Assessment of Difficulty During Orotracheal Intubation In Patients With Cervical Spine Immobilization—A Comparison of Macintosh and Truview Laryngoscopes

ABSTRACT

Patients with cervical spine disease/trauma with intact or partially intact neurological status requiring endotracheal intubation present as special cases of difficult airway. Securing the airway in such patients can be a difficult task for any anaesthesiologist especially during emergency situations. Failure to immobilize the neck during tracheal intubation in patients with cervical spine injuries can result in devastating neurological outcome. The purpose of this study was to compare the difficulty during oro-tracheal intubation in patients with cervical spine immobilization (using Manual In-line Axial Stabilization) in two groups using Macintosh or TruView laryngoscopes utilizing the Intubation Difficulty Scale (IDS), to compare the duration and success rate of intubation in the two groups. Sixty consenting patients scheduled for elective surgery and requiring general anaesthesia with orotracheal intubation were entered into the study and were equally randomized to undergo intubation using a Macintosh or TruView EVO2™ laryngoscope with the cervical spine immobilized using Manual In-line Axial Stabilization (MILS). A single attempt at laryngoscopy was given. Time taken for intubation was observed. Duration exceeding 120 s was considered as a failure. Parameters of IDS score were observed to compare the difficulty between the two groups. IDS score was significantly lower in TruView Group. All patients in the Macintosh Group were intubated successfully while 24(80%) patients in TruView Group could be intubated successfully. The average duration of intubation was significantly longer in the TruView Group compared to Macintosh Group. TruView laryngoscope provided a significantly better glottic view and required less optimizing maneuvers. Duration of intubation was prolonged with TruView owing to significantly more number of intubations, also more time in obtaining glottic view causing failure of intubation in some cases. TruView laryngoscope required more time but reduced the intubation difficulty and was less successful within the stipulated time for laryngoscopy than Macintosh laryngoscope for intubation in patients with cervical spine immobilization.

KEYWORDS:

INTRODUCTION

Patients with cervical spine disease/trauma present as special cases for airway management. Securing the airway in such patients can be a difficult task for any anaesthesiologist especially during emergency situations. Endotracheal intubation may be required in these cases for the purpose of resuscitation, administration of general anaesthesia or respiratory support.

In an emergency situation, wherein a cervical spine injury is suspected and/or cervical spine stability is in question, routine laryngoscopy and intubation may result in a neurological disaster for the patient and a medicolegal one for the anaesthesiologist. Various manoeuvres are used to stabilize the cervical spine during intubation in such patients. Manual-inline-axial-stabilization (MILS) is one such method which has been advocated. It is widely used and has been proved to be safe in these situations.

However, a major drawback of MILS is that it restricts the glottic view thus increasing the difficulty in securing the airway. To overcome this problem several devices like intubating LMA, Bullard laryngoscope, fibreoptic laryngoscope etc. have been designed which minimize the cervical spine movement.
The TruView EVO2 laryngoscope is one such device which has a modified laryngoscope blade. It consists of an optical system, which provides an unmagnified view of the vocal cords through an optical side port. It provides an angled view of the glottis which does not require neck extension and allows indirect tracheal intubation.

Our institution provides health care to many such patients with cervical spine injuries which present as cases of difficult airway. Anaesthesiologists at our institute have therefore, considerable experience of managing the airway in such cases wherein restriction of the cervical spine movement is desirable or is mandated. Further, consultants in our department have gained considerable experience in the use of the TruView laryngoscope. Therefore, this randomized control study was undertaken to observe which airway device would be better suited in such a situation.

AIMS & OBJECTIVES

- To compare the difficulty during orotracheal intubation in patients with cervical spine immobilization [using Manual In-line Axial Stabilization (MILS)] in two groups using Macintosh or TruView laryngoscopes utilizing the Intubation Difficulty Scale (IDS).
- To compare the duration of intubation in the two groups.
- To compare the overall success rate of intubation in the two groups.

A labelled, high resolution lateral x-ray of a normal upper cervical spine is shown in Figure 1. Several items are notable.

**Motion**

The cervical spine is designed to support the head and to permit maximal motion in three dimensions without damaging the spinal cord. The three axes of motion are:

- flexion/extension (floor to ceiling)
- lateral bending (shoulder-to-shoulder)
- Axial rotation (turning side-to-side).

**Movement with Intubation**

To visualize the glottis and introduce an endotracheal tube, it is necessary to "align the pharyngeal and laryngeal axis". Nevertheless, to place a tube via direct laryngoscopy, you still must be obtained a "line of sight" view between your eye and enough of the glottis to allow placement of the endotracheal (ET) tube. This requires a complex series of movements. Figure 2 is taken from a series of cinefluoroscopic images we’ve obtained during direct laryngoscopy (DL) and intubation.

