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Original Article

Comparison of Paraglossal Technique of Miller Blade Insertion with McCoy and Macintosh Adult Laryngoscopes on the Cormack–Lehane Grade in Patients with Simulated Restricted Neck Mobility—A Randomized Control Trial

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Abstract

Background The paucity in round-the-clock availability of advanced tools like flexible bronchoscopes and video laryngoscopes makes it preferable to have alternative easily available gadgets for securing the airway in patients with cervical spine injuries where head and neck movements must be strictly avoided. This study compared the paraglossal technique of Miller blade insertion with the McCoy and Macintosh laryngoscope blades on the Cormack and Lehane grading (CLG) in patients with simulated restricted neck mobility.

Methods We randomized 90 patients undergoing general anesthesia to be intubated either using Miller blade (Group-Mill), McCoy blade (Group-McCoy), or Macintosh blade (Group-Mac) following neck restriction using a soft cervical collar. CLG grade, the number of intubation attempts, use of bougie, intubation time, and hemodynamic parameters were noted. Nonparametric data were compared using the chi-squared test and parametric data using one-way analysis of variance.

Results Group-MILL had significantly higher patients with Grade-1 CLG compared to Group-Mac ($p = 0.02$). The number of attempts, use of bougie, and intubation time were, however, comparable among the three groups. The hemodynamic parameters at intubation were not significantly different among the groups.

Conclusion In adult patients with simulated restricted neck, the Miller laryngoscope blade, despite providing a better laryngeal view, showed no benefit in decreasing the intubation time when compared to the McCoy or Macintosh blades.

Keywords
- adult
- laryngoscopes
- airway management
- intubation

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Introduction

Tracheal intubation should be done with utmost precaution in patients with cervical spine injury. While inability to secure the airway can cause morbidity and mortality, restricting neck flexion–extension during attempts at intubation is also highly essential to prevent neurological damage. Restricting the neck movements makes visualization of the vocal cords difficult as the oral, pharyngeal, and laryngeal axes are not optimally aligned. Awake fiberoptic remains the gold standard for intubating such patients. However, it needs expertise and lacks widespread availability due to cost constraints and maintenance. Various other airway gadgets have also been used and several studies have compared them with different laryngoscopes in simulated restricted neck scenarios, either using a cervical collar or manual in-line stabilization.[1–6]

Studies have demonstrated the superiority of video laryngoscopes over conventional Macintosh and McCoy laryngoscope blades in such situations.[2,3,5] However, the use of Miller laryngoscope blade has not been studied.[7] In this study, we have compared the paraglossal technique of Miller laryngoscope with the McCoy and Macintosh adult laryngoscope blades in a simulated restricted neck scenario. Our primary objective was the comparison of Cormack and Lehane grade (CLG). Secondary objectives were the number of attempts, use of bougie, intubation time, and hemodynamics from baseline to 5 minutes postintubation.

Materials and Methods

This randomized controlled trial was approved by Institutional Human Ethics Committee (MGMCRI/Res//01/2019/07/IHEC/019) of a tertiary care teaching institute and registered with Clinical Trial Registry-India (CTRI/2020/10/028667, https://www.ctri.nic.in). It was performed from July 2021 to February 2022 and followed the principles laid down in the Declaration of Helsinki, 2013. Ninety patients receiving general anesthesia with endotracheal intubation were enrolled in the study. Patients, aged between 18 and 60 years, with American Society of Anesthesiologists physical status 1 and 2, body mass index (BMI) of 18 to 30 kg/m^2 who gave written informed consent for participation in the study, and use of the data for research and educational purposes were included. Patients with anticipated difficult airway, cervical neck injury, neck pathology, posted for emergency surgeries or with increased risk of pulmonary aspiration were excluded.

Block randomization was performed using the "Permuted block" feature of the "Statistics and Sample Size" Android app, version 25.0 (Truc TT, Ho Chi Minh City, Vietnam), with a predefined block size of ten. The randomization sequence was generated by a resident not involved in the study and handed over to the investigators in sealed opaque sequentially numbered envelopes containing the allocated group: Miller group: Group-MILL; McCoy group: Group-McCoy; and Macintosh group: Group-Mac. The patients were also blinded to the allocated group.

