7 (20%)	15 (42.9%)	12 (34.3%)	34
	Total	35	35	35	105
		X^2= 4.26, *P*=0.11			
CL grade	l	18 (51.4%)	24 (68.6%)	32 (91.4%)	74
	ll	17 (48.6%)	11 (31.4%)	3 (8.6%)	31
	Total	35	35	35	105
		X^2= 13.51, *P*<0.01			

Table-1: Comparison of gender, age, ASA grade, MPC and CL grade between the study groups.

Time of recording of heart rate	Laryngeal blade used for intubation						*P* Value
	Macintosh		McCoy		Millers		
	Heart Rate						
	Mean ± SD	Change in %	Mean± SD	Change in %	Mean ± SD	Change in %	
Baseline	72.22±7.73		75.68±8.57		76.45±10.25		0.93
Pre-induction	83.11±7.43	15.07%	83.31±8.57	10.08%	82.94±10.47	8.48%	0.64
Post-induction	73.82±7.19	2.21%	74.71±8.10	-1.28%	72.42±8.45	-5.27%	0.48
1 minute after intubation	93.85±6.28	29.96%	86.02±7.89	13.66%	131.54±12.06	71.78%	<0.01
3 minute after intubation	83.51±5.72	15.63%	80.02±7.59	5.73%	110±11	43.88%	<0.01
10 minute after intubation	74.57±6.62	3.25%	75.08±7.60	-0.79%	83.62±9.22	9.38%	<0.01

Table-2: Comparison of mean heart rate between the groups according to laryngeal blades used for intubation

Time of recording of systolic blood pressure	Laryngeal blade used for intubation						P Value
	Macintosh		McCoy		Miller		
	Systolic blood pressure						
	Mean ±SD	Change in %	Mean ±SD	Change in %	Mean ±SD	Change in %	
Baseline	122.65 ±8.01		121.88 ±8.03		113.28 ± 10.64		0.12
Pre-induction	127± 8.04	3.54%	126.05 ±8	3.42%	129.91 ± 10.70	14.68%	0.17
Post-induction	119.08 ±7.83	-2.91%	120.48 ±7.97	-1.14%	119.08 ± 10.77	5.12%	0.75
1 minute after induction	139± 5.88	13.33%	132.45 ±6.76	8.67%	162.31 ± 12.65	43.28%	<0.01
3 minute after induction	127.57 ±5.92	4.01%	125.48 ±7.40	2.96%	140.80 ± 11.70	24.29%	<0.01
10 minute after induction	118.37 ±7.70	-3.4%	120.37 ±7.60	-1.23%	121.34 ± 11.31	7.11%	0.37

Table-3: Comparison of systolic blood pressure between the groups according to laryngeal blades used for intubation

Time of recording of diastolic blood pressure	Laryngeal blade used for intubation						P Value
	Macintosh		McCoy		Millers		
	Diastolic blood pressure						
	Mean ±SD		Mean±SD		Mean±SD		
Baseline	77.02 ±6.91		78.02 ±5.46		80.22 ±8.41		0.15
Pre-induction	79± 6.88	2.57%	80.68±5.36	3.40%	82.71 ±7.52	3.10%	0.09
Post-induction	75.48 ±6.82	-2%	76.08 ±5.59	-2.4%	76.05 ±8.28	-5.19%	0.92
1 minute after induction	86.34 ±6.09	12.10%	83.37 ±5.73	6.85%	100.51 ±7.51	25.29%	<0.01
3 minute after induction	80.54 ±6.25	4.57%	79.42 ±5.43	1.79%	89.94 ±8.01	12.11%	<0.01
10 minute after induction	75.54 ±6.31	-1.92%	76.60 ±5.79	-1.8%	78.28 ±7.92	-2.41%	0.23

Table-4: Comparison of diastolic blood pressure between the groups according to laryngeal blades used for intubation

7.59 for McCoy, and 131.54 ± 12.06 and 110 ± 11 for Miller blade respectively. While at 10 minutes post intubation, the mean heart rate for Macintosh and McCoy blades i.e., 74.57 ± 6.62 and 75.08 ± 7.60, were close to the baseline while the mean heart rate for Miller blade was 83.62 ± 9.22.

There was no statistically significant variation in heart rate at baseline across the groups, and when compared to immediate pre induction and post induction periods in all the groups.

Rise in heart rate following intubation was greatest with Miller blade, followed by Macintosh and least with McCoy blade which was found to be statistically significant (P< 0.01).

