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Comparative Evaluation of Macintosh, McCoy and Truview Laryngoscope in Simulated Difficult Laryngoscopy Using Rigid Neck Collar in Overweight Patients : A Randomized, Controlled Clinical Trial

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ABSTRACT

Background: To compare the safety and efficacy of Macintosh, McCoy and Truview laryngoscope in simulated difficult laryngoscopy using rigid neck collar in overweight patients. **Methods:** It was a Prospective, randomized, controlled clinical trial conducted in a tertiary care teaching hospital. Overweight patients (BMI= 25-29.9) with American Society of Anesthesiologists physical status I and II, age 18 to 60 years and scheduled recruited for elective surgery requiring general anesthesia with oral endotracheal intubation were included. The patients were divided into three groups comprising of 40 patients each in which Macintosh, McCoy and Truview laryngoscopes were used respectively. Difficult laryngoscopy was simulated using rigid neck collar. The primary outcome measure was modified Intubation Difficulty Score (IDS). The secondary outcome measures were number of attempts, ease of intubation, overall success rate, time of intubation, Percentage of Glottic Opening score, hemodynamic parameters and complications. **Results:** The mean Intubation Difficulty Score was significantly lower with Truview Laryngoscope (1.68) as compared to Macintosh (4.21)and MacCoy (3.03) laryngoscopes. The median Percentage of Glottic Opening score was also significantly improved in the Truview group(78.21) compared to the other groups. Number of successful first intubation attempt was significantly higher in the Truview group(63.16%) compared to the other groups. The overall success rate was similar among groups. However, the time of intubation was significantly higher for Truview (41.21±2 sec) compared to Macintosh and McCoy laryngoscopes. **Conclusion:** The Truview laryngoscope allowed better glottic visualization, greater ease of intubation, fewer intubation attempts, but a longer intubation time compared to Macintosh and MacCoy laryngoscopes.

Keywords: Difficult laryngoscopy, Intubation, TruView laryngoscope.

INTRODUCTION

Perioperative care of the overweight patients presenting with cervical immobilization might present unique challenges for the anesthesia team. Restricted neck movement due to application of cervical collar poses a significant difficulty in intubation because of non- alignment of oral, pharyngeal and laryngeal axes. Application of a cervical collar not only reduces cervical spine movements, but it also reduces the mouth opening, rendering laryngoscopy difficult.[1] Besides, the neck collar lifts up the chin and tips the larynx anterior.[2]

Furthermore, intubation is often a demanding task in the overweight patients. Although controversial,[3] BMI is considered as associated with difficult intubation, both in the ICU and in the OT.[5-7] There are conflicting reports regarding the correlation of BMI with DI.[8-10] Two prospective studies found no correlation between BMI and DI,[8,9] whereas a retrospective study of large samples concluded that the correlation was weak but statistically significant.[10] According to the WHO, individuals with BMI equal to or greater than 25 and less than 30 are considered overweight.[11] [Annexure 1].

In patients with raised BMI, intubation may be difficult due to the poor visibility of the soft palate, tonsils, and uvula upon mouth opening.[12-17] Short necks with indistinct anatomical landmarks and the inability to hyperextend the patient's neck due to associated spinal injuries increases the technical difficulty of insertion of a surgical airway as a salvage technique in cases of unsuccessful intubation and ventilation. Facial anatomy may impede the anesthesiologist's ability to adequately bag-mask the patient. Restrictive tidal volumes in the supine position may be associated with inadequate

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preoxygenation and associated rapid desaturation following the induction of general anesthesia.

