Upper cervical spine movement during intubation: fluoroscopic comparison of the AirWay Scope, McCoy laryngoscope, and Macintosh laryngoscope

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Background. The AirWay Scope (AWS) is a new fibreoptic intubation device, which allows visualization of the glottic structures without alignment of the oral, pharyngeal, and tracheal axes, and thus may be useful in patients with limited cervical spine (C-spine) movement. We fluoroscopically evaluated upper C-spine movement during intubation with the AWS or Macintosh or McCoy laryngoscope.

Methods. Forty-five patients, with normal C-spine, scheduled for elective surgery were randomly assigned to one of the three intubation devices. Movement of the upper C-spine was examined by measuring angles formed by adjacent vertebrae during intubation. Time to intubation was also recorded.

Results. Median cumulative upper C-spine movement was 22.3°, 32.3°, and 36.5° with the AWS, Macintosh laryngoscope, and McCoy laryngoscope, respectively (P<0.001, AWS vs Macintosh and McCoy). The AWS reduced maximum movement of the C-spine at C1/C2 in comparison with the Macintosh or McCoy laryngoscope (P=0.012), and at C3/C4 in comparison with the McCoy laryngoscope (P=0.019). Intubation time was significantly longer in the AWS group than in the Macintosh group (P=0.03).

Conclusions. Compared with the Macintosh or McCoy laryngoscope, the AWS produced less movement of upper C-spine for intubation in patients with a normal C-spine.

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Direct laryngoscopy requires cervical spine (C-spine) extension to align the oral, pharyngeal, and laryngeal axes. Difficult intubation can be anticipated in patients with limited C-spine movement, such as those with ankylosing spondylitis, diabetes mellitus, or post-burn contracture of soft tissue in the neck, because of poor visualization of the larynx by means of direct laryngoscopy.¹⁻⁴

The AirWay Scope® (AWS) (PENTAX, Tokyo, Japan) is a new video laryngoscope that consists of a monitor, camera, and disposable introducer (INTLOCK®). The main grip-shaped unit contains a charge-coupled device (CCD) camera and a light source, with a retractable 2.4-in. liquid crystal device (LCD) monitor that can provide a full-colour view from the CCD camera. The INTLOCK® facilitates visualization of the glottis by the CCD camera and includes a side channel for tracheal tube placement (Fig. 1). Because of its structure, the AWS appeared to require less cervical movement than a conventional laryngoscope for identifying the vocal cords and tracheal intubation. A prospective, randomized, controlled study was conducted to compare C-spine movement required for laryngoscopy and intubation with the use of the AWS, Macintosh laryngoscope, or McCoy laryngoscope in patients with normal C-spine.

Methods

The study was approved by the ethics committee of Iida Municipal Hospital, and written informed consent was
obtained from all participants. We initially enrolled 45 patients, aged 18 to 82 yr, ASA physical status I–II, who were scheduled to undergo elective surgery requiring general anaesthesia with tracheal intubation. Patients with previous neck surgery, possible pregnancy, or an unstable C-spine and patients in whom difficult intubation was anticipated were excluded. Patients without incisors were also excluded. On the morning of surgery, patients were randomly assigned to the use of one of three scopes: the AWS (AWS group), Macintosh laryngoscope (size 3, Welch Allyn, Skaneateles Falls, NY, USA) (Macintosh group), or McCoy laryngoscope (size 3, Penlon Ltd, Abingdon, UK) (McCoy group).

The Mallampati airway score, thyromental, and sternomental distances with neck extension and degree of mouth opening were evaluated as factors predicting difficult intubation. Patients were premedicated with 20 mg raftidine, an H₂ blocker, 120 min before induction of anaesthesia. Standard monitoring techniques including electrocardiography, non-invasive blood pressure measurement, and pulse oxymetry were applied. Patients received 6 litre of 100% oxygen for several minutes before total i.v. anaesthesia was induced with propofol 1 mg kg⁻¹, fentanyl 100 μg, and vecuronium 0.1 mg kg⁻¹. Lidocaine 2%, 2 ml, was administered intravenously to prevent pain associated with the propofol administration. Before laryngoscopy, patients were placed in the neutral position on the operating table. With standard precautions taken to protect against radiation exposure, C-spine movement was observed fluoroscopically and recorded on videotape with the use of a mobile image intensifier (SIREMOBILE Compact, Siemens, Erlangen, Germany) throughout laryngoscopy until intubation was achieved. The patient’s mouth was opened by the cross-finger method. The AWS was introduced into the patient’s mouth and advanced into the posterior pharynx along the midline until the glottic opening was observed on the LCD monitor. The McCoy laryngoscope was inserted in the neutral position and then used in the activated position. Laryngoscopy was performed by an anaesthetist (YT).