**EQUIPMENTS**

The Macintosh is one of the most popular blades. The tongue has a gentle curve that extends to the tip. In cross section, the tongue, web, and flange form a reverse Z (Fig. 3).

**TruView EVO2 Laryngoscope (Figs 4–6)**

The TruView EVO2, an optical laryngoscope, (Truphatek International Ltd., Netanya, Israel), is a recently introduced device with a unique blade that provides an optical view ‘around the corner’. The blade is a modified laryngoscope blade incorporating an unmagnified optic side port with anterior fraction of 35% in the line of sight allowing indirect tracheal intubation.

It has a curved blade, consisting of a straight blade part and a curved tip (horizontal elevation angle; 40°). The optical apparatus provides a 42° angled deflection view through the 15 mm eyepiece. The TruView eyepiece can be connected to an endoscopic camera head with a monitor allowing audience viewing of the procedure for training procedure. In addition, the TruView has a port that connects to the auxiliary port of the anaesthesia machine (flow rate 4 – 6 L/min) which prevents misting and clears secretions for the lens.

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**Fig. 1** Lateral x-ray of a normal upper cervical spine.

**Fig. 2** Cinefluoroscopic images obtained during direct laryngoscopy and intubation.
provides clearer and wider – angle vision provided by conventional laryngoscopes. The angle of view facilitates vision in patients with limited neck extension. It does not require head extension and allows accurate observation of vocal cords even with the patient in horizontal head position.

**METHODOLOGY**

Approval from the Grecian Hospital ethics committee was obtained for this randomized controlled study. Informed consent from all the patients entered into the study was taken.

60 patients scheduled for elective surgery and requiring general anaesthesia with orotracheal intubation were entered into the study and were equally randomized into following two groups using draw of lots.

Group I - Orotracheal intubation using Macintosh laryngoscope.

Group II - Orotracheal intubation using TruView laryngoscope.

**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 cm
- Thyro-mental distance ≥6 cm
- Sterno-mental distance ≥12 cm
- Routine investigations including – Haemogram, Liver function tests, Kidney function tests, Serum electrolytes, Random blood sugar, Urine (routine and microscopic examination), E.C.G., Chest X-ray
- Informed consent

Fig. 3 Blade of a standard Macintosh laryngoscope.

Fig. 4 TruView EVO laryngoscope in various positions. Upper plate shows side view, lower plate shows operator’s view. Wide arrow points at the eyepiece; slim arrow shows the connection to the auxiliary oxygen flow meter.

and provides continuous oxygen insufflation during intubation.

The glottic opening procedure using the EVO2 is similar to the routine laryngoscopic procedure and does not require the learning of any special skill. The EVO2
Assessment of difficulty during orotracheal intubation in patients with cervical spine immobilization

**Technique**

After pre-anaesthetic evaluation, eligible patients were equally randomized into the two groups. All patients received a standardized general anaesthetic and monitoring.

- Baseline vitals were observed.
- Following induction of anaesthesia, patients were manually ventilated with oxygen and Isoflurane 1%.
- MILS 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 of both laryngoscopes, according to the Group to which the patient had been assigned followed by orotracheal intubation with an appropriate size regular (pvc) cuffed endotracheal tube.

While intubating with TruView laryngoscope following technique was used:\(^{12}\)

- To prevent fogging and to keep lens clear of secretions, TruView™ EVO2’s oxygen port was connected to oxygen supply line at a minimum rate of 8 l/min.
- TruView™ EVO2 laryngoscope was held in left hand. With right hand patient’s mouth was

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**Fig. 5** Removable parts of a TruView laryngoscope. Left – Optical view tube with lenses and prisms; Right – FiberClip™ (Replaceable light guide).

**Fig. 6** Labelled picture of an assembled TruView laryngoscope.
opened slightly and blade was inserted in the mouth in the midline to the 0- depth line marked on the TruView EVO2™ blade using two fingers as a guideline (Fig. 7).

- Glottis was viewed through the eyepiece from a comfortable distance while advancing TruView™ EVO2 until the 1- line depth and it was possible to see the vocal cords (Fig. 8).
- Once adequate glottic view was achieved, endotracheal tube with the OptiShape™ stylet (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
- The total IDS score
- The total duration of intubation
- Success of intubation

**Duration 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/Endtidal CO₂.

A single attempt at laryngoscopy was given.

Failure was defined as laryngoscopy time exceeding 120 s. If the duration of laryngoscopy exceeded 120 s, manual in-line stabilization was released and patient was intubated conventionally.

