A comparison of the Airway Scope® and McCoy laryngoscope in patients with simulated restricted neck mobility

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Summary
We compared the efficacy of the Airway Scope® and McCoy laryngoscope as intubation tools with the neck stabilised by a rigid cervical collar. After induction of anaesthesia and neck stabilisation, 100 patients were randomly assigned to tracheal intubation with an Airway Scope or McCoy laryngoscope. Overall intubation success rate, time required for intubation, number of intubation attempts required for successful intubation, and airway complications related to intubation were recorded. Overall intubation success rates were 100% with both devices and a similar number of intubation attempts were required. However, the mean (SD) time required for successful intubation was shorter with the Airway Scope (30 (7) s) than with the McCoy laryngoscope (40 (14) s; p < 0.0001). The incidences of intubation complications were similar, but oesophageal intubation (in six cases) occurred only with McCoy laryngoscope.

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Accepted: 3 March 2010

The Airway Scope® (Pentax, Tokyo, Japan) (Fig. 1) is a new videolaryngoscope for tracheal intubation. The Airway Scope provides a view of the glottis and enables intubation without alignment of the oral, pharyngeal, and tracheal axes. The Airway Scope requires less cervical spine movement than conventional laryngoscopy with a Macintosh laryngoscope [1] and is effective when the neck is stabilised in the neutral position in manikins [2–4] and in humans [5–8]. The distal hinged tip of the McCoy laryngoscope (Penlon Ltd, Abingdon, UK) improves laryngoscopic views when the neck is immobilised by a cervical collar [9]. When the neck is manually stabilised in the neutral position, it improved laryngoscopic views in 86% of Cormack and Lehane grade-3 views with the Macintosh laryngoscope [10].

The Airway Scope and McCoy laryngoscope have yet to be compared in a simulated difficult airway in humans. We compared the two devices as aids for tracheal intubation in patients whose necks were immobilised by rigid cervical collars. Specifically, we tested the hypothesis that intubation success rates of both devices are similar, but that intubation with the Airway Scope is faster than with the McCoy laryngoscope.

Methods
With approval of the Human Research Committee at Kosei Hospital (Tokyo, Japan) and written informed consent, 100 patients scheduled for various surgical procedures requiring tracheal intubation for surgical anaesthesia were enrolled. Patients were aged 18–86 years, and were designated American Society of Anaesthesiologists (ASA) physical status 1–3. Exclusion criteria were an increased risk of pulmonary aspiration, cervical spine pathology, or anticipated airway difficulties (Mallampati grade 4 or thyromental distance < 6 cm).

Before induction of anaesthesia, patients’ heads were elevated 7 cm with a pillow. Anaesthesia was induced...
with fentanyl 2 μg.kg⁻¹ and propofol 2 mg.kg⁻¹, and after confirmation of facemask ventilation, rocuronium 0.6 mg.kg⁻¹ was given for neuromuscular blockade. Anaesthesia was maintained with sevoflurane 2% in oxygen. After full neuromuscular blockade was confirmed with a nerve stimulator, the pillow was removed and an appropriately sized rigid Philadelphia Cervical Collar (Tracheostomy Philadelphia Collar, Philadelphia Cervical Collar Co, Thorofare, NJ, USA) was positioned around the neck. Patients were then randomly allocated to tracheal intubation with an Airway Scope preloaded with a tracheal tube (7 mm internal diameter for women and 8 mm for men) or McCoy laryngoscope with a styleted tracheal tube. Randomisation was based on computer-generated codes that were maintained in sequentially numbered opaque envelopes.

For patients allocated to intubation with the Airway Scope, the scope was inserted in the mouth and positioned with the glottis seen at the centre of the cross-mark on its monitor. The tracheal tube was then advanced into the trachea and the scope was detached and removed from the mouth. Finally, the respiratory circuit was connected and ventilation confirmed with capnography. For patients assigned to intubation with the McCoy laryngoscope, the intubating investigator reported the modified Cormack and Lehane laryngoscopy grade [11] and the Percentage of Glottic Opening (POGO) score [12] with the laryngoscope in the Macintosh configuration and in the activated McCoy configuration.