The duration of laryngoscopy was defined as the time when the laryngoscope or the AWS passed the central incisors to the time when the anaesthetist withdrew the device from the patient’s mouth after tracheal intubation. The difficulty of laryngoscopy was assessed according to the Cormack–Lehane grading system: grade 1, full view; grade 2, only arytenoid cartilages visible; grade 3, only epiglottis visible; and grade 4, epiglottis not visible.⁶

We used the McGregor line, which joins the most dorsal and caudal part of the occiput to the posterior hard palate, as a reference line for the occipital bone. The reference for C1 was an imaginary line between the lower cortical margin of the anterior arch and the posterior arch. The references for C2–C4 were imaginary lines between the anterior, inferior margin of the respective vertebral bodies and the lower cortical margin of the respective spinous processes (Fig. 2). We depended on appropriate reference lines if initial anatomical marks were not available radiographically. Intubation was divided into two time intervals: T1, mouth opening with the cross-finger manoeuvre to insertion of one of the laryngoscopes or the AWS; T2, laryngoscopy to achievement of intubation. The fluoroscopic image recorded on videotape was converted to digital format with the use of a video capture card. Maximum movement of the C-spine was determined for each time interval by a radiologist (KR) who was unfamiliar with the laryngoscopes being studied and blinded to the purpose of the study, and a snapshot was printed out. Movement of the upper C-spine was evaluated by measuring angles formed by adjacent vertebral reference lines from occipital bone to C4 during the two time intervals, and the difference between the neutral position and maximum change in the angles was defined as maximum change in the angle between adjacent cervical vertebrae. A negative value denotes flexion of the C-spine, and a positive value denotes extension of the C-spine. The sum of the maximum changes in the angles of adjacent vertebrae from the occipital bone to C4 was taken as cumulative upper C-spine movement.

**Statistical analyses**

Patient age, height, weight, thyromental, and sternomental distances with neck extension, degree of mouth opening, and duration of laryngoscopy are expressed as mean values (SD). Analysis of variance (ANOVA) was used to examine differences between groups, and Fisher’s PLSD.
test was used as a post hoc test. Differences in the sex ratio were analysed by χ² test. Maximum change in the angle between adjacent cervical vertebrae and cumulative upper C-spine movement are expressed as median values and ranges. Between-group differences in these values were analysed by Kruskal–Wallis test and Mann–Whitney U-test. Differences in the Mallampati airway scores and Cormack–Lehane grades were also analysed by Kruskal–Wallis test. All statistical analyses were done with StatView 5.0 (SAS Institute Inc., Cary, NC, USA). Probability values of <0.05 were considered significant.

Results

Of the 45 patients initially enrolled, 37 patients completed the study (Table 1). Seven patients were excluded because movement was not accurately recorded on videotape during laryngoscopy (two in the AWS group, three in the Macintosh group, and two in the McCoy group). One patient assigned to the McCoy group was excluded because it was not possible to view the vocal cords with the McCoy laryngoscope; this patient was intubated with a full view of the larynx with the AWS. Laryngoscopy lasted 29 (sn 15) s in the AWS group, 16 (10) s in the Macintosh group and 23 (5) s in the McCoy group (P=0.030, AWS group compared with Macintosh).

During T1, median cumulative upper C-spine movement was −5.0° (range −16° to −1°) in the AWS group, −1.3° (range −9.5° to 4.0°) in the Macintosh group, and −4.0° (range −12° to 6.5°) in the McCoy group. These values did not differ significantly.

During T2, median cumulative upper C-spine movement was 22.3° (range 3.5° to 30.0°) in the AWS group, 32.3° (range 19° to 39.5°) in the Macintosh group, and 36.5° (range 23° to 56°) in the McCoy group (Fig. 3) (P<0.001, AWS group compared with Macintosh and McCoy). Among changes in the angle between adjacent cervical vertebrae during T2, median movement at C1/C2 was 6.0° (range −1° to 9.0°), 9.8° (range 3° to 17°), and 8° (range 4° to 22°) with the AWS and Macintosh and McCoy laryngoscopes, respectively (P<0.012, AWS group compared with Macintosh and McCoy). Median movement at C3/C4 was −0.3° (range −5.0° to 7.0°), 2.5° (range −3.0° to 8.0°), and 6.0° (range −3.5° to 11.5°) with the AWS and Macintosh and McCoy laryngoscopes, respectively. Median movement at C3/C4 was significantly less in the AWS group than in the McCoy group (P=0.019). Otherwise, there was no statistical difference in C-spine movement between groups.