All patients included in the study were kept nil per oral (6 hours for solids and 2 hours for clear liquids) and received premedication with tab. alprazolam 0.5 mg and tab. pantoprazole 40 mg on the night before and morning of the surgery and tab. metoclopramide 10 mg in the morning of surgery. In the operating room, an 18-gauge intravenous (IV) cannula was inserted, and noninvasive blood pressure, electrocardiogram, and pulse-oximetry monitoring were attached (GE B40 monitor; GE Healthcare, Wisconsin, United States). Baseline hemodynamic parameters were noted. A restricted neck scenario was created using a soft cervical neck collar (TYNOR, Tynor Orthotics Private Limited, Mohali, India), medium or large, depending on patient's neck circumference and height of the neck as per the manufacturers' recommendation. There was no restriction in mouth opening in any patient because of the application of soft collar. All patients were preoxygenated for 3 minutes using the circle system and 8 L/min of oxygen. A standardized induction technique with 2µg/kg fentanyl, 2 mg/kg propofol, 0.1 mg/kg vecuronium, oxygen with nitrous-oxide (50:50), and sevoflurane titrated to deliver a minimum alveolar concentration of 1 MAC was used. The sealed envelopes were then opened to determine the allocated group. Based on the assigned group, direct laryngoscopy was performed with either Miller, McCoy, or Macintosh laryngoscope blades. All intubations were performed 3 minutes after IV vecuronium administration by a single consultant anesthesiologist. The paraglossal technique was used for insertion of Miller blade.[8] The best possible view of the glottis was obtained and the CLG was noted. A cuffed endotracheal tube of appropriate size was advanced into the trachea under direct vision. In case of failure to negotiate the tracheal tube into the vocal cords, an intubating bougie was employed and this was noted. Following intubation, the adequacy of ventilation was confirmed by chest auscultation and capnography. Mask ventilation was resumed if the saturation dropped to 95% or the time taken to intubation exceeded 90 seconds. A second attempt was then made by the same operator. If both attempts failed, it was considered a failure. The cervical collar was removed, and the trachea was intubated with the conventional laryngoscope in a sniffing position. The number of attempts was noted. Intubation time was defined from the removal of the mask to the appearance of the first waveform capnography. The first attempt success rate was defined as the passage of the endotracheal tube with or without bougie with a single laryngoscopy attempt. Hemodynamic parameters were recorded after induction, after intubation, and every 1-minute intervals for the first 5 minutes postintubation.

Sample Size Calculation

The sample size was calculated using R programming software. Anticipating that there would be a 20% difference in the number of patients with CLG 1 and 2 between the three groups, Group-MILL, Group McCoy and Group-Mac with 90% power and 5% level of significance with Bonferroni correction; the sample size was estimated as 30 in each group. Data was collected using a study proforma and entered into an MS

Excel sheet. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Chicago, United States) software. Qualitative data such as Gender, American Society of Anesthesiologists status, CLG, number of attempts, and use of bougie were interpreted using the chi-squared test. Age, weight, height, BMI, intubation time, and hemodynamics were summarized as mean and analyzed using one-way analysis of variance test. *p*-Value less than 0.05 was considered statistically significant.

Results

Ninety patients were screened for eligibility by continuous sampling and were found eligible for the study. None of the patients were excluded after randomization (►**Fig. 1**). Baseline characteristics were comparable among the three groups (►**Table 1**). There were no intubation failures in any group.

The proportion of patients with CLG of 1 and 2 was significantly higher in Group-MILL when compared with Group-Mac ($p = 0.02$) but comparable to Group McCoy ($p = 0.13$). ►**Table 2** The difference in CLG between Group McCoy and Group Mac was not significant ($p = 0.39$ ►**Table 2**). The mean time taken for intubation was, however, similar in all three groups ($p = 0.151$) ►**Table 2**. Four intubations in Group-MILL took much longer time than the rest in the group (►**Fig. 2**). Irrespective of the group, several patients who had a CLG of 2 also required a bougie for negotiating the tracheal tube into the larynx ($p = 0.54$) ►**Table 2**. Only four out of the 90 patients (2 in Group-MILL, 1 in Group-McCoy, and 1 in Group-Mac) in our study required a second attempt. The first attempt success rate was, therefore, 96% in Group-McCoy and Group-Mac, and 93% in Group-MILL.

