

A Comparative Crossover Randomized Study of Miller and Macintosh Blade for Laryngoscopic View and Ease of Intubating Conditions in Adults

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ABSTRACT

Background: Although several types of laryngoscope blades of different sizes and shapes are present, Miller (MIL) blade is the most preferable blade among paediatric population. However, there is dearth in the literature regarding the use of these blades in the adult population. This study aimed to compare the laryngoscopic view and ease of intubation using MIL and Macintosh (MAC) blade among adults.

Methods: A total of 172 patients who were >18 years age, with ASA grades I and II, undergoing elective surgeries with general anaesthesia were included. Patients were distributed in two groups (MAC/MIL and MIL/MAC), where laryngoscopy was first done with MAC blade, followed by MIL blade in the MAC/MIL group and vice-versa in the MIL/MAC group. Grading of laryngoscopic views, number of attempts, ease of intubation and use of backward, upward, rightward pressure (BURP) were noted. R v 3.6.0 was used for statistical analysis and P values ≤ 0.05 were considered as statistically significant.

Results: MIL blade showed better laryngoscopic view compared to MAC blade (32.6% vs. 15.1%; $P < 0.002$). BURP application helped improve the laryngoscopic views with MAC blade. Intubation with MIL blade was easier with regards to ease of intubation and number of attempts 19 (P value < 0.05).

Conclusion: Glottis visualization is better with the MIL blade as compared to the MAC blade. Therefore, the MIL blade might be helpful in securing the airway among adult patients.

Skilful management of airway is primarily crucial for anesthetizing patients who are undergoing surgical procedures. Airway management consists of laryngoscopy, intubation and ventilation. However, successful intubation depends mainly on laryngoscopy. Optimal laryngoscopy should provide good glottis view, space for passing the tube easily, along with minimal haemodynamic changes. However, laryngoscopy depends on several factors like the skill of the operator, patient's airway anatomy, intubating conditions, the laryngoscope used and its blades.

Over several decades, many studies have been conducted to compare different types of laryngoscopes

and blades and study their clinical uses and limitations [1]. However, there is still a long-standing debate over the most appropriate type of blade used for laryngoscopy [2-3] which can be applied even in difficult scenarios, as meticulous management of the airway is of utmost importance to the anaesthesiologist.

There are around 30 different blades with unique specifications useful in various scenarios [4] but the most commonly used blades in day-to-day practice are Macintosh (MAC) blade and Miller (MIL) blades [5]. However, both the blades have certain advantages, such as MIL blade provides better glottis visualization, as it is

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a straight blade. However, MAC blade is a curved blade which provides an easier tracheal intubation [6].

Many studies have compared both MIL and MAC blades in the paediatric population [2,6]. However, video laryngoscopy is the most explored research area in adult population [7] and there is a dearth of evidence for use of MIL and MAC blade among adults. Therefore, we hypothesized that both blades perform similarly with regard to intubating conditions and haemodynamic changes in adult population. We designed this study to evaluate the clinical feasibility of using MIL vs. MAC blade in adult patients by comparing both types of blades in terms of superiority of laryngoscopic view, ease of intubation, number of attempts at intubation and haemodynamic changes occurring during intubation.

Methods

A prospective randomized open-label cross-over study was carried out at a tertiary care hospital during October 2016 to February 2018, after obtaining approval from the institutional ethical committee. The CTRI registration number applicable to the study is CTRI/2018/07/015064. A total of 172 patients posted for elective surgeries under general anaesthesia (GA), belonging to ASA grades I and II, of both genders and >18 years of age were included in the study. However, pregnant women, patients who were considered full stomach, patients with anticipated difficult intubation, having previous history of oral surgeries/oral thrush, pathology in neck, patients with ischemic heart disease or who refused to give consent were excluded. All patients were randomly distributed in two groups, namely MAC/MIL and MIL/MAC (86 patients in each group) by a computer-generated random number table. Written informed consent was obtained from each patient prior to an intervention. Standardized anaesthesia protocol was followed in all cases. In the MAC/MIL group, intubation was first done with MAC blade and followed by MIL blade. The reverse scenario was followed for MIL/MAC group, i.e., intubation with MIL blade, followed by MAC blade.

