Assessment of cervical spine movement during laryngoscopy with Macintosh and Truview laryngoscopes

Neerja Bhardwaj, Kajal Jain, Madhusudan Rao[1], Arup Kumar Mandal[2]

Departments of Anesthesia and Intensive Care, [2]Urology, Postgraduate Institute of Medical Education and Research, Chandigarh, [1]Department of Anesthesia and Intensive Care, Sanjay Gandhi Postgraduate Institute, Lucknow, Uttar Pradesh, India

Abstract

Background: Truview laryngoscope provides an indirect view of the glottis and will cause less cervical spine movement since a ventral lifting force will not be required to visualize the glottis compared to Macintosh laryngoscope.
Materials and Methods: A randomized crossover study to assess the degree of movement of cervical spine during endotracheal intubation with Truview laryngoscope was conducted in 25 adult ASA-I patients. After a standard anesthetic technique laryngoscopy was performed twice in each patient using in turn both the Macintosh and Truview laryngoscopes. A baseline radiograph with the head and neck in a neutral position was followed by a second radiograph taken during each laryngoscopy. An experienced radiologist analyzed and measured the cervical movement.
Results: Significant cervical spine movement occurred at all segments when compared to the baseline with both the Macintosh and Truview laryngoscopes ($P < 0.001$). However, the movement was significantly less with Truview compared to the Macintosh laryngoscope at C_0–C_1 (21%; $P = 0.005$) and C_1–C_2 levels (32%; $P = 0.009$). The atlantooccipital distance (AOD) traversed while using Truview laryngoscope was significantly less than with Macintosh blade (26%; $P = 0.001$). Truview blade produced a better laryngoscopic view ($P = 0.005$) than Macintosh blade, but had a longer time to laryngoscopy ($P = 0.04$).
Conclusion: Truview laryngoscope produced a better laryngoscopic view of glottis as compared with Macintosh laryngoscopy. It also produced significantly less cervical spine movement at C_0–C_1 and C_1–C_2 levels than with Macintosh laryngoscope in patients without cervical spine injury and without manual in-line stabilization (MILS). Further studies are warranted with Truview laryngoscope using MILS.

Key words: Airway, anesthetic techniques, equipment, laryngoscopes, Truview Macintosh, monitoring, radiological

Introduction

Direct laryngoscopy with Macintosh laryngoscope involves extension of the head at the occipitoatlantoaxial complex and flexion of lower cervical vertebrae in order to align oral, pharyngeal, and laryngeal axes; and therefore, allow intubation under direct vision. This maneuver causes maximum movement of the cervical spine which may be hazardous in patients with suspected/confirmed cervical spine injury carrying risk of neurological deterioration.[1,2] Performance of manual in-line stabilization (MILS) to reduce cervical movement during laryngoscopy as well as application of cricoid pressure to avoid aspiration deteriorates the laryngeal exposure and makes intubation difficult.[3,4]

Address for correspondence: Prof. Neerja Bhardwaj,
Department of Anaesthesia and Intensive Care, Postgraduate Institute of Medical Education and Research, Chandigarh - 160 012, India.
E-mail: neerja.bhardwaj@gmail.com

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Since the cervical movement associated with the use of Macintosh laryngoscope is substantial, other devices have been evaluated and studied for their effect on cervical spine movement.[5-13] It has been found that cervical movement is greatest with Macintosh, followed by McCoy, and is least with Bullard laryngoscope.[5-7] Laryngoscopic devices which enable a non-line-of-sight view of glottis are likely to cause less movement of cervical spine because less ventral force is required to visualize the glottic aperture. Airway Scope®, GlideScope®, and Airtraq® have been shown by many authors to minimize movement of cervical spine in patients who require immobilization of the cervical spine.[8-13]

Truview® laryngoscope (Truphatek International Ltd, Netanya, Israel) is a fiber optic device which enables an indirect view of the vocal cords. It has an optical apparatus which provides a 42° angled deflection view and this provides a good vision of the larynx in patients with limited neck extension.[14] Truview® laryngoscope produces a better laryngoscopic view with less maximal force applied during intubation but with longer time to intubation as compared to the Macintosh blade.[14,15] Truview blade has a port that connects to oxygen flow meter to clear away secretions, prevent misting, and provide continuous oxygen insufflations during intubation. It was hypothesized that use of Truview blade will cause less cervical spine movement since a ventral lifting force will not be required to visualize the glottis. Therefore, the primary aim of this study was to compare the degree of cervical spine movement produced by Truview and Macintosh laryngoscopes. The secondary aim was to assess the quality of glottic exposure, time taken to intubate, and any associated oxygen desaturation.