There was no significant difference in the heart rate (HR) at any time point among the three groups (►**Fig. 3**). The mean arterial pressure (MAP) following intubation was

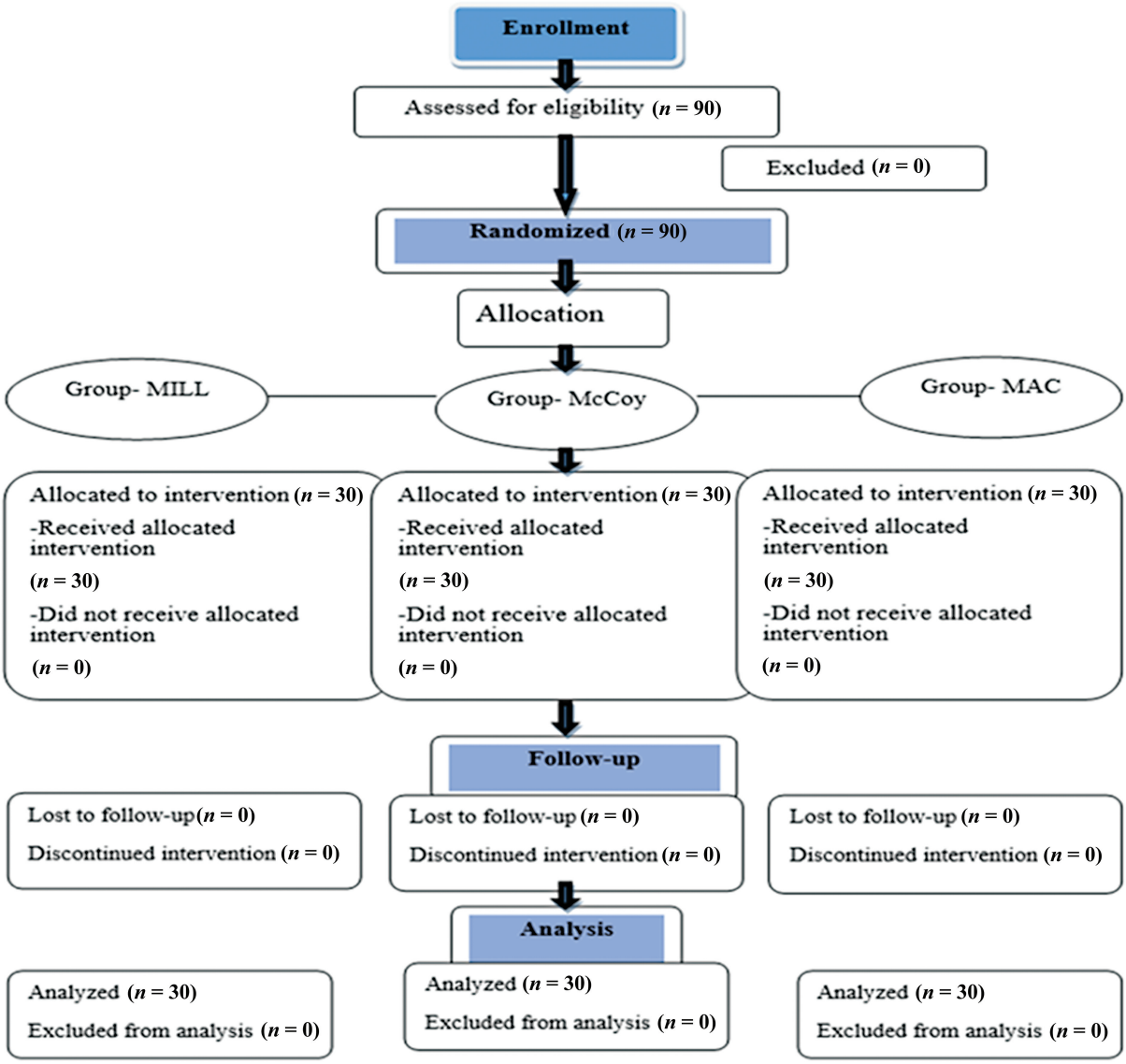

Fig. 1 Consolidated standards of reporting trials flow diagram.

Table 1 Demographic data

Variables	Group-MILL $n = 30$	Group-McCoy $n = 30$	Group-Mac $n = 30$	*p*-Value
Age in years	37 ± 12	34 ± 11	35 ± 10	0.75
Gender (M: F)	17:13	18:12	16:14	0.87
Weight in kg	61.93 ± 8.70	60.8 ± 11.22	58.97 ± 10.70	0.53
Height in cm	160.97 ± 8.72	161.67 ± 9.22	161.13 ± 22.55	0.98
BMI in kg/m^2	23.94 ± 3.21	23.54 ± 3.78	23.52 ± 4.13	0.88
Mallampati Grade- 1:2	9:21	13:17	11:19	0.70

Abbreviation: BMI, body mass index.

