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Comparing Macintosh, Miller and Truview Laryngoscopes for Evaluation of Intubation Difficulty in Patients with Immobilized Cervical Spine

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Abstract

Context: To evaluate intubation difficulty comparing Macintosh, Miller and Truview blades in patients with immobilized cervical spine.

Aims:

1. To compare the difficulty during orotracheal intubation between Macintosh, Miller or Truview laryngoscopes utilizing the Intubation Difficulty Scale (IDS).

2. To compare the time taken for intubation.

3. Success rate of intubation in the three groups.

Settings and Designs: Prospective randomized cross sectional study.

Methods and Materials: This study was conducted in healthy Patients to evaluate the difficulty during intubation using the mentioned laryngoscopes, with the neck immobilized using Manual In-line Axial Stabilization (MIAS). Evaluation was done using intubation difficulty score (having seven parameters), success rate and duration of intubation. Intubation failure was defined as duration exceeding 120 seconds for which MIAS was relaxed and intubation was done conventionally.

Statistics: One Way Analysis of Variance with Duncan's mean test.

Results: All patients in the Macintosh group , 18 (90%) in Miller group and 16 (80%) in Truview group were intubated successfully. The duration of intubation was significantly longer and IDS score, least in Truviewgroup. Truview provided better glottic view and required less optimizing maneuvers.

Conclusions: The Intubation Difficulty Scale (IDS) score in parients with cervical spine immobilization (MIAS) is significantly least with TruView laryngoscope compared to conventional laryngoscopy using Macintosh or Miller laryngoscope.

The time taken for intubation was shortest with Macintosh laryngoscope. Success rate of intubation is highest with Macintosh laryngoscope while it is least with TruView laryngoscope under the stipulated time limit (120 seconds) for laryngoscopy.

Keywords: laryngoscopes Macintosh; Truview; Miller; Intubation difficulty scores laryngoscopes; Cervical spine.

Introduction

Anaesthesiologists manipulate the cervical spine (C-spine) every day of their lives (during endotracheal intubation and patient positioning) and they deal frequently with patients having C-spine disease.[1] Patients with cervical spine injury especially need to be handled with care. Nearly 4500 years ago an Egyptian physician described a patient with a cervical spine injury: "one having a dislocation of the vertebra of his neck while he is unconscious of his two legs and his two arms and his urine dribbles, an ailment not to be treated."[2] Although the current outlook is not so bleak, cervical spine injury continues to be a catastrophic event.[3] A considerable number of fractures are missed on initial evaluation of patients in the emergency. The major factor in the development of a secondary injury is the failure to immobilise the neck.[4] Under ideal situations, patients with diagnosed or suspected cervical spine injury requiring intubation would simply be managed by flexible fibre optic laryngoscopy and intubation; no neck motion would ever be required. Unfortunately, this is not feasible in many situations.[5] Usually, at many centres in India, fiberoptic laryngoscopy is not available especially in emergency departments. Also, we are confronted by the combative or intoxicated patient with the potential full stomach in whom an awake fibre optic intubation is not feasible, and in which an asleep intubation is not deemed acceptable. We are hence constantly asking "in which patient is it acceptable to do a direct laryngoscopy (DL) and is there anything that can be done to minimise the risk of C-spine injury during such a DL".[5] A key concern is the poor glottic view obtained during direct laryngoscopy with cervical spine immobilisation. Heath[6] studied the effect on laryngoscopy of two different cervical spine immobilisation techniques in fifty patients. He recommended that manual inline immobilisation should be the method of choice for cervical spine stabilisation during tracheal intubation. In a in vivo cinefluroscopic study,[7] compared with Macintosh, the Miller blade was associated with a statistically significant but quantitatively small decrease in cervical extension. The TruView EVO_2, an optical laryngoscope, (Truphatek International Ltd., Netanya, Israel), provides a 42° angled deflection view through the 15 mm eyepiece.[8] M. Barak et al have reported that TruView blade provided a better laryngoscopic view while requiring significantly less force and resulted in less soft tissue trauma following intubation.[9] We propose to study and compare the ease of laryngoscopy and success of intubation with manual inline stabilisation (MILS) using Macintosh, Miller and TruView laryngoscopes utilising the Intubation Difficulty Score (IDS).[10]