Materials and Methods

Following Institute Ethics Committee approval and written informed consent; a randomized controlled, crossover study was conducted in 25 ASA-I patients of age 18-50 years. All patients scheduled to undergo percutaneous nephrolithotomy (PCNL) for renal stones under general anesthesia and requiring tracheal intubation were included in the study. Patients with history of cervical spine injury, conditions with risk of gastric aspiration like gastroesophageal reflux disease and pregnant women, difficult intubation, and patients with body mass index >30 kg/m^2 were excluded from the study.

The included patients were not premedicated and a standard anesthetic technique was followed for all patients included in the study. No cricoid pressure or MILS was provided during intubation. After preoxygenation with 100% oxygen, anesthesia was induced with intravenous propofol 2 mg/kg and morphine 0.1 mg/kg. Tracheal intubation was achieved using vecuronium 0.1 mg/kg and laryngoscopy was attempted 4 min after administration of nondepolarizing muscle relaxant. Laryngoscopy was performed twice in each patient using in turn both the Macintosh and Truview laryngoscope in a random order generated from the computer. Trachea was intubated after second laryngoscopy using appropriate sized cuffed endotracheal tube preloaded with stylet. During each laryngoscopy, the laryngeal view was graded based on modified Cormack and Lehane criteria and laryngoscopy time was noted (from insertion of the blade between the teeth until the best view of glottis was seen).[16] Between laryngoscopies, the lungs were ventilated with 100% oxygen using a bag and mask to avoid hypoxemia. All patients were intubated after the second laryngoscopy and rest of the anesthetic management was at the discretion of attending anesthetist. All patients were monitored using a 5-lead electrocardiogram, pulse oximeter, noninvasive blood pressure, and end-tidal carbon dioxide. A lateral view digital radiograph including first four cervical vertebrae, dorsal part of the hard palate, and caudal portion of the occiput was obtained. A baseline radiograph was taken with the head and neck in a neutral position [Figure 1]. A second radiograph was taken during each laryngoscopy after obtaining the best view of larynx [Figures 2 and 3].

The radiographs were analyzed and cervical measurements calculated by an experienced radiologist who knew the purpose of the study but was not familiar with either of the laryngoscopes or order in which they were used. The reference for the occiput (C_0, McGregor line) was defined as a line drawn between the posterior margin of hard palate and opisthion. The C_1 reference is a line between the anterior and posterior arches of the atlas. The C_2–C_4 reference is a tangent through the anterior and posterior basal plate of the respective vertebral bodies. Using the line joining the tip of spinous process of C_2–C_4 as the common reference line, angles between adjacent levels were calculated with this line as the baseline. The angles were measured using a goniometer. The angles between