Therefore, intubation in overweight patients with cervical immobilization using a neck collar might be even more difficult. Several options have been mentioned by various authors for intubation in patients with cervical spine immobilization, like direct laryngoscopy with the aid of a gum elastic bougie, Airway Scope, McCoy laryngoscope, C-Trach, Intubating Laryngeal Mask Airway and Bullard laryngoscope have been used with different success rate.[18,19]

The Truview EVO2(C) laryngoscope (TL) (Truphatek International® , Israel), a novel device, applies the optical principle of light refraction to provide a good view of an anteriorly placed larynx, allowing a view of the glottis via the prismatic lens without having to align oral, pharyngeal and tracheal axes. It provides a 42° anterior refraction in the line of sight, making difficult cases easier to intubate.[20] Presence of an optical system view tube that consists of prisms and lenses that extend vision beyond the distal end of the blade, reduces the amount of force needed to successfully intubate a patient by greater than 30%.[20] It is used for endotracheal intubation where there is difficulty in visualizing the laryngeal inlet, especially in cases with limited neck extension.[21,22] The device is specially designed to confirm positioning of the endotracheal tube as well as to record entry of the tube into glottis for research and archiving.

The McCoy laryngoscope (Penlon) is designed to elevate the epiglottis with its hinged tip and requires less neck movement during laryngoscopy.[23] It is frequently used to facilitate tracheal intubation when the view of the glottic opening is restricted.[22] The advantage of McCoy and TruView laryngoscopes over conventional laryngoscope has been demonstrated in direct comparison studies.[21,25,26]

In this present study, we compared the Truview laryngoscope with conventional Macintosh and MacCoy laryngoscopes, hypothesizing that tracheal intubation would be easier with Truview laryngoscope compared to Macintosh or MacCoy in simulated difficult laryngoscopy due to rigid neck collar in overweight patients.

MATERIALS AND METHODS

Following the approval of Institutional Ethical Committee and well informed written consent for this prospective, randomized, double blind study, 120 patients were enrolled for the study. This study was conducted in accordance with the ethical standards on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008(5). Our study followed the CONSORT recommendations. Eligibility criteria for the patients included American Society of Anesthesiologists (ASA) physical status I and II, age 18 to 60 years, overweight (BMI= 25 to 29.9) and patients scheduled for elective surgery requiring general anesthesia with oral endotracheal intubation. The exclusion criteria included patients with anticipated difficult airway, obese (body mass index [BMI] >30) patients, patients with risk of pulmonary aspiration of gastric contents, pregnant patients and patients with airway distortion or trauma. Data were collected in the operating room and post-anesthesia care unit of a tertiary care teaching hospital. The patients were divided into three groups comprising of 40 patients each in which intubation was done with Macintosh, McCoy and Truview laryngoscopes respectively. Block randomization was done on computer-generated codes sealed in sequentially numbered envelopes. An anesthesiologist, not involved in the intubation procedure, generated random allocation sequence, enrolled participants and assigned patients to intervention. Patients and outcome assessors were blinded to the study. After pre-anesthetic evaluation, an appropriate sized rigid cervical collar (Ambulance, MGRM Medicare Limited, Hyderabad, India) was placed as per manufacturer's instructions. Mouth opening was measured before and after its application. Standard monitoring including ECG, noninvasive arterial pressure, SpO2, and measurement of end-tidal carbon dioxide were used.

Patients were premeditated through intravenous (IV) route with inj. Dexamethasone 4 mg IV, inj. Midazolam 0.05mg/kg IV, inj. Fentanyl 2 µg/kg IV and inj. Glycopyrrolate 0.01mg/kg IV following which preoxygenation was done with 100% oxygen for 3 minutes. Anaesthesia was induced with inj. Propofol 2mg/kg IV and relaxation was done with inj.Vecuronium 0.1 mg/kg IV. An anesthesiologist (BD), having experience of more than 75 intubations with Macintosh and McCoy laryngoscope and more than 50 intubations with Truview laryngoscope applied the laryngoscopy in all patients. Intubation was done with a 7.0-mm cuffed tracheal tube in females and an 8.0-mm cuffed tracheal tube in males. For patients allocated to intubation with the Truview, the Truview™ EVO2 laryngoscope was passed through the center of the mouth, with 6 L/min of oxygen flow through the side port to prevent fogging. Once the glottis was visualized, the endotracheal tube was advanced and the laryngoscope was detached and removed from the mouth. Finally, the respiratory circuit was connected and placement of the tube was confirmed with square wave capnography.[14] In case of McCoy, all laryngoscopy was done compressing the hinge and flexing the tip of the laryngoscope blade. If introduction of the intubating device was not possible or there were more than three attempts for intubation or intubation time will be more than 120sec, it was considered to be a failure. In case of failure to intubate, cervical collar was then removed

and intubation was proceeded. Failure to intubate (>3 attempts or >120sec) was documented.