Patients abstained from solids for 6 hours and from liquids for 3 hours to clear fluids prior to anaesthesia. Patients were pre-medicated with one tablet of Ranitidine (150 mg) and Ondansetron (4 mg) with a few sips of water in the morning hours before surgery. Intravenous access was secured by 18G cannula before shifting the patients to operation theatre. All the base line parameters were noted using standard monitors, such as electrocardiogram (ECG) lead II, pulse oximeter (SpO₂), non-invasive blood pressure cuff (NIBP), end tidal CO₂ (ET CO₂). After putting all the patients in sniffing position, they preoxygenated with 100% oxygen for 3 minutes. Anaesthesia was inducted intravenously by injecting all the patients with fentanyl (2µg kg⁻¹) and propofol (2 mg kg⁻¹) body weight. Feasibility of

ventilation with face mask was checked prior to injection of muscle relaxant (0.5 mg kg⁻¹ body weight atracurium), and the patients were subsequently ventilated with 0.5-1% of isoflurane, oxygen and air till train-of-four (TOF) of 0 was achieved. Laryngoscopy was performed by the laryngoscopist, who had the experience of 50 intubation with both the blades. Patients were intubated with MAC or MIL blade first, according to the group they belonged. During intubation, the MAC blade was advanced along the right surface of the tongue while the MIL blade was advanced along the central surface of the tongue, the tips of both blades being placed in the vallecula. In the MAC/MIL group, initial laryngoscopic grading was noted first with a MAC blade, followed by a MIL blade and vice versa in the MIL/MAC group using modified Cormack and Lehane (CL) grading of the laryngoscopic views [8]. However, in case of CL grading 2a or more, backward, upward, rightward pressure (BURP) was performed by the laryngoscopist and any improvement in the laryngoscopic grading was noted. All the patients were also graded using modified Mallampatti grade [9]. An adequate depth of anaesthesia was maintained following each laryngoscopic attempt. However, patients were intubated after the second laryngoscopic attempt irrespective of the type of blade. Ease of intubation was graded during intubation [6] following intubation; bilateral air entry was confirmed by 5-point auscultation technique [10] and ET CO₂. Tube was secured and connected to circle breathing system. Immediately post intubation, haemodynamic parameters, namely systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), oxygen saturation (SPO₂) and heart rate (HR) were recorded after first laryngoscopy and second laryngoscopy at different time intervals (3 and 5 minutes, respectively) along with base line. The patients were ventilated with 100% oxygen between attempts at laryngoscopy and intubation and no patient was allowed to desaturate below 90% to minimize the effect of previous attempt and to reduce the complication. For each blade, the time required to view glottis was also recorded, where the time was recorded from insertion of the laryngoscope into the mouth till first glottis view was obtained. All the patients were injected with 4 mg of ondansetron post-surgery to prevent post-operative nausea and vomiting. The residual neuromuscular blockade was antagonized by injecting neostigmine (0.05 mg kg⁻¹) and glycopyrrolate (0.01 mg kg⁻¹) and patients were extubated once extubation criteria were met.

Sample size

Based on the previous study [7], where glottis was visualized in 63% patients using MAC blade compared to 83% patients using under Miller blade. The effect size Cohen's *h* based on the proportion of success in two groups (63% and 83%) is 0.4577966. The minimum

sample size required to detect the aforementioned effect size significant under 0.05 alpha error with 80% power is 75 per group. Therefore, a sample size of total 172 patients (86 patients per group) was justified to be included for the study.

Statistical Analysis

Data was analysed using R v 3.6.0. Results were represented as frequency and percentages for non-continuous variables, whereas continuous variables were presented as mean \pm standard deviation (SD). Unpaired T-test was used to compare the mean difference in SBP, DBP, MAP and HR between base line, after laryngoscopy 1 and after laryngoscopy 2 among MIL/MAC and MAC/MIL groups, along with the mean time taken to view the glottis by both the blades. Pearson Chi-square test was used to compare laryngoscopic view, ease of intubation and number of attempts between Macintosh and Miller blades. The agreement between CL grading between MIL/MAC and MAC/MIL group using Cohen Kappa test. A P value of ≤ 0.05 was considered statistically significant.

Results

The mean age of the patients was found to be 40.19 ± 13.265 years, ranging 18–65 years with female predominance (52.3%). Majority of patients belonged to ASA class I (66.9%) and Mallampati grade II (77.9%). There was a significant difference between patients' characteristics with respect to ASA and Mallampati grade ($P < 0.0001$; Table 1).