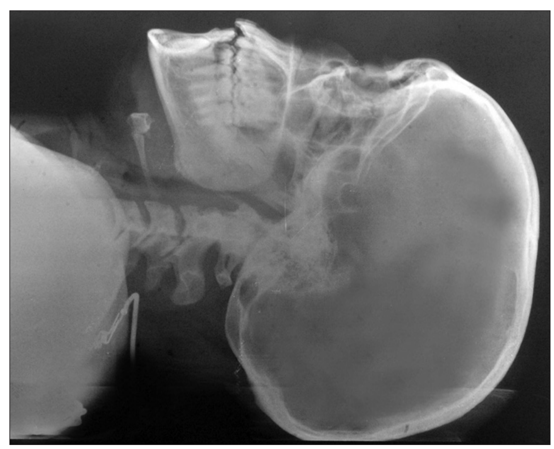

Figure 1: Baseline lateral cervical spine radiograph

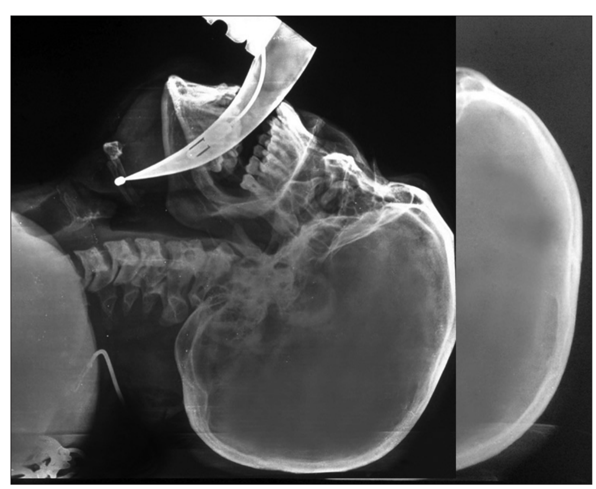

Figure 2: Lateral view of cervical spine using Macintosh laryngoscope

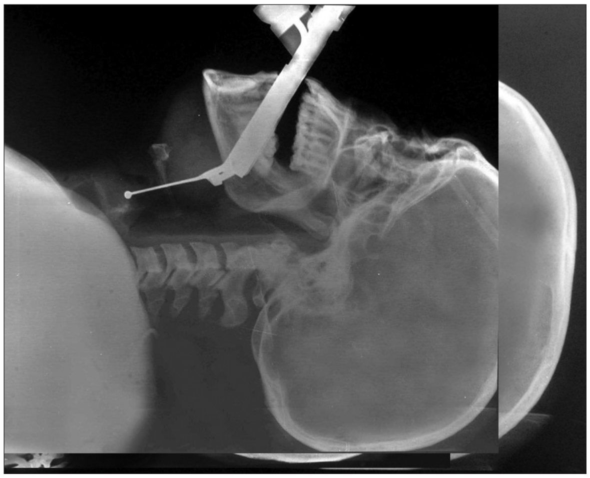

Figure 3: Lateral view of cervical spine using Truview laryngoscope

adjacent levels were calculated based on differences between the angles; for example, C_1–C_2 angle = (C_1 to common line angle) - (C_2 to common line angle). Positive angles denote flexion, and negative angles extension. The distance between the occiput and C_1 (AOD) was measured as the length of a vertical line drawn from C1 to the occiput (mm).

Statistical analysis

Sample size was calculated based on an assumption that Truview laryngoscope will reduce the cervical spine movement by 30% compared to Macintosh laryngoscope.[13] Based on this 20 patients would be required to detect a significant difference between the two laryngoscopes with an $\alpha = 0.05$ and $\beta = 0.9$, and so 25 patients were recruited to participate in the study. Kolmogorov-Smirnov test was performed for testing normality and data is expressed as mean (standard deviation (SD)). Analysis of variance was performed to examine differences between groups, followed by the post-hoc test of Student-Newman-Keuls. $P < 0.05$ was considered significant.

Results

The data was normally distributed and the patients included 18 males and seven females; with a mean age of 38 ± 8.5 years and mean weight of 64.8 ± 11.1 kg. The time taken for laryngoscopy by Truview laryngoscope (9.8 ± 5 s) was significantly longer ($P = 0.04$) compared to Macintosh laryngoscopy (7.6 ± 2.2 s). The laryngoscopic view was significantly better with Truview laryngoscope ($P = 0.005$) compared to Macintosh laryngoscope. More patients showed grade 1 laryngoscopic view when Truview laryngoscope ($n = 10$) was utilized compared to Macintosh laryngoscope ($n = 1$). No patient had a grade 3 laryngoscopic view with Truview laryngoscope compared to seven patients with Macintosh laryngoscope.

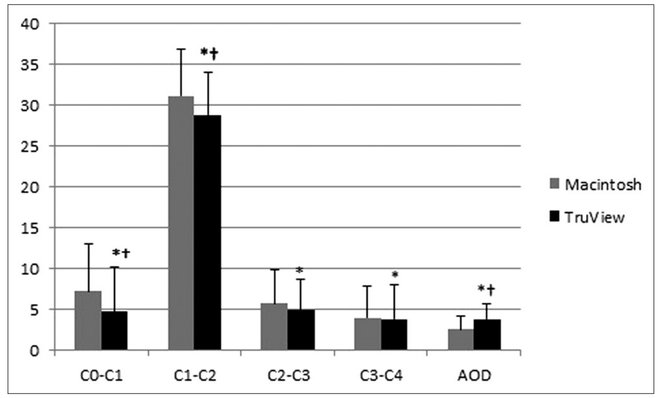

Figure 4: Mean segmental cervical spine movement with Truview versus Macintosh laryngoscope. $*P < 0.001$, $^{\dagger}P = 0.005$ (C0–C1), 0.009 (C1–C2), and 0.001 (atlantooccipital distance (AOD))