Comparison of systolic blood pressure

Table 3 shows comparison of systolic blood pressure between the groups according to laryngeal blades used for intubation. There was no statistically significant variation noted in systolic blood pressure at baseline across the groups, and when compared to immediate pre induction and post induction periods in all the groups.

Macintosh group

The mean systolic blood pressure at baseline in this group was 122.65 ± 8.01 and the mean pre induction and the mean post induction systolic blood pressure was 127 ± 8.04 and 119.08 ± 7.83 respectively. At 1 minute after intubation, there was a rise in systolic blood pressure to 139 ± 5.88, followed a gradual fall in systolic blood pressure at 3 minutes and 10 minutes after intubation with a mean systolic blood pressure 127.57 ± 5.92 and 118.37 ± 7.70 respectively.

McCoy group

The mean systolic blood pressure at baseline in this group was 121.88 ± 8.03 and the mean pre induction and the mean post induction systolic blood pressure was 126.05 ± 8 and 120.48 ± 7.97 respectively. At 1 minute after intubation, there was a rise in systolic blood pressure to 132.45 ± 6.76, followed by a gradual fall in systolic blood pressure at 3 minutes and 10 minutes after intubation with a mean systolic blood pressure 125.48 ± 7.40 and 120.37 ± 7.60 respectively.

Miller group

The mean systolic blood pressure at baseline in this group was 113.28 ± 10.64 and the mean pre induction and the mean post induction systolic blood pressure was 129.91 ± 10.70 and 119.08 ± 10.77 respectively. At 1 minute after intubation, there was a rise in systolic blood pressure to 162.31 ± 12.65, followed by a gradual fall in systolic blood pressure at 3 minutes and 10 minutes after intubation with mean systolic blood pressure 140.80 ± 11.70 and 121.34 ± 11.31 respectively.

Following intubation, at 1 minute and 3 minutes there was increase in systolic blood pressure with mean of 139 ± 5.88 and 127.57 ± 5.92 respectively in Macintosh group, as compared to 132.45 ± 6.76 and 125.48 ± 7.40 respectively in McCoy group and 162.31 ± 12.65 and 140.80 ± 11.70 respectively in Miller group. These observations at 1 minute and 3 minutes after intubation were found to be statistically significant (P<0.01). However the mean systolic blood pressure at 10 minutes after intubation with Macintosh, McCoy and Miller blade were 118.37 ± 7.70, 120.37 ± 7.60 and 121.34 ± 11.31 respectively, but the difference was not statistically significant.

Thus, systolic blood pressure following intubation was highest with the Miller blade, followed by Macintosh and least with McCoy blade which was found to be statistically significant (P<0.01)

Comparison of diastolic blood pressure

Table 4 shows comparison of systolic blood pressure between the groups according to laryngeal blades used for intubation. The changes observed in diastolic blood pressure before and after induction and at different time intervals between Macintosh, McCoy and Miller blade. The diastolic blood pressure taken just before entering the OT was taken as the baseline value for comparison.

Macintosh group

The mean diastolic blood pressure at baseline in this group was 77.02 ± 6.91 and the mean pre induction and the mean post induction diastolic blood pressure was 79 ± 6.88 and 75.48 ± 6.82 respectively. At 1 minute after intubation there was a rise in diastolic blood pressure to 86.34 ± 6.09 followed by a gradual fall in diastolic blood pressure at 3 minutes and 10 minutes after intubation with a mean diastolic blood pressure 80.54 ± 6.25 and 75.54 ± 6.31 respectively.

McCoy group

The mean diastolic blood pressure at baseline in this group was 78.02 ± 5.46 and the mean pre induction and the mean post induction systolic blood pressure was 80.68 ± 5.36 and 76.08 ± 5.59 respectively. At 1 minute after intubation there was a rise in diastolic blood pressure to 83.37 ± 5.73 followed by a gradual fall in diastolic blood pressure at 3 minutes and 10 minutes after intubation with a mean diastolic blood pressure 79.42 ± 5.43 and 76.60 ± 5.79 respectively.

Miller group

The mean diastolic blood pressure at baseline in this group was 80.22 ± 8.41 and the mean pre induction and the mean post induction diastolic blood pressure are 82.71 ± 7.52 and 76.05 ± 8.28 respectively. At 1 minute after intubation there was a rise in diastolic blood pressure to 100.51 ± 7.51. There was a gradual fall in diastolic blood pressure at 3 minutes and 10 minutes after intubation with mean systolic blood pressure 89.94 ± 8.01 and 78.28 ± 7.92 respectively.

There was no statistically significant variation noted in diastolic blood pressure at baseline across the groups, and when compared to immediate pre induction and post induction periods in all the groups.