Table 1- Characteristics of patients

Patients characteristics	N (%)	P value
Gender	Female 90 (52.3)	0.61
	Male 82 (47.7)	
ASA Grade	I 115 (66.9)	$<0.0001^{***}$
	II 57 (33.1)	
Mallampati Grade	I 38 (22.1)	$<0.0001^{***}$
	II 134 (77.9)	

Note: *** indicates statistically significant P value of <0.0001

Laryngoscopic grades obtained with the two blades were shown in Table 2. A significant association was found between the scoring of MIL and MAC blade ($P < 0.002$). Most patients had laryngoscopic view of CL grade-1 with MIL blade (56/172; 32.6%) compared to CL grade-2a (63/172, 36.6%) with MAC blade, indicating a better laryngoscopic view with MIL blade compared to MAC blade (Table 2).

Table 2- Laryngoscopic view (LV) without BURP

Laryngoscopic view	Miller Blade					Total	
	1	2a	2b	3	4		
Macintosh Blade	1	8	10	4	4	0	26
	2a	29	14	10	10	0	63
	2b	13	10	23	8	0	54
	3	6	1	12	8	1	28
	4	0	0	0	1	0	1
Total	56	35	49	31	1	172	
Pearson Chi-Square	P = 0.002*						

Note: * indicates statistically significant P value of <0.01

However, 30.81% patients had similar laryngoscopic view with both blades. The kappa values of 0.1 and 0.03 was noted, showing a very slight and almost no agreement between CL scoring between MIL/MAC and MAC/MIL group, respectively. BURP was applied in 116/172 (67.44%) patients using MIL blade and in 146/172 (84.88%) using MAC blade during laryngoscopy. An improved laryngoscopic view was noted in 108/116 and patients in MIL/MAC group. Similar results of an improved laryngoscopic view was also noted in the MAC/MIL group 132 (103/146 patients).

The comparative account of time taken to view glottis, ease of intubation and number of attempts made while intubating were presented in (Table 3).

Table 3- Comparative account of intubation details of Miller's and Macintosh blade

Parameters	Blade Type		P value
	Miller Blade	Macintosh Blade	
Time required for glottis view (s)ξ	13.01 \pm 5.79	12.61 \pm 4.79	0.961
Number of Attempts€	1	80 (93)	0.019*
	2	6 (7)	
	3	0 (0)	
	4 (could not intubate)	0 (0)	
Ease of Intubation€	Grade 1	76 (88.4)	0.0001**
	Grade 2	8 (9.3)	
	Grade 3	2 (2.3)	
	Grade 4	0 (0)	

Note: ξ data presented as mean \pm SD€ data presented as frequency (%). * and ** indicate statistically significant with P values of <0.05 and <0.001

Time taken for glottis visualization was similar with both blades (13.01±5.79 vs. 12.61±4.79 seconds; P value: 0.961). The ease of intubation was significantly higher with MIL blade compared to MAC blade (grade 1: 88.4% vs. 58.1%; P value: 0.0001). Similar results were noticed with number of attempts, where the airway was intubated in the first attempt in more patients with MIL blade compared to MAC blade (93% vs. 75.6%; P value: 0.019), as presented in Table 3. All patients (86) in MIL

group were intubated successfully, whereas 4 (4.6%) patients out of 86 could not be intubated with MAC blade and had to be intubated with the MIL blade (Table 3). Hemodynamic changes were compared between baseline and post laryngoscopy (laryngoscopy 1 and laryngoscopy 2) between the MAC/MIL and MIL/MAC groups. Insignificant hemodynamic changes were observed for SBP, DBP, MAP and HR (P values >0.05) between the groups, as shown in (Table 4).

Table 4- Hemodynamic changes between Miller's and Macintosh blade

Blade type	SBP Mean ± SD	DBP Mean ± SD	MAP Mean ± SD	HR Mean ± SD
Mil/MAC				
Baseline	141.33±19.54	82.24±10.38	97.59±17.40	81.64±11.93
After laryngoscopy 1	114.83±19.15	70.16±13.45	81.17±17.13	81.27±12.01
After laryngoscopy 2	137.40±21.77	83.73±15.74	100.58±19.02	90.60±14.59
Mac/MIL				
Baseline	141.79±17.85	81.98±10.77	94.28±25.16	83.41±15.72
After laryngoscopy 1	116.99±21.55	71.74±14.68	84.57±17.03	79.62±13.95
After laryngoscopy 2	138.80±28.49	84.65±16.27	101.88±23.12	89.77±15.90
Unpaired T-test	P values: <0.81¥ and 0.65#	P values: <0.66¥ and 0.41#	P values: 0.29¥ and 0.10#	P values: 0.32¥ and 0.07#

Note: MIL/MAC: Miller/Macintosh; MAC/MIL: Macintosh/Miller; SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; HR: heart rate and SD: standard deviation.