The sample size was calculated to detect a difference of 20 s in intubation time between any two groups, with α = 0.05.

Data were analyzed using One Way Analysis of Variance with Duncan’s mean test.
RESULTS

A total of 60 patients were enrolled in the study, 30 in each group. The average age (mean ± S.D.) of patients was 57.2 ± 15.1 and 54.8 ± 15 in Group I and Group II, respectively. Although there was a male preponderance in both the groups, the gender distribution between the two groups was similar. There were 23 males and 7 females in Group I whereas 21 males and 9 females in Group II.

The average body mass index (BMI) (mean ± S.D.) of patients was 24.5 ± 1.8 kg/m² and 24.3 ± 2 kg/m² in Group I and Group II, respectively.

The age and BMI were comparable in the two groups and there was no statistically significant difference between the two groups.

It was found that 70% of patients in Group I and 73.33% in Group II had Mallampati class 2 while 30% of patients in Group I and 26.67% in Group II had Mallampati class 1 classification upon oral examination.

The average inter-incisor distance (IID) (mean ± S.D.) of patients was 4.4 ± 0.4 cm and 4.4 ± 0.5 cm in Group I and Group II, respectively.

The average thyro-mental distance (TMD) (mean ± S.D.) of patients was 7.1 ± 0.6 cm and 6.8 ± 0.6 cm in Group I and Group II, respectively.

The average sterno-mental distance (SMD) (mean ± S.D.) of patients was 16 ± 1.3 cm and 16.1 ± 1 cm in Group I and Group II, respectively.

The inter-incisor, thyro-mental and SMDs of patients in the two groups were comparable and there was no statistically significant difference between the two groups.

Success rate of intubation

All patients in Group I (Macintosh) were successfully intubated while 24 patients in Group II (TruView) were intubated successfully. The success rate of intubation was 100% and 80% in Group I and Group II, respectively.

Duration of intubation

The average duration of intubation (mean ± S.D.) was 16.2 ± 6.7 and 53.4 ± 25.8 in Group I and Group II, respectively. The difference between the duration of intubation among the two groups was statistically significant. Duration of intubation was significantly prolonged in Group II (TruView) compared to Group I (Macintosh).

Analysis of Parameters of IDS

Number of Additional Intubation Attempts - N1

Nine patients (30%) in Group I while none in Group II were intubated in the first attempt. Further, three patients (10%) in Group I and eight (33.33%) in Group II required more than three intubation attempts. The average N1 points and hence the number of intubation attempts were significantly increased in Group II.

Number of Additional Operators – N2

All patients were intubated by a single anaesthesiologist (operator), without any additional operator directly attempting intubation. Therefore N2 points in all the cases were zero.

Number of Alternative Techniques Used – N3

Twenty one patients (70%) in Group I and all patients in Group II required the use of a stylet for intubation. In Group II, all patients were intubated using the OptiShape™ stylet provided with the Truview EVO2 laryngoscope. Average N3 points were significantly higher in Group II.

Glottic Exposure (Cormack – Lehane grade) – N4

There were no cases in Group I with grade 1 Cormack–Lehane view while 18 cases (75%) in Group II had grade 1 view on laryngoscopy. Average N4 points were least in Group II. Glottic view significantly improved in Group II compared to Group I.

Subjective Measure of Lifting Force - N5

All patients in Group I and II required an increased lifting force while all patients in Group II required a normal lifting force during intubation which is significant.

Necessity of Applied External Laryngeal Pressure for Optimizing the Glottic Exposure – N6

Most cases in Group I (90%) required external laryngeal pressure while only two cases (8.33%) in Group II needed external laryngeal pressure to optimize the glottic view during intubation.

Position of Vocal Cords – N7

In all patients vocal cords were abducted and there was no impediment to intubation due to the position of the vocal cords. Therefore, the N7 points in all cases were zero.

Comparison of IDS Score

Twelve patients (40%) in Group I while three patients (12.5%) in Group II had IDS score >5 (moderate to major difficulty). The IDS score was less in Group II which was statistically significant (Table 1).

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
traumatized 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. Immobilization should be provided.

Failure to adequately immobilize the neck during tracheal intubation in patients with cervical spine injuries can result in a devastating neurological outcome. A widely used approach is neck immobilization using MILS. In anatomical studies, after complete C4-C5 ligamentous injury, MIAS did reduce segmental angular rotation and distraction, although it did increase subluxation, compared with nonimmobilization. It is therefore an accepted practice in many institutions to remove rigid collars and use MIAS for cervical immobilization during tracheal intubation in patients with suspected or proven cervical spine injury.