With the Macintosh laryngoscope, segmental cervical spine movement was 7.2 ± 5.8°, 31.2 ± 5.7°, 5.7° ±4.1°, and 4 ± 3.9°; and with Truview laryngoscope it was 4.7 ± 5.5°, 28.8 ± 5.3°, 5 ± 3.7°, and 3.8 ± 4.2°at C_0–C_1, C_1–C_2, C_2–C_3, and C_3–C_4 segments; respectively ($P < 0.001$). The atlantooccipital distance was 2.6 ± 1.6 mm with Macintosh laryngoscope and 3.8 ± 1.9 mm with Trueview laryngoscope when compared to the baseline value of 6.4 ± 3.3 mm ($P < 0.001$) [Figure 4]. Truview laryngoscope produced less extension of the cervical spine at C_0–C_1 (21%; $P = 0.005$), C_1–C_2 (32%; $P = 0.009$), and AOD (26%; $P = 0.001$) compared to the Macintosh laryngoscope.

Discussion

The results of our study showed that in healthy patients without MILS Truview laryngoscope produced significantly reduced cervical spine movement at C_0–C_1 and C_1–C_2 levels when compared to the Macintosh laryngoscope. The AOD was also significantly less with Truview compared to Macintosh laryngoscope. The laryngoscopic view was significantly better with the Truview laryngoscope, but the time to laryngoscopy was significantly longer when compared to the Macintosh laryngoscope.

Patients of cervical spine trauma require endotracheal intubation to protect the airway for ventilation and to administer anesthesia. Direct laryngoscopy and intubation using Macintosh blade requires extension of the cervical spine to align the oral, pharyngeal, and laryngeal axes. This maneuver carries the potential risk of increasing neurological damage during intubation. Many authors have shown Macintosh laryngoscope to produce a significant cervical spine extension.[5,9-11] Uzun *et al*., found a rotation of 19° at C_1–C_2 level when using Macintosh laryngoscope which is close to the instability limit of >20°.[17,18] In the present study also, Macintosh laryngoscope produced maximum extension at the C_1–C_2, C_2–C_3, and atlantooccipital joints.

A variety of equipment has been compared with the Macintosh laryngoscope with the aim of finding one which produces minimum degree of cervical movement. Bullard laryngoscope by virtue of its anatomical shape does not require alignment of the three axes. Therefore, its use has been found to result in maximum reduction in cervical spine movement (Macintosh = 25.9 ± 2.8°, Bullard = 12.6 ± 1.8°), when compared to other devices tested.[5,7] Fiber optic bronchoscopy also produces less movement of the cervical spine and is therefore considered the gold standard for intubation in patients with cervical spine injury.[19] It requires training and experience for its use, and poor visualization in presence of blood and secretions limits its use in situations requiring rapid intubation. Also, tongue pull and jaw thrust maneuvers commonly used to enlarge the pharyngeal space have been found to cause greater cervical spine movement.[19] Studies utilizing rigid video laryngoscopes (Airway scope, Glidescope, Airtraq) have shown reduced cervical spine movement of a variable degree [Table 1].[8-13]

Laryngoscope blades like Miller and McCoy have been researched for cervical spine movement. MacIntyre *et al*., found no difference in the degree of cervical movement between Macintosh and McCoy laryngoscopes although McCoy laryngoscope causes reduction in anterioposterior forces across the cervical region during intubation.[6] Similarly, Maruyama *et al*., found McCoy laryngoscope to be no different than Macintosh laryngoscope in terms of cervical spine movement.[10] A number of studies have also demonstrated that reduction in cervical spine movement is not dependent on the type of laryngoscope blade, that is, Miller, Macintosh, and McCoy.[7,20]