The primary outcome measure of the study was the difference in intubation times between the Airway Scope and the McCoy laryngoscope. In a preliminary study the mean (SD) intubation time with the Airway Scope and optimal intubation conditions was 30 (15) s. Assuming the SD of intubation times for both the Airway Scope and McCoy laryngoscope in patients with a collar in place was also 15 s, we calculated that 50 patients in each group would provide 90% power for detecting a 10-s difference in mean intubation times between the groups.
with a two-tailed alpha of 0.05. We thus enrolled 100 patients.

Non-continuous data were compared with Mann–Whitney U-tests. The incidence of intubation complications and the overall intubation success rate were tested by Fisher’s exact or chi-square tests as appropriate. Continuous data were compared using unpaired t-tests. For patients assigned to the McCoy laryngoscope group, modified Cormack and Lehane scores and POGO scores with the laryngoscope in the Macintosh configuration and in the activated McCoy configuration were compared with the Wilcoxon signed-rank test. Statistical analysis was performed using STATVIEW version 5.0 (SAS Institute Inc, Cary, NC, USA) and SAMPLE POWER 2.0 (SPSS, Chicago, IL, USA). A value of p < 0.05 was considered significant.

Results

Morphometric and airway assessment data of patients are presented in Table 1. Overall intubation success rates were 100% for both devices. The number of first, second, and third attempts at intubation were 29, 17, and 4 for the Airway Scope and 36, 14, and 0 for the McCoy laryngoscope (p = 0.09). Time to intubation was significantly faster with the Airway Scope (30 (7) s) than with the McCoy laryngoscope (40 (14) s; p < 0.0001).

For patients assigned to the McCoy laryngoscope group, the modified Cormack and Lehane scores were worse in the Macintosh configuration than in the activated McCoy configuration (p < 0.0001; Fig. 2). Glottic structures were not visible (a modified Cormack and Lehane grade 3a or greater) in 34 patients in the Macintosh configuration compared with only 13 patients when the device was in its McCoy configuration. Among 34 patients with a 3a view in the Macintosh configuration, activation of the distal hinged tip (McCoy configuration) improved the view to 2b in 11 patients and to 2a in 10 others. In 13 patients, though, the view remained grade 3a. Of 10 patients with 2b views with the Macintosh configuration, the view improved to 2a with the McCoy configuration in seven patients, but remained unchanged in three others. In six patients who had grade 2a views with the Macintosh configuration, the view did not improve with the McCoy configuration. The median (IQR [range]) POGO score was also worse in the Macintosh configuration (0 (0–0 [0–40] %) than in the McCoy configuration (0 (0–20 [0–70] %); p < 0.0001).

There were six oesophageal intubations with the McCoy laryngoscope, but none with the Airway Scope (p = 0.027). Mucosal trauma occurred in three patients with the McCoy laryngoscope and in four with the Airway Scope (p > 0.99). Lip injury occurred in four patients with the Airway Scope, but none with the McCoy laryngoscope (p = 0.12). There were no dental injuries or hypoxia in either group.

Reasons for failed intubation (at the first or second attempt) using the McCoy laryngoscope were tactile resistance encountered while advancing the tube into the trachea due to limited oropharyngeal space caused by limited mouth opening (n = 4), suboptimal laryngoscopy because limited mouth opening prevented adequate blade insertion (n = 4), and oesophageal intubation (n = 6). All oesophageal intubations occurred on the first attempt, and were corrected at the second attempt with the McCoy laryngoscope. Intubations with the Airway Scope failed because of difficulty positioning the blade’s tip posterior to the epiglottis (n = 25).