Methods and Materials

After approval from the hospital's ethics committee, 60 consenting patients scheduled for elective surgery and requiring general anaesthesia with orotracheal intubation were entered into the study and were equally randomised into Patient Inclusion Criteria - Age 18 years and above; Either sex; Patient scheduled for elective surgical procedure and requiring orotracheal intubation; A.S.A. grade I – II; Mallampati Class I – II; Inter-incisor distance > 3.5 c.m; thyro-mental distance > 6 c.m; sterno-mental distance > 12 c.m. Patients with risk factors for gastric aspiration, cervical spine disorder, and those with history of difficult Intubation were excluded from the study. After pre-anaesthetic evaluation and investigations, eligible patients were equally randomised into following three groups using draw of lots - Group I Macintosh; Group II Miller; Group III TruView. All patients received a standardised general anaesthetic and monitoring including electrocardiography, heart rate, pulse oximetry, non invasive blood pressure (NIBP), capnography and end-tidal carbon dioxide and volatile anaesthetic levels. Patients were pre-medicated with midazolam 40µg/kg to a maximum of 3 mg and fentanyl 2µg/kg before induction with induction propofol 2mg/kg. Following induction of anesthesia, patients were manually ventilated with oxygen and Isoflurane 1%. Neuromuscular blockade was achieved with Rocuronium 0.9mg/kg following which the support below the head (e.g. pillow, cushioned ring/halo) was removed so that the head lied in the neutral position. Manual In-line Axial Stabilization was then applied by an experienced assistant such that the mastoid process and the sides of the neck were held in position preventing any movement (flexion, extension or rotation) of the neck. Laryngoscopy was then performed, by an anaesthesiologist adequately experienced in the use all three laryngoscopes, according to the group to which the patient had been assigned followed by orotracheal intubation with an appropriate size regular cuffed endotracheal tube. In group III, to prevent fogging and to keep lens clear of secretions, TruView EVO_2's oxygen port was connected to oxygen supply line at a minimum rate of 8 Litres/minute. It was held in left hand and with the right hand, patient's mouth was opened slightly and blade was inserted in the mouth in

the midline to the 0- depth line marked on the TruView EVO_2 blade using two fingers as a guide. Glottis was viewed through the eyepiece from a comfortable distance while advancing TruView™ EVO_2 until the 1- line depth and it was possible to see the vocal cords. Once adequate glottic view was achieved, endotracheal tube with the Opti Shape stylet -provided with the laryngoscope, (if needed) was inserted from at right side of mouth and advanced until the tip of the tube could be seen while looking through the optical view tube. Then the tube was passed through the vocal cords while observing through the optical view tube to verify tube placement. Duration of intubation of was noted by an independent observer not assisting or directly involved in the process of laryngoscopy and intubation. The following observations were made: The seven parameters of IDS score; total IDS score; total duration of intubation and success of intubation. The duration of an intubation attempt was defined as the time taken from insertion of the laryngoscope blade in the oral cavity till the placement of the endotracheal tube through the vocal cords was visually confirmed by the anaesthesiologist performing the intubation. In situations where visual confirmation of the tube passing through the cords was not done, the attempt was not considered complete till the tube was connected to the breathing circuit and successful placement was confirmed by capnography/ end tidal CO_2. A single attempt at laryngoscopy was given. Failure was defined as laryngoscopy time exceeding 120 seconds. If the duration of laryngoscopy exceeded 120 seconds, manual in-line stabilisation was released and patient was intubated conventionally. Data was analysed using One Way Analysis of Variance with Duncan's mean test.

Results

A total of 60 patients were enrolled in the study, 20 in each group. The demographic variables (Tables 1 and 2) similar in all the groups. Although there was a male preponderance in the groups, the gender distribution between the three groups was similar.

Table 1: Age, Gender and Body Mass Index of cases enrolled into study.

	Group I (n =20)	Group II (n =20)	Group III (n =20)
BMI (kg/m²) Mean S.D ±	24.8 ± 1.9	24.5 ± 1.8	24.3 ± 2
Age (years) Mean S.D.±	42± 17.2	47.2± 15.1	44.8± 15
Gender			
Male	15	13	14
Female	5	7	6

Table 2: Airway parameters of cases enrolled into study.

	Group I (n =20)	Group II (n =20)	Group III (n =20)
Mallampati 1	25%	35%	35%
Class 2	75%	65%	65%
IID (cm) Mean ± S.D.	4.5 ± 0.5	4.4 ± 0.4	4.4 ± 0.5
TMD (cm) Mean ± S.D.	7.1 ± 0.6	6.7 ± 0.6	6.8 ± 0.6
SMD (cm) Mean ± S.D	16 ± 1.3	15.8 ± 0.7	16.1 ± 1

All patients in Group I (Macintosh) were successfully intubated while 18 patients in Group II (Miller) and 16 patients in Group III (TruView) were intubated successfully (Table 3). The success rate of intubation was 100%, 90% and 80% in Group I, Group II and Group III respectively. The average duration of intubation (mean ± S.D.) was 16.2 ± 6.7, 25.7 ± 15.4 and 53.4 ± 25.8 seconds in Group I, Group II and Group III respectively, which was statistically significant. Duration of intubation was significantly prolonged in Group III (TruView) compared to Group I (Macintosh) and Group II (Miller).