Any episode of hypotension (MAP <20% of baseline), bradycardia (HR <40 bpm), hypertension (MAP >20% of baseline), cardiac arrhythmia, or hypoxemia (SpO <90%) was noted.

The primary outcome measure was modified Intubation Difficulty Score, as described by Adnet et al[28] [Annexure 2]. The secondary outcome measures were: number of attempts, , overall success rate, Ease of Intubation, Percentage of Glottic Opening (POGO) score, hemodynamic parameters (heart rate and mean arterial pressure in pre-induction and the interval of 1, 3 and 5 minutes post-intubation) and airway trauma. Ease of Intubation was assessed on a score of 0 to 3 :

1.Easy: tracheal intubation without maneuver.

2.Satisfactory : tracheal intubation with maneuvers.

3.Difficult : tracheal intubation not even with maneuvers.

RESULTS

Statistical analysis

On the basis of pilot study done on 5 patients in each group, mean IDS score in in MacIntosh group was 4.6 ± .5477, in Mc Coy group was 2.6 ± .5477, and in Truview group was 1.8 ± .8367 respectively. Taking these values as reference, the minimum required sample size with 99% power of study and 1% level of significance is 38 patients in each study group. To reduce margin of error, total sample size taken was 120 (40 patients per group).

Formula used is:

For comparing mean of two groups

$$N >= 2\frac{(\text{standard deviation})^2 * (Z\alpha + Z\beta)^2}{(\text{mean difference})^2}$$

Where Zα is the value of Z at two sided alpha error of 1% and Zβ is value of Z at power of 99% and mean difference is difference in mean values of two groups.

Pooled standard deviation= Sqrt(((S1)2+(S2)2)/2)

Where S1 is standard deviation of 1group

And S2 is standard deviation of other group.

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by

Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used. Quantitative variables were compared using ANOVA/Kruskal Wallis Test (when the data sets were not normally distributed) between the three groups. Qualitative variables were correlated using Chi-Square test. A p value of ≤ 0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.Stats as used in previous studies.

Total 120 patients were analysed with 40 patients in each group.The three groups were comparable in baseline demographic and airway assessment characteristics [Table 1]. The mean Intubation Difficulty Score was also reduced significantly in Truview group [Figure 1].

The number of successful first intubation attempt was significantly lower in the Truview group [Table 2]. The overall success rate was similar in the three groups with two failures in each group [Table 2]. There were no differences in complications [Table 2].

The Ease of Intubation score was also significant in favour of the Truview group [Table 3].

Pulse rate was significantly lower in Truview group at 1, 3 and 5 min after intubation [Figure 2]. Mean arterial BP was significantly lower at 1 and 3 min after intubation in Truview group [Figure 3].

The median POGO score was also significantly improved in the Truview group. [Figure 4]. However, the time of intubation was significantly higher for Truview 41.21± 2 seconds) compared to Macintosh and MacCoy laryngoscopes.[Figure 5].

Table 1: Comparison of patient's baseline characteristics between the Macintosh, Mc Coy and Truview groups. Values are mean (SD), number or median (interquartile range).

Parameters	MacIntosh (n=40)	Mc Coy (n=40)	Truview (n=40)	P value
Age (years)	39.8±10.96	39.98±10.36	35.48±10.71	0.162
Sex (M:F)	22 : 18	22 : 18	20 : 20	0.875
Weight (kg)	69.28± 5.38	69.05± 6.37	68.47±5.48	0.815
Body mass index (BMI) (Kg/m2)	26.5±0.94	26.53±0.88	26.29±0.91	0.438
ASA physical status (median)	1	1	1	
Mallampati Grade	2.02±0.58	2.1±0.55	2.02±0.73	0.825
Thyromental distance (cm)	6.32±0.47	6.34±0.51	6.42±0.47	0.705
Neck circumference (cm)	39.66±1.99	40.24±1.5	40.32±1.47	0.279

Table 2: Comparison of intubation attempts, overall success rate (%), time of intubation (sec), Percentage of Glottic Opening (POGO), Intubation Difficulty Score (IDS), Esophageal Intubation and complications between Mac intosh, McCoy and Truview groups. Values are number (%), mean (SD) and median (inter-quartile range).