Truview laryngoscope is a device which provides an indirect view of the vocal cords and has been shown in many studies to provide a better laryngoscopic view compared to Macintosh laryngoscope. It was speculated that Truview laryngoscope unlike Airtraq will not require a ventral lifting force to adequately visualize the glottis, and therefore will cause less movement of cervical spine but with better view of laryngeal inlet.[11,15] In our study, Truview laryngoscope reduced the cervical spine movement when compared to Macintosh blade. Majority of movement takes place in upper cervical vertebrae and is likely to cause maximum damage, therefore reduction in movement at C_0–C_1 and C_1–C_2 is clinically important. In our study, we measured only the laryngoscopy time rather than the intubation time since we believed that it was unethical to intubate each patient on two occasions. Duration of laryngoscopy was prolonged with the Truview laryngoscope in our study as shown by other authors.[14,15] It took us 9.8 ± 5 s with Truview laryngoscope to secure the airway compared to Macintosh laryngoscopy (7.6 ± 2.2 s), but there were no events of desaturation. Also a difference of 2.2 s is clinically not significant. More familiarity with Macintosh laryngoscope may be one of the reasons for quicker intubation with it. Patients in our study were healthy with no cervical trauma, also no MILS performed, and therefore this result cannot be extrapolated to patients with cervical spine injury. As Truview laryngoscopy requires an anesthetist to look through the lens to focus on the vocal cords and he is able to see the tube only when its tip comes into view, practice and good eye-hand coordination is required. A prolonged or delayed intubation may expose a patient of cervical trauma to hypoxia, therefore techniques causing quick intubation are preferred. Availability of a side port for oxygen insufflation in Truview laryngoscope can avoid any hypoxic events related to prolonged intubation time.

Laryngoscopic view obtained with Truview laryngoscope was significantly better than with Macintosh laryngoscope in our study as reported by other authors also.[14,15] Application of MILS and cricoid pressure is likely to distort the laryngeal view and make intubation difficult. Since Truview laryngoscope allows good glottic view in patients where a traditional laryngoscope provides poor view, intubation is likely to be easier. Studies using Truview during application of MILS are warranted. In many studies, authors have not tried to achieve full glottis visualization before intubation, but have rather tried to minimize neck movement by accepting the first view that allows endotracheal intubation.[6,8,11,13] In our study, we chose the end point for laryngoscopy as the best view of glottis and lateral spine radiograph was taken at this time. This end point was chosen because majority of movement takes place in upper cervical vertebrae during intubation as shown by Sawin *et al*., and Lennarson *et al*.[21,22]

Table 1: Summary of percentage movement of cervical spine with various intubating devices

Author	Device	Percentage reduction in C-spine motion	Segmental level	MILS
Turkstra *et al*.[8]	Glidescope	50	C_2-C_5	Yes
Hirabayashi *et al*.[9]	AWS	37, 37, 68	C_0-C1, C_1-C_2, C_3-C_4	No
Hirabayashi *et al*.[11]	Airtraq	19, 16, 44	C_0-C_1, C_1-C_2, C_3-C_4	No
Turkstra *et al*.[13]	Airtraq	53, 95, 33	C_0-C_1, C_2-C_5, C_5-Th	Yes
Our study	Truview	32, 18, 22	C_0-C_1, C_1-C_2, AOD	No

MILS=Manual in-line stabilization, AOD=Atlantooccipital distance, Th=Thoracic

Our study used static X-rays to calculate the degree of cervical spine movement. Fluoroscopy was not utilized to avoid cumulative radiation exposure (patients undergoing PCNL procedure) and its limited ability to ascertain atlantooccipital distance. This study was performed in the operating room under ideal conditions; and thus, the results cannot be extrapolated in patients with cervical spine injury undergoing intubation in the emergency situation. All laryngoscopies were performed by the same anesthesiologist and so he could not be blinded to the laryngoscopes used and the intubation sequence. Radiographic bias is also possible, because laryngoscope appeared on the radiographs. However, the radiologist who calculated the cervical measurements did not know the purpose of the study and was not familiar with either of the laryngoscopes or the order in which they were used.

In conclusion, the Truview laryngoscope produced a better laryngoscopic view of glottis as compared with Macintosh layngoscopy. It also produced significantly less cervical spine movement at C_0–C_1 and C_1–C_2 levels than with Macintosh laryngoscope in patients without cervical spine injury and without MILS. Further studies are warranted with Truview laryngoscope using MILS.

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