Table 3: Comparison of success rate and duration of intubation among Group I, Group II and Group III. *Duration significantly prolonged in Group III.

	Successful Intubations	Unsuccessful Intubations	Success rate	Duration of intubation (Mean ± S.D.) (seconds)
Group I (n=20)	20	0	100%	16.2 ± 6.7
Group II (n=20)	18	2	90%	25.7 ± 15.4
Group III (n=20)	16	4	80%	*53.4 ± 25.8

Analysis of Parameters of Intubation Difficulty Scale (IDS) (Table 4 to 9)

The average number of additional intubation attempts (N1 points) were significantly increased

Table 4: Comparison of number of intubation attempts among Group I, Group II and Group III. n, number of successful intubations;* Number of intubation attempts significantly increased in Group III.

	Number of intubation attempts				Average N_1 points (Mean ± S.D.)
	1	2	3	>3	
Group I (n=20)	6(30%)	7(35%)	4(20%)	3(15%)	1.2 ± 1.1
Group II (n=18)	3(16.6%)	6(33.3%)	8(44.4%)	1(5.5%)	1.3 ± 0.8
Group III (n=16)	0(0%)	2(12.5%)	6(37.5%)	8(50%)	2.5 ± 1.1*

Table 5: Comparison of alternative technique used among Group I, Group II and Group III.

	Used	Not used	Average N_3 points (Mean ± S.D.)
Group I (n = 20)	14 (70%)	6 (30%)	0.7 ± 0.5
Group II (n = 18)	11 (61.1%)	7 (38.8%)	0.6 ± 0.5
Group III (n = 16)	16 (100%)	0 (0%)	1 ± 0.0

* Average N3 points significantly higher in Group III; n, number of successful intubations

Table 6: Comparison of glottic exposure among Group I, Group II and Group III n, number of successful intubations.

	Cormark Lehane Grade				Average N_4 points (Mean ± S.D.)
	1	2	3	4	
Group I (n=20)	0(0%)	2(10%)	18(90%)	0 (0%)	1.9 ± 0.3
Group II (n=18)	0(0%)	8(44.4%)	10(55.5 %)	0(0%)	1.6 ± 0.5*
Group III (n=16)	13(81.3 %)	3(18.7%)	0(0%)	0(0%)	0.2 ± 0.4**

* Glottic view significantly better in Group II, compared to Group I;
** Glottic view significantly better in Group III compared to Group I and Group II.

Table 7: Comparison of lifting force during laryngoscopy among Group I, Group II and Group III, Increased lifting force needed in Group I and II; n, number of successful intubations.

	Normal	Increased	Average N_5 points (Mean ± S.D)
Group I (n = 20)	0 (0%)	20(100%)	1.0 ± 0.0
Group II (n = 18)	0 (0%)	18 (100%)	1.0 ± 0.0
Group III (n = 16)	16 (100%)	0 (0%)	0 ± 0.0

Table 8: Comparison of applied external laryngeal pressure among patients in Group I, Group II and Group III. n, number of successful intubations.

	Applied	Not Applied	Average N_6 points (Mean ± S.D.)
Group I (n = 20)	18(90%)	2(10%)	0.9 ± 0.3
Group II (n = 18)	15(83.3%)	3(16.6%)	0.8 ± 0.3
Group III (n = 16)	2(12.5%)	14(87.5%)	0.1 ± 0.3

Table 9: Comparison of IDS score among patients in Group I, Group II and Group III.

	Intubation Difficulty Scale (IDS) Score		
	0–5	>5	(Mean ± S.D.)
Group I (n = 20)	9 (45%)	11 (55%)	5.8 ± 1.4
Group II (n = 18)	10 (55.5%)	8 (44.4%)	5.3 ± 1.4
Group III (n = 16)	14 (87.5%)	2 (12.5%)	3.8 ± 1.3*

n, number of successful intubations.
* IDS score significantly less in Group III compared to Group I and Group II.