Parameters	MacIntosh(n=40)	McCoy(n=40)	Truview(n=40)	P value
Intubation attempts (1/2/3)	13/19/6	12/20//6	24/12/2	0.041
Overall Success rate (%)	95	95	95	1.00
Time of Intubation (sec)	31.87±3.13	31.68±3.01	41.21±2	<0.001

Percentage of Glottic Opening (POGO)	49.05 ± 18.9	62 ± 1.32	78.21 ± 4.16	< 0.001
Intubation Difficulty Score (IDS)	4.21 ± 1.04	3.03 ± 0.88	1.68 ± 0.81	< 0.001
Esophageal Intubation	6	4	1	0.16
Complications *Blood on laryngoscope *minor laceration *dental or other airway trauma	 3 0 0	 4 1 0	 2 5 1	0.29

Table 3: Comparison of Ease of intubation between Macintosh, McCoy and Truview groups. (p value = 0.0398 , statistically significant)

Score	MacIntosh	McCoy	Truview
1	14	12	25
2	24	26	14
3	2	2	1

ANNEXURES

Table 1: Definitions of BMI, calculated as weight (kg) divided by height^2 (m)^2.

BMI (kg m^{-2})	
<25	Normal
25–30	Overweight
>30	Obese
>35	Morbidly obese
>55	Super-morbidly obese

Table 2: Intubation Difficulty Scale

Parameter	Score
Number of attempts >1	N_1
Number of operators >1	N_2
Number of alternative techniques	N_3
Cormack–Lehane (CL) grade 1	N_4
Lifting force required	
Normal	$N_5 = 0$
Increased	$N_5 = 1$
Laryngeal pressure	
Not applied	$N_6 = 0$
Applied	$N_6 = 1$
Vocal cord mobility	
Abduction	$N_7 = 0$
Adduction	$N_7 = 1$
Total IDS = sum of scores	N_1–N_7

(IDS 0 = easy,
IDS 1-5 = slight difficulty,
IDS >5 = moderate to major difficulty in intubation,
IDS=¥ Impossible intubation)

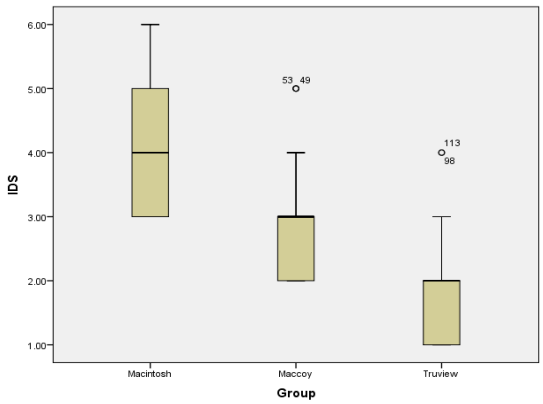

Figure 1: Comparison of Intubation Difficulty Score (IDS) between the three groups. values are in mean and standard deviation. IDS was significantly lower in Truview group. Statistically significant, p ≤ 0.05.

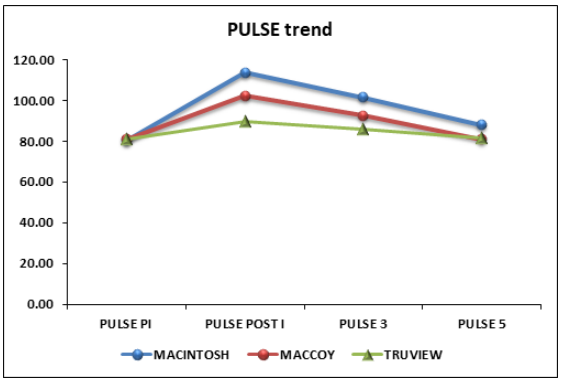

Figure 2: Comparison of pulse rate between the three groups up to 5 minutes after intubation. Values are in mean and standard deviation. Statistically significant, p ≤ 0.05.