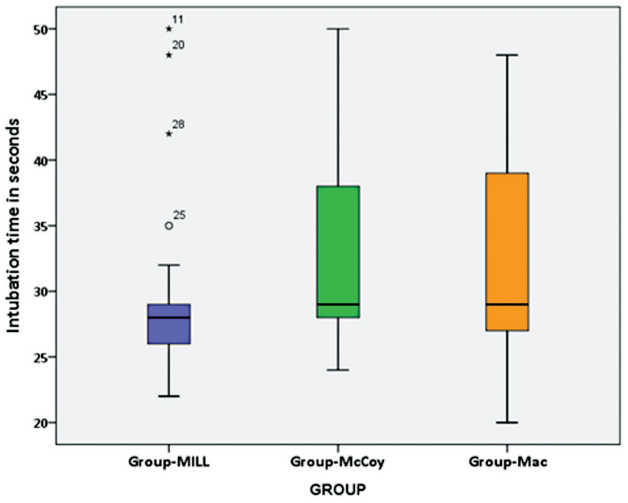

Fig. 2 The box–whisker plot displays the median (interquartile range) intubation time in seconds in the three groups. "*" Depicts extreme values and "°" depicts outliers.

higher in Group-McCoy and Group-Macintosh when compared with Group-MILL (*p*-value = 0.001) (►**Fig. 3**). This increase was, however, not clinically significant. The MAP at the other time points did not differ significantly among groups.

Discussion

We found that in adult patients with simulated restricted neck, intubation characteristics and intubation time did not vary irrespective of whether Miller, McCoy, or Macintosh laryngoscope blades were used. Though the Miller blade has been used in various difficult airway scenarios, no previous studies have compared it with Macintosh and McCoy laryngoscopes in simulated restricted neck situations.[8–11]

We preferred the use of soft collars as rigid neck collar in addition to restricting the neck movements can decrease the mouth opening and increase the Mallampati score.[12] A soft collar simulates difficult intubation by providing a certain extent of cervical spine immobility (although not similar to rigid collars) and the avoidance of the ideal sniffing intubating position.[5] All intubations were done by a single experienced anesthesiologist to eliminate performer bias.

In our study, a higher percentage of patients had favorable CLG in Miller group compared to the others. Studies on normal airways have also shown better CLG with Miller laryngoscope compared to Macintosh laryngoscope.[13,14] Studies comparing Miller with Macintosh laryngoscopes have reported similar results even in patients with laryngeal mass, large epiglottis, receding mandible, and missing tooth.[8–10] This might be due to the small curvature at the distal 5 cm of the tip of the Miller blade that helps in lifting

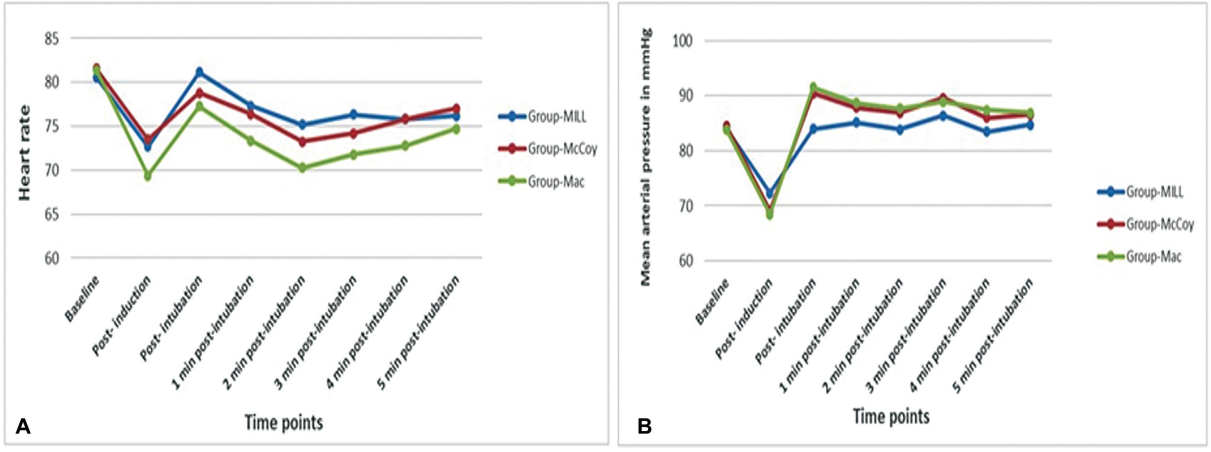

Fig. 3 Comparison of changes in heart rate (**A**) and mean arterial pressure (**B**) among the three groups at various time points.