in Group III. All patients were intubated by a single anaesthesiologist without any additional operator directly attempting intubation. Therefore N_2 points in all the cases were zero. Fourteen patients (70%) in Group I and eleven (61.1%) in Group II required the use of a stylet for intubation. In Group III, all patients were intubated using the OptiShape stylet provided with the Truview EVO_2 laryngoscope. Average N_3 points were significantly higher in Group III. Glottic view (N_4 points) significantly improved in Group II compared to Group I while it was significantly better in Group III compared to the other two groups. All patients in Group I and II required an increased lifting force (N_5 points) while all patients in Group III required a normal lifting force during intubation which is significant. Most cases in Group I (90%) required external laryngeal pressure (N_6 points) while only two cases (12.5%) in Group III needed external laryngeal pressure to optimise the glottic view during intubation. In all patients vocal cords were abducted and there was no impediment to intubation due the position of the vocal cords. Therefore the N_7 points in all cases were zero. The IDS score and hence the intubation difficulty was least in Group III which was statistically significant.

Discussion

Trauma patients with suspected cervical spine injuries pose several problems while securing the airway and can be a challenge to the anaesthesiologist.

The acutely traumatised patient requires urgent airway attention, owing to a high incidence of profound hypoxia and acidosis, allowing little time for assessment. A cervical spine injury is not confirmed in many such situations. Intubation must proceed promptly but with care.[11]

Failure to adequately immobilise the neck during tracheal intubation in patients with cervical spine injuries can result in a devastating

neurological outcome. A widely used approach is neck immobilisation using manual in-line axial stabilisation (MIAS). The evidence base supporting MIAS is surprisingly limited. In anatomical studies, after complete C_4–C_5 ligamentous injury, MIAS did reduce segmental angular rotation and distraction, although it did increase subluxation, compared with non immobilisation. In a case series of 150 patients with traumatic cervical spine injuries with well preserved neurological function, oral tracheal intubation with MIAS, whether performed after induction of general anaesthesia or with patient awake, did not result in any neurological complications.[12]

It is therefore an accepted practice in many institutions to remove rigid collars and use MIAS for cervical immobilisation during tracheal intubation in patients with suspected or proven cervical spine injury. A key concern remains the fact that glottic views obtained during direct laryngoscopy with cervical spine immobilisation are consistently poorer, compared with non-immobilised controls, which is a major factor in determining the difficulty of intubation. Consequently, manoeuvres to stabilise the neck patients at risk of cervical injury may result in failure to secure the airway, which may result in substantial morbidity and even mortality in this patient group. These issues highlight the need to develop alternative approaches to securing the airway in patients at risk of cervical spine injury.[12]

In those centres that have developed skill with the technique, the fiberoptc laryngoscopy and intubation has proved to be a very useful tool. However its use is limited by various factors including availability, skill and feasibility in certain situations. In such situations, a laryngoscope will be useful which improves the glottic view with MIAS, does not require learning of any special skill for its use and takes minimum time to assemble and intubate.

There have been studies on various indirect optical view laryngoscopes in similar situations – Bullard laryngoscope,[13] WuScope,[14] Airtraq laryngoscope,[12] Gildescope.[15] Although results have been positive in most studies, there is no evidence that one method is better than the others.

Keeping these factors under consideration, we proposed that intubation difficulty would be reduced with TruView (a recently introduced optical laryngoscope) compared to conventional laryngosocpy with Macintosh or Miller laryngoscope. To our knowledge at the time of beginning this study there was no such analysis done. The TruView EVO_2 laryngoscope (Truphatek International Ltd., Netanya, Israel) is a recently introduced optical laryngoscope. It is quite similar to a conventional laryngoscope with a similar handle and a modified blade incorporating a view tube with a prism system.[8]

As compared to Macintosh and Miller blades, it provides a anterior refraction of 42° to the line of sight, improving the glottic view, hence reducing the lifting force required and possibly less cervical spine movement. The glottic opening procedure using the TruView is simpler to routine laryngoscopy and does not require learning of any special skill. This principle formed the basis of analysis of this device. During the pilot phase of this study, we noted that the duration of intubation with the TruView was much prolonged with multiple attempts at laryngoscopy. Considering the limited time available during an emergency situation and patient safety during the study, duration of intubation was capped at 120 seconds, beyond which the attempt would be considered a failure, and allowing only a single attempt at laryngoscopy. Further, to reduce the incidence of fogging, oxygen with a minimum flow of 8 L/min, was connected to the side port of the laryngoscope. Our study demonstrated that intubation difficulty was significantly reduced with TruView in comparison to Macintosh or Miller blades. Most patients in TruView group (87.5%) had IDS score 0–5 (easy to slight difficulty).Eleven patients (55%) in Macintosh group, eight (44.4%) in Miller group while only two patients (12.5%) in TruView group had IDS score >5 (moderate to major difficulty). In a similar study by Smith et al using Wuscope[87] there were 79% patients in the fibreoptic group and 39% patients in the Macintosh group with IDS = 0 (easy intubation).