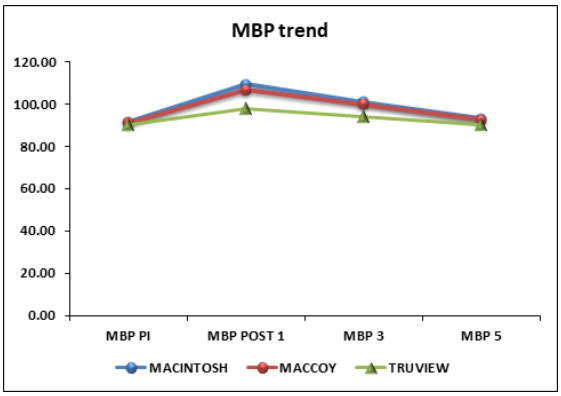

Figure 3: Comparison of mean arterial pressure between the three groups up to 5 minutes after intubation.Values are in mean and standard deviation. Statistically significant, p ≤ 0.05.

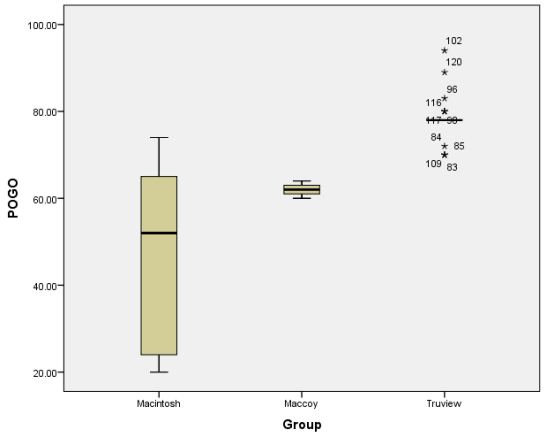

Figure 4: Comparison of POGO score between the three groups. values are in mean and standard deviation. POGO score was significantly higher in truview group. Statistically significant, p ≤ 0.05.

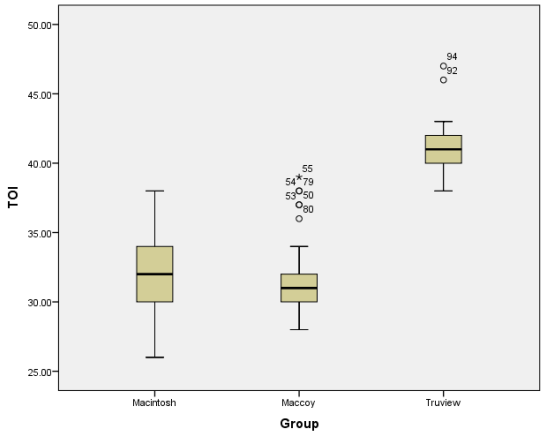

Figure 5: Comparison of time of intubation (TOI) between the three groups. Values are in mean and standard deviation. TOI was significantly higher in Truview group. Statistically significant, $p \leq 0.05$.

DISCUSSION

In the present study, we compared Truview laryngoscope with MacCoy and Macintosh laryngoscopes in difficult laryngoscopy situation using a rigid neck collar in overweight patients undergoing elective surgeries requiring general anesthesia and tracheal intubation. The use of rigid cervical collar or manual in-line stabilization of the cervical spine to prevent neck movements may result in poor laryngeal view on conventional laryngoscopy leading to difficulty in intubation.[1] Rigid neck collar not only prevents the alignment of oral, pharyngeal and laryngeal axes, but it also limits the mouth opening, rendering normal airway difficult.[29]

In addition to this, with the growing number of overweight and obese adults, increasing attention is being paid to difficult intubation as intubation is often a difficult task in the overweight patients. Overall 23% world adult population is overweight and 9.8% obese.[30] By 2030, the number of overweight and obese adults is projected to be 2.16 and 1.12 billion, (38% and 20%), respectively.[31] Therefore, intubation in overweight patients with cervical immobilization is an issue of great concern.