Table 2 Intubation characteristics in the three study groups

	Group-Mill $n = 30$	Group-McCoy $n = 30$	Group-Mac $n = 30$	*p*-Value
CLG 1:2:3	16:13:1	13:11:6	8:15:7	Group-Mill and Group-McCoy = 0.13 Group-Mill and Group-Mac = 0.02* Group-McCoy and Group-Mac = 0.39
No. of attempts 1:2	28:2	29:1	29:1	0.76
Use of bougie No: Yes	11:19	14:16	10:20	0.54
Intubation time (sec) Mean ± SD	29 ± 7	32 ± 7	32 ± 8	0.151

Abbreviations: CLG, Cormack and Lehane grading; SD, standard deviation.
*Significant $p < 0.05$

the epiglottis.[7] The paraglossal insertion technique described by Magill in 1930 improves glottic visualization by reducing tongue compression as well as the backward displacement of the epiglottis and tongue.[15]

Though newer airway equipment like video laryngoscopes and flexible bronchoscopes offer solution in difficult intubation scenarios, the round-the-clock availability of such devices, the operator's expertise, and patient cooperation for awake intubation need to be considered.[16] Therefore, despite the availability of various newer gadgets for airway management and intubation, the classic direct laryngoscope is still an essential piece of equipment. In addition to being inexpensive, lightweight, and durable, it requires extremely little maintenance.

In contrast to our study that showed no difference in first-attempt success rate between Macintosh and McCoy blades, Bharti et al found a higher first-attempt success rate with McCoy than Macintosh (91 vs. 84%) in patients with immobilized cervical spine.[2] Despite similar intubating conditions, our first attempt success rate with McCoy was much higher (96%) than that reported by Rohini et al (88%)[17] or Bharti et al (91%).[2] Various factors like the technique of cervical spine immobilization, intubation adjuncts (bougie/ stylet), and external laryngeal pressure application influence the success at intubation. We could not use external laryngeal manipulation in our study because of the use of the cervical collar, while Rohini et al and Bharti et al have used the manual in line technique for immobilization where the laryngeal manipulation can be applied. Another difference is the use of a bougie in our study, while a stylet was used in the above two studies. A rigid stylet in contrast to a bougie is sometimes difficult to negotiate through the vocal cords if the curvature is not appropriate.

Even with a good glottic visualization in our study, Group-MILL and Group-Mac still required relatively more use of bougie compared to Group-McCoy. Similarly, Hosalli et al have described the use of a bougie in 10 out of 30 patients with Macintosh, while only 6 out of 30 patients with McCoy required a bougie.[18] During a routine intubation, despite using the sniffing posture to optimally align the three axes, they still do not fall in a straight line and so the endotracheal tubes have been designed with a curvature to permit insertion along the curvature into the larynx. In the restricted neck movement situation, the improper alignment of the three axes (oral, pharyngeal, and laryngeal) makes it necessary to apply a greater lifting force to visualize the vocal cords. The vocal cords though visualized; the airway curvature does not match with the curvature of the tracheal tube, therefore, increasing the need for an intubation guide.

Excluding the outliers, the interquartile range (IQR) of intubation time in the Miller group was narrow when compared to both the McCoy and Macintosh group (►**Fig. 2**). While Kumari et al[19] have taken a slightly longer median intubation time (35.5 [IQR: 30–45] s) with McCoy, Jain et al[20] report shorter intubation time (26 [IQR: 19–32] s). The median time taken for intubation using Macintosh laryngoscope by Szarpak et al[21] was comparable to our study (29.5 [IQR: 27–35.5] s). The intubation time is also influenced by the same factors that contribute to the success at intubation.

The changes in HR and MAP were comparable among the three groups. While some studies have described an increase in both HR and MAP with the Macintosh laryngoscope during tracheal intubation compared to McCoy,[2,18] Venkatesan and Renganathan[22] have shown Miller caused greater increase in HR and MAP during intubation than McCoy and Macintosh blades.

The major limitation of our study was the use of soft cervical collar that does not offer total restriction of cervical spine movements as seen with a rigid neck collar. Another limitation is the inability to blind the investigator to the device used.

Conclusion

In adult patients with simulated restricted neck, the Miller laryngoscope blade despite providing a better laryngeal view showed no benefit in decreasing the intubation time or improving the first attempt success rate when compared to the McCoy or Macintosh blades.

Conflict of Interest
None declared.

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