¥ denotes P value on comparing Mac/Mil and Mil/Mac groups with respect to hemodynamic changes between baseline and laryngoscopy1. # denotes P value on comparing Mac/Mil and Mil/Mac groups with respect to hemodynamic changes between and laryngoscopy 1 and laryngoscopy 2.

Discussion

Most common procedures performed by the anaesthesiologist is direct laryngoscopy to secure the airway. Expert airway management is an essential skill of an anaesthesiologist. However, the blade used for laryngoscopy is one of the determining factors for successful intubation. An ideal blade should provide good laryngoscopic view, better intubating conditions (in terms of ease of intubation and number of attempts), minimal hemodynamic changes and complications. Thus, the present study was designed to compare the laryngoscopic view and ease of intubation using MIL and MAC blade in the adult population. This is the first crossover study that compared the MIL and MAC blades to the best of our knowledge.

In this study, we found that the laryngoscopic view was better with the MIL blade compared to MAC blade and were accorded with the findings of Vargheese et al. [8] and Wojewodzka-Zelezniakowicz et al. [11]. They stated that MIL blade provided better laryngoscopic view on comparing with MAC blade. Researchers also highlighted that MIL blade provided a better laryngoscopic view than MAC blade on manikin in normal and difficult airway scenario [8]. BURP has been proven to influence a change in the CL grade; however, contradictory results were reported [2, 12]. Therefore, we studied the use of BURP while intubating with both blades whenever the laryngoscopic view was poor.

Furthermore, BURP was used while intubating patients with MIL and MAC blade to improve the laryngoscopic grading. We noted that BURP was useful in improving laryngoscopic view and its use was more often needed with the MAC blade as compared to MIL blade. Our results were in accordance with the findings of Vargheese et al. [2] and they pointed out that BURP influenced the CL grade and MAC blade (15.1% vs. 59.9%) had more improved view grade compared to MIL blade (32.6% vs. 62.8%) following BURP. However, contradictory results were reported by Garhwal et al. [12] who noted that external manipulation was more frequently required in MIL group (71.67%) compared to MAC group (28.33%). This may be either due to mechanics of the blade [13] or employing a central approach of inserting the MIL blade, providing a good laryngoscopic view, but less favourable intubating conditions [14]. In case of limited laryngoscopic view, changing of a blade can provide a better glottis view because the tip of MIL blade is placed in the vallecula, which can provide satisfactory intubating conditions [2]. Moreover, MIL blade has an added advantage that it can be used in patients with a narrow mouth opening due to the sleek design of its blade [15]. In our study also, we changed blade in four cases where we failed to intubate patients with MAC blade, and MIL blade was used to aid intubation.

This study demonstrated that MIL blade was better than MAC blade with respect to ease of intubation and number of attempts. We observed grade 1 ease of intubation with MIL blade compared to MAC blade (88.4% vs. 58.1%)

with successful first attempt intubation (93% vs. 75.6%). Similar findings were reported by Wojewodzka-Zelezniakowicz et al. [11] that highlighted that patients were intubated in the first attempt using MIL blade (44.7% vs. 36.8%; P value: 0.045) Conversely, Kulkarni et al. [7] noted that ease of intubation was better with MAC blade with 90% of patients having grade 1 ease of intubation. Wojewodzka-Zelezniakowicz et al. [11] also pointed out that a shorter time was taken to intubate with MIL blade (37.5 vs. 40.5 seconds; P value: 0.011) and were not in accordance with the findings of this study (P value: 0.961).

Our findings showed that there were no significant hemodynamic changes between the MAC/MIL and MIL/MAC group during different stages of laryngoscopy, in concordance with the results of Baliarsing et al. [16]. Conversely, Nishiyama et al. [17], reported significantly higher SBP with MIL blade, compared to McCoy and MAC blade. However, they used three different types of blades for laryngoscopy. There were certain limitations to this study, such as a potential bias may exist due to a majority of patients belonging to ASA-I and Mallampatti-II group and injuries during laryngoscopy were not noted. Hence, a multicentric study with equal distribution of patients along with observation on the complications and injuries during laryngoscopy can be explored in future.

Conclusion

This study concluded that glottis visualisation is better with the MIL blade even when tip is placed in the vallecula. MIL blade can be easily intubated as compared to the MAC blade; however, similar amount of time is taken by both the blades to view the glottis. We conclude that the MIL blade may be more reliable for examining and securing the airway in adult patients under normal situations.

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