A key concern remains the fact that glottic views obtained during DL with cervical spine immobilization are consistently poorer, compared with non-immobilized controls. MIAS prevents head extension and neck flexion, which are necessary for optimal alignment of the three airway axes and exposure of the vocal cords using direct laryngoscopic techniques. These issues highlight the need to develop alternative approaches to securing the airway in patients at risk of cervical spine injury.

Various methods of intubation for the unstable cervical spine have been studied – Awake blind nasotracheal, fibreoptic oro/nasotracheal, retrograde catheter, cricothyrotomy; Anesthetized with no relaxant blind nasotracheal, fibreoptic oro/nasotracheal; anaesthetized rapid sequence with muscle relaxants orotracheal laryngoscopic intubation. There have been studies on more recently developed indirect view laryngoscopes in similar situations – Bullard laryngoscope, WuScope, Airtraq laryngoscope, Gildescope.

Under ideal situations, patients in both categories would simply be managed by flexible fiberoptic laryngoscopy and intubation; no neck motion would ever be required. In those centres that have developed skill with the technique, the FOB has proved to be a very useful tool. However, not all anaesthetists feel sufficiently skilled with the technique to include it in their therapeutic armamentarium.

Moreover, this is not feasible in many situations especially at an emergency site or situation. We are confronted by the combative or intoxicated patient with the potential full stomach in whom an awake fibreoptic intubation is not feasible, and in which an asleep intubation - which in most hands takes at least a minute or more - is not deemed acceptable. 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. Keeping these factors under consideration, we proposed that intubation difficulty would be reduced with TruView (a recently introduced optical laryngoscope) compared to conventional laryngoscopy with Macintosh laryngoscope.

The TruView EVO2 laryngoscope is quite similar to a conventional laryngoscope with a similar handle and a modified blade incorporating a view tube with a prism system. As compared to Macintosh and Miller blades, it provides a refraction anterior to the line of sight improving the glottic view. The anterior refraction provided is 42° to the line of sight hence reducing the lifting force required and

<table>
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<tr>
<th>Intubation Difficulty Scale (IDS) Score</th>
<th>0–5</th>
<th>&gt;5 (Mean ± S.D.)</th>
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<tr>
<td>Group I (n = 30)</td>
<td>18 (60%)</td>
<td>12 (40%)</td>
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<tr>
<td>Group II (n = 24)</td>
<td>21 (87.5%)</td>
<td>3 (12.5%)</td>
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*IDS score significantly less in Group II compared to Group I (One Way ANOVA with Duncan’s Mean test at 0.05 level).
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 s, 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 blade. Most patients in TruView Group (90%) had IDS score 0–5 (easy to slight difficulty). Twelve patients (40%) in Macintosh Group, while only three patients (12.5%) in TruView Group had IDS score >5 (moderate to major difficulty).

The main factor for a reduced IDS score was significantly improved glottic view in the TruView Group. Glottic view was the best in the TruView Group which is significant. 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. However, the mean duration of intubation was significantly prolonged, 53.4 s in the TruView Group as compared to Macintosh Group (16.2 s). The average duration of intubation was the less in the Macintosh Group. The increased duration of intubation was associated with an increased number of intubation attempts. 50% of patients in the TruView Group required more than three attempts to intubate compared to 20% in the Macintosh 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 less in the TruView Group (80%) compared to Macintosh (100%) group owing to the prolonged intubation time in all the six failed cases in the TruView Group. Lesser success rate in the TruView Group could be attributed the time limit described (120 s) for patient safety and to simulate emergency conditions in our study.

Despite the longer duration of intubation and less success rate, the TruView has a decreased IDS score. When using a Macintosh laryngoscope without neck extension, the view of glottic visualization was Cormack and Lehane grade IV. When the larynx was observed using the EVO2, the vocal cords could be visually confirmed, and tracheal intubation was readily performed.

CONCLUSIONS

- The IDS score and hence the difficulty during orotracheal intubation with cervical spine immobilization (using MILS) is significantly less with the TruView laryngoscope compared to conventional laryngoscopy using Macintosh laryngoscope. Glottic view is significantly better during laryngoscopy with TruView laryngoscope compared to Macintosh laryngoscope. Lifting force and optimization manoeuvres are least required with TruView laryngoscope. However number of intubation attempts required is significantly higher with TruView laryngoscope.

- The duration of intubation is less with the Macintosh laryngoscope while it is much more with TruView laryngoscope.

- Success rate of intubation is more with Macintosh laryngoscope than with TruView laryngoscope under the stipulated time limit (120 s) for laryngoscopy.

REFERENCES


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