Discussion

In the present study, the AWS, compared with the Macintosh and McCoy laryngoscopes, required less movement of the C-spine during laryngoscopy but a significantly longer time to tracheal intubation. Extension of the angle between adjacent vertebrae at C1/C2 during T2 was significantly reduced with the AWS. Change in the angle at C3/C4 was 8.0° (range 2.5° to 17°) with the AWS and Macintosh and McCoy laryngoscopes, respectively (P<0.05, AWS group compared with Macintosh and McCoy). Median movement at C3/C4 was significantly less in the AWS group compared with Macintosh and McCoy laryngoscopes, respectively (P<0.012, AWS group compared with Macintosh and McCoy). Median movement at C3/C4 was −0.3° (range −5.0° to 7.0°), 2.5° (range −3.0° to 8.0°), and 6.0° (range −3.5° to 11.5°) with the AWS and Macintosh and McCoy laryngoscopes, respectively. Median movement at C3/C4 was significantly less in the AWS group than in the McCoy group (P=0.019). Otherwise, there was no statistical difference in C-spine movement between groups.

Table 1  Patient data per group. *P<0.05, vs AWS group. Data are mean (range) or mean (sd)

<table>
<thead>
<tr>
<th></th>
<th>AWS group (n=12)</th>
<th>Macintosh group (n=12)</th>
<th>McCoy group (n=13)</th>
<th>P-value</th>
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<tr>
<td>Sex (F/M)</td>
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<td>6/6</td>
<td>6/7</td>
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<td>Age (yr)</td>
<td>50.8 (27–82)</td>
<td>48.1 (24–63)</td>
<td>51.3 (18–78)</td>
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<td>Height (cm)</td>
<td>162.0 (7.1)</td>
<td>161.6 (10.2)</td>
<td>162.4 (7.0)</td>
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<tr>
<td>Weight (kg)</td>
<td>58.0 (6.5)</td>
<td>56.5 (13.6)</td>
<td>56.8 (7.4)</td>
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<tr>
<td>Mallampati classification (I/II/III/IV)</td>
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<td>(8/4/0/0)</td>
<td>(10/3/0/0)</td>
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<tr>
<td>Thymorermal distance (cm)</td>
<td>9.1 (0.9)</td>
<td>9.9 (1.3)</td>
<td>9.5 (1.3)</td>
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<tr>
<td>Sternomental distance (cm)</td>
<td>17.1 (2.0)</td>
<td>17.3 (2.2)</td>
<td>16.7 (1.8)</td>
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<td>Mouth opening (cm)</td>
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<td>5.0 (0.6)</td>
<td>4.7 (0.8)</td>
<td>0.51</td>
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<td>Cormack–Lehane grade (I/II/III/IV)</td>
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<td>(10/2/0/0)</td>
<td>(12/1/0/0)</td>
<td>0.52</td>
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<tr>
<td>Duration of laryngoscopy (s)</td>
<td>29.8 (15.4)</td>
<td>16.8 (10.7)*</td>
<td>23.0 (5.0)</td>
<td>0.030</td>
</tr>
</tbody>
</table>
AirWay Scope and cervical spine movement

![Diagram of cumulative movement of the upper cervical spine during T1 and T2. T1 is the time from mouth opening with the cross-finger manoeuvre to insertion of the AWS or laryngoscope. T2 is the time from laryngoscopy to intubation. *P<0.01, vs AWS group.](https://academic.oup.com/bja/article-abstract/100/1/120/387137)

Fig 3 Cumulative movement of the upper cervical spine during T1 and T2. T1 is the time from mouth opening with the cross-finger manoeuvre to insertion of the AWS or laryngoscope. T2 is the time from laryngoscopy to intubation. *P<0.01, vs AWS group.

Movement of the C-spine during intubation with various devices, such as the Bullard laryngoscope, intubating lighted stylet, GlideScope, intubating laryngeal mask, and McCoy laryngoscope, has been well evaluated. However, the effect of the McCoy laryngoscope on C-spine movement remains open to discussion. Two studies have reported no significant difference in C-spine movement between the Macintosh and McCoy laryngoscopes. However, the McCoy laryngoscope provided better laryngeal exposure in patients in whom a cervical collar limited C-spine movement, suggesting that the McCoy laryngoscope required less excursion of the C-spine than the Macintosh laryngoscope required. In our study, the maximum change in the angle between adjacent cervical vertebrae and cumulative upper C-spine movement did not differ between the McCoy and the Macintosh laryngoscopes, and are consistent with previous findings.

Use of a Macintosh laryngoscope is probably the most familiar method for anaesthetists. In the present study, intubation time was significantly longer, by 13 s, with the AWS. Although this may not be clinically significant in most patients, a shorter intubation time is desirable in clinical settings, such as intubation in non-fasted or respiratory-compromised patients. Increased vigilance, therefore, may be required to prevent vomiting, aspiration, or oxygen desaturation when the AWS is used for intubation.

In conclusion, the AWS allowed intubation with less movement of the upper C-spine but a longer intubation time in patients with a normal C-spine. Further studies in patients with limited C-spine movement are necessary to confirm any advantage of the AWS.

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References

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