Similar results were seen in a study by Maharaj et al using Airtraq laryngoscope 69, with 19 out of 20 patients in the Airtraq group having an IDS of zero.

The main factor for a reduced IDS score was significantly improved glottic view in the TruView group. 81.3% of patients in TruView group had Cormack-Lehane grade 1 view while no patient in either Macintosh or Miller group had grade 1 view. 90% patients in Macintosh group and 55.55 in Miller group had grade 3 view. Glottic view in the miller group was significantly better than in the Macintosh group while glottic view was the best in the TruView group which is significant. In a vivo cinefluroscopic study by LeGrand et al,[5] it was

observed that direct laryngoscopy and orotracheal intubation with Miller blade resulted in 15 – 20% less cranio-cervical extension than with Macintosh blade, on average approximately 3° less at occiput – C_1 and approximately 5° less from occiput to C_5. This could account for a better glottic view with cervical spine immobilisation in the Miller group compared to Macintosh in our study.

In a study of 200 patients by J.B. Li et al[16] comparing TruView and Macintosh laryngoscope, glottic view was significantly improved with TruView laryngoscope. Similar results were obtained in a study by Lieberman et al.[17] Our study confirms and extends these findings of improved glottic view with TruView laryngoscope even in patients with cervical spine immobilisation. Moreover, less number of patients in the TruView group required manoeuvres like external laryngeal pressure to improve the glottic view, an observation also made in the study by J.B. Li et al.[16]

However, the mean duration of intubation was significantly prolonged, 53.4 seconds in the TruView group as compared to Macintosh or the Miller group (16.2 and 25.7 seconds respectively). The average duration of intubation was the least in the Macintosh group. Similar results were also obtained in the study by J.B. Li et al wherein the mean time to intubate with the TruView was significantly prolonged (51 seconds) compared to Macintosh laryngoscope (34 seconds) 50. Similar results also obtained with the WuScope in the study by Smith et al.

The increased duration of intubation was associated with an increased number of intubation attempts. 50% of patients in the TruView group required more than 3 attempts to intubate compared to 15% in the Macintosh and 5.5% in the Miller group. Thus although the glottic view was better with the TruView, it required increased number of intubation attempts.

We observed that while advancing the endotracheal tube towards the glottis in the TruView group it tended to move posterior to the glottis. Overcoming this problem required the use of the preformed Optishape™ stylet provided with the TruView laryngoscope. Further, it was noticed that withdrawing the TruView laryngoscope and then advancing the endotracheal tube towards the glottis resulted in successful placement of the endotracheal tube rather than advancing and lifting the laryngoscope blade further as this moved the larynx more anterior to the endotracheal tube which actually increased the difficulty.

The success rate of intubation was least in the TruView group (80%) compared to Macintosh (100%) and Miller (90%) group owing to the prolonged intubation time in all the four failed cases in the TruView group. Lesser success rate in the TruView group could be attributed the time limit described (120 seconds) for patient safety and to simulate emergency conditions in our study. Thus success rates in our study might not reflect those during routine intubations. No cases in the TruView group encountered the problem of fogging. Keeping a minimum flow of 8L/min of oxygen successfully avoided this problem.

The anaesthesiologist performing the laryngoscopy could not be blinded to the laryngoscope being used as this is obviously impossible. Hence observer bias cannot be completely ignored in our study especially regarding subjective parameters of the intubation difficulty score.

Despite the longer duration of intubation and less success rate, the TruView has a decreased IDS score. This might be useful certain clinical situations as reported by M. Gotou et al.[18]

The manipulation procedure of the EV02 is similar to the routine laryngoscopic and does not require learning of any special skill.[18] The use of optical laryngoscopes such as the $EV0_2$ may compensate for the disadvantages of awake fibreoptic intubation, and their use allows safe tracheal intubation.[18] In our study however, lower difficulty score was associated with longer intubation times indicating possibly a comparatively lesser experience with TruView than with conventional laryngoscopy. Skilled hand eye coordination is perhaps required to manipulate the endotracheal tube under indirect vision.

As noted by Crosby et al,[7] anaesthetists should intubate the patients in the manner with which they have the most expertise. The paramount issue is to avoid spinal movement and not the mode of intubation.

Conclusions

Tru View Laryngoscope had the least difficulty but required more time to intubate in patients with cervical spine immobilization (MIAS), compared to conventional laryngoscopy using macintosh or miller laryngoscopy.

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