Table 1 Morphometric characteristics and airway assessment data. Data presented as number or mean (SD).

<table>
<thead>
<tr>
<th></th>
<th>Airway Scope* (n = 50)</th>
<th>McCoy laryngoscope (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age; years</td>
<td>62 (16)</td>
<td>58 (22)</td>
</tr>
<tr>
<td>Sex; M/F</td>
<td>26/24</td>
<td>27/23</td>
</tr>
<tr>
<td>Height; cm</td>
<td>160 (9)</td>
<td>160 (11)</td>
</tr>
<tr>
<td>Weight; kg</td>
<td>59 (9)</td>
<td>55 (10)</td>
</tr>
<tr>
<td>Body mass index; kg.m(^{-2})</td>
<td>22.9 (2.8)</td>
<td>21.2 (2.4)</td>
</tr>
<tr>
<td>Mallampati score; 1/2/3/4</td>
<td>20/20/10/0</td>
<td>29/14/7/0</td>
</tr>
<tr>
<td>MOUTH opening; cm</td>
<td>4.9 (0.7)</td>
<td>4.7 (0.7)</td>
</tr>
<tr>
<td>MOUTH opening with collar; cm</td>
<td>2.0 (0.3)</td>
<td>2.0 (0.3)</td>
</tr>
<tr>
<td>Thyromental distance; cm</td>
<td>8.1 (0.8)</td>
<td>7.7 (0.9)</td>
</tr>
<tr>
<td>Sternomental distance; cm</td>
<td>17.3 (1.6)</td>
<td>20.0 (1.7)</td>
</tr>
</tbody>
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Figure 2 Modified Cormack and Lehane scores before (Macintosh configuration) and after (McCoy configuration) activation of the McCoy blade in the McCoy laryngoscope group.
Discussion

We have demonstrated that both the Airway Scope and the McCoy laryngoscope offer high success rates when difficult airways are simulated by application of a rigid cervical collar. However, intubation was about 10 s faster with the Airway Scope and was less likely to result in oesophageal intubation than with the McCoy laryngoscope. The Airway Scope was successful in all our patients, although multiple attempts were required in 42%. All failed attempts with the Airway Scope resulted from the introducer blade’s tip advancing into the vallecula rather than beneath the epiglottis. However, this was easily corrected by partially withdrawing the device, and with a subsequent scooping movement of the introducer blade, lifting the epiglottis, and advancing the tracheal tube into the trachea. Only a few seconds were required for this manoeuvre, which helps to explain why intubation times with the Airway Scope were faster than with the McCoy laryngoscope. The tracheas of patients with modified Cormack and Lehane grade 2a or 2b could presumably have been intubated with the McCoy blade in the Macintosh configuration. It could be argued that activation of McCoy blade prolonged the time for intubation and contributed to slower intubation times with the McCoy laryngoscope. For the 16 patients with modified Cormack and Lehane grades 2a or 2b and with the McCoy blade in the Macintosh configuration, the mean intubation time was 32 s. Even subtracting the few seconds required for McCoy blade activation from the intubation times in these patients would result in longer intubation times in the entire McCoy group than in the Airway Scope group.

There were no oesophageal intubations in patients assigned to the Airway Scope. It provided a nearly complete view of the larynx and allowed the operator to observe advancement of the tube into the trachea from outside the larynx. This continuous view allowed detection of inaccurate tube advancement which was then corrected before oesophageal intubation. In contrast, oesophageal intubation occurred in 12% of patients assigned to the McCoy laryngoscope. This could be attributed to poor visibility of the glottis as well as poor manoeuvrability of the tube due to limited oropharyngeal space, caused by limited mouth opening.

Although we were concerned that the view through the Airway Scope might become obstructed by secretions or fogging, neither problem was observed. In spite of the relative bulkiness of the introducer blade, the Airway Scope could be used in patients with a mouth opening as little as 20 mm. However, all the lip injuries with