The primary outcome measure in our study was Intubation Difficulty Score (IDS). The TruView laryngoscope reduced the intubation difficulty score and improved the glottis view, compared with Macintosh and McCoy laryngoscopes in patients with immobilized cervical spine. In addition to this, the first attempt successes rate were significantly improved with Truview laryngoscope. Overall success rate was comparable between the three groups. However, the time to intubation was increased with Truview laryngoscope as compared to Macintosh and McCoy laryngoscopes.

In our study, the McCoy laryngoscope improved the laryngoscopic view and reduced the Intubation Difficulty Score as compared to the Macintosh laryngoscope but was found to be less superior than the TruView laryngoscope. Although the lifting the epiglottis with the McCoy laryngoscope improves glottic exposure, it may require some extension of cervical spine to expose the larynx.

In the present study, the first attempt intubation success rate was around 34%, 32 % and 63% in the McIntosh, McCoy and Truview group respectively. Twenty four out of 40 patients were intubated in the first attempt with the Truview, while 13 and 12 patients were intubated in the first attempt with Macintosh and McCoy, respectively. Bharti et al,[36] noticed that the first attempt success rate was 95% in the TruView laryngoscope group while 84% in the Macintosh group and 91% in the McCoy group. In present study, improper visualization of the glottic opening and suboptimal space in the oral cavity to negotiate the tube were the probable causes of higher number of subsequent attempts with Macintosh and McCoy.

A Truview laryngoscope provides an indirect view of glottis without need to align oral, pharyngeal, and tracheal axes and therefore requires no cervical spine movements. Previous studies have demonstrated that Truview improves the laryngeal view when compared with the Macintosh laryngoscope in patients with normal and anticipated difficult airways.[21,22] Truview has been used successfully in patients with difficult airways in whom laryngoscopy with the Macintosh laryngoscope failed.[33]

Furthermore, the TruView laryngoscope required less number of optimization maneuvers and had reduced intubation difficulty scores. Joseph et al,[37] also reported low intubation difficulty scores with the Truview laryngoscope than with the McCoy laryngoscope in patients with cervical spine immobilization.

In our study, Truview was associated with significantly less intubation difficulty, more ease of intubation and better visualization of glottic opening. These findings are in agreement with the other previous studies.[20,36-38] Higher POGO score, less IDS and more ease of intubation with Truview were probably due to the structural difference from Macintosh or MacCoy blades. TruView EVO2 illuminates and expands the angular view of the larynx and adjacent structures. It is used for endotracheal intubation where there is difficulty in visualizing the laryngeal inlet, especially in cases with limited neck extension.[21,37]

With Macintosh and MacCoy blade, proper visualization of glottic opening requires alignment of oral, pharyngeal and laryngeal axes which was not possible with rigid neck collar. Furthermore, less space inside the oral cavity renders the insertion of tracheal tube difficult. Esophageal intubations were more with Macintosh and MacCoy group but those were not statistically significant. Hemodynamic response to laryngoscopy and intubation was least

with Truview. Pulse rate and mean arterial pressure remained significantly less up to 1, 3 and 5 minutes after intubation, while the mean arterial pressure remained significantly less up to 1 and 3 after intubation in the Truview group. Bharti et al,[36] found there was increase in heart rate and mean arterial pressure was less with TruView and McCoy laryngoscopes as compared to the Macintosh laryngoscope. The possible explanation might be that the Truview imparts less force to align the oro-pharyngeal-laryngeal axes for intubation, thereby reduces the traction force required to lift the epiglottis. Blunted hemodynamic response with the Truview laryngoscope shows less laryngeal manipulations and force required during intubation, thereby reducing the potential for hemodynamic stimulation.[36-38]