At 1 minute and 3 minutes after intubation, there was increase in diastolic blood pressure with mean of 86.34 ± 6.09 and 80.54 ± 6.25 respectively above baseline in Macintosh group, as compared to 83.37 ± 5.73 and 79.42 ± 5.43 respectively in McCoy group, and 100.51 ± 7.51 and 89.94 ± 8.01 respectively in Miller group. These observations at 1 minute and 3 minutes after intubation were found to be statistically significant (P<0.01). However the mean diastolic blood pressure 10 minutes after intubation with Macintosh, McCoy and Miller blade were 75.54 ± 6.31, 76.60 ± 5.79 and 78.28

± 7.92 respectively, which was not statistically significant. So, diastolic blood pressure following intubation was highest with the Miller blade, followed by Macintosh and least with McCoy blade which was found to be statistically significant (*P*<0.01).

DISCUSSION

Laryngoscope blades of different shapes have been designed to aid and ease the process of intubation. Laryngoscopy and endotracheal intubation trigger major stress response, in the form of increased catecholamines leading to tachycardia and hypertension, which increases myocardial oxygen demand, thus can be sometimes catastrophic in patients with cardiovascular disease, geriatric age group, and patients with raised intracranial pressure. The shape of a laryngoscope blade affects the degree of exposure of the larynx, while the amount of force exerted by the operator in attempts to achieve satisfactory exposure of the glottis during laryngoscopy and intubation is the key determinant for mechanical stimulation of stretch receptors present in the respiratory tract. The use of certain types of laryngoscope blades can help in achieving reduction in the amount of force required for exposure and thus, lower the stimulation of stretch receptors and reduce haemodynamic response.

In this prospective randomized study we evaluated the laryngoscopic view and haemodynamic response associated with use of Macintosh, McCoy and Miller blades and found that visualisation of the larynx was best with Miller blade, followed by McCoy and then Macintosh which was found to be statistically significant (*P*<0.01). Similar findings were obtained in the study by Ashok Kumar B K et al.[7] Atul P Kulkarni et al compared the extent of glottis visualization and ease of intubation with Macintosh, Miller, McCoy blades and the Trueview® laryngoscope and they found that glottis visualization was best achieved with straight blades such as Miller blade and TrueView® laryngoscope, but trachea was more easily intubated with McCoy and Macintosh blades and Trueview® laryngoscope.[8] Arino JJ et al evaluated the Macintosh, McCoy, Miller, Belscope and Lee-Fiberview laryngoscopes for grade of laryngeal visualization and the difficulty of intubation and found that the glottic views obtained with the Belscope and Miller laryngoscopes were similar to each other, and better than with the other types of laryngoscopes. They also found that though laryngoscopy was better with straight blades, curved blades provided better conditions for intubation.[9] Nishiyama T et al compared the stress response during laryngoscopy using three different laryngoscopes, Macintosh, Miller and McCoy. Systolic blood pressure after laryngoscopy was slightly higher in the Miller group than in two other groups. Plasma epinephrine concentration after laryngoscopy was lower in the McCoy group than the other two groups. These results suggest that the stress response during laryngoscopy without intubation is highest with the Miller blade and the least with the McCoy blade.[10] A comparative study of haemodynamic stress response to laryngoscopy with the McCoy, Macintosh and the Miller blades by G. Venkatesan et al showed that the haemodynamic stress response was least with the McCoy, greatest with Miller and intermediate with Macintosh blade.[11] McCoy EP, Mirakhur RK et al compared the stress response to laryngoscopy using the Macintosh and McCoy blade by measuring clinical cardiovascular parameters and catecholamine concentrations and concluded that the stress response to laryngoscopy is less marked with McCoy blade and that it is probably due to lesser magnitude of force necessary to obtain a clear view of the larynx.[12]

The results we obtained reinforce findings of earlier studies and show that the Miller blade affords the best glottic visualisation, followed by McCoy blade and then Macintosh blade, and the difference was found to be statistically significant (*P*<0.01). The McCoy blade elicited the least haemodynamic response, followed by Macintosh blade and the Miller blade produced the greatest haemodynamic response.

CONCLUSION

The McCoy blade produces the least haemodynamic response to laryngoscopy, followed by Macintosh blade and then Miller blade which produces the greatest haemodynamic response. The Miller blade provided the best visualization of the larynx during intubation but McCoy blade produced the least haemodynamic response during laryngoscopy, and hence the McCoy blade is preferable when less haemodynamic response to intubation is desirable.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 29-08-2019; **Accepted:** 24-09-2019; **Published:** 30-09-2019