In the present study, time to intubation with the TruView laryngoscope was increased significantly with McCoy and Macintosh laryngoscopes.In contrast to this, Bharti et al,[36] found that the time to intubation with the TruView laryngoscope was comparable with McCoy and Macintosh laryngoscopes. However, few studies reported an increase in time to intubation with the Truview laryngoscope due to some difficulties experienced during advancement of the tracheal tube toward the glottis.[21,32,35,37,39,40] Barak et al,[21] and Timanaykar et al,[34] demonstrated that whilst the Truview produced a better laryngoscopic view and less maximal force applied during intubation, the duration of intubation was longer as compared to Macintosh.

Joseph et al,[37] found that the duration of intubation was significantly less with the McCoy laryngoscope (mean of 22.9 s with standard deviation of 8.5) than with theTruView laryngoscope (mean of 33.2 s with standard deviation of 12.3), with a P value of less than 0.001.The main reason for increased duration of tracheal intubation with TruView is the difficulty experienced in advancing the tube through the lateral side of the patient's mouth, which was also reported by Barak et al,[21] and Malik et al.[32]

Another problem with the TruView laryngoscope is fogging on the distal lens which may reduce the image quality. We used oxygen insufflation from the side port to reduce lens fogging.In addition to this, although the anaesthetists who took part in this study practiced with the Truview blade several times prior to starting the study, their experience with the new device was less than that with the Macintosh blade. Moreover , the use of the Truview blade requires the anaesthesiologist to intubate in an indirect manner, seeing the endotracheal tube through the lens. Initially, the anaesthesiologist does not see the endotracheal tube as he looks through the lens of the Truview and focuses on the vocal cords. The tube needs to be advanced blindly until its tip enters the Truview visual field.Subsequently, the tube should be introduced through the vocal cords while looking through the lens. Performing this technique needs good eye– hand co-ordination and practice. This may be another reason for the difference in duration of intubation between the groups.

The Truview blade is designed to enable indirect laryngoscopic view; thus, the anaesthetist applies less force on the anterior larynx, resulting in fewer patients with bleeding and soft tissue damage as demonstrated by Joseph et al.[37] However, in our study, there was no significant difference in complications between the three laryngoscopes. Furthermore, McCoy caused lesser complications and airway trauma as compared to Macintosh, as shown by Gotiwale et al.[41]

The main limitation of this study is that the potential of observer bias exists, as it is impossible to blind the anesthesiologist to the device being used. This could have led to bias if the anesthetist already had a preference to the device. However, we incorporated the Intubation Difficulty Score for the assessment of ease of intubation that incorporates multiple indices of intubation difficulty and objectively quantifies the complexity of tracheal intubations. Secondly, we used POGO score to assess the visualization of the vocal cord. POGO is used to visualize vocal cords during direct laryngoscopy, but because of the lack of any universal scoring system, we used POGO score. We chose POGO score instead of modified Cormack-Lehane because the POGO score can distinguish patients with large and small degrees of partial glottic visibility; it might provide a better outcome for assessing the difference between various intubation techniques.[42] Another limitation of our study is that we did not compare the relative efficiencies of these devices with other intubation modalities which are recommended in difficult airway scenarios, such as the intubating laryngeal mask airway, the Bullard laryngoscope, Airtraq, and glidescope. Further comparative studies are needed to determine the relative efficacies of these devices.

CONCLUSION

The Truview laryngoscope, as compared to McCoy and McIntosh, significantly offers better laryngeal view, has higher success rate at first intubation attempt, reduces the IDS and has least effect on hemodynamic parameters in simulated difficult laryngoscopy using rigid neck collar in overweight patients. The Truview thus appears preferable to Macintosh and McCoy laryngoscope simulated difficult laryngoscopy using rigid neck collar in overweight patients. However, it is not a substitute for intubation in every case as it has a longer time for intubation than the other two blades. This could probably be reduced by more experience, training and better hand eye co-ordination. Overall, the Truview appears preferable to Macintosh and McCoy laryngoscope simulated difficult

laryngoscopy using rigid neck collar in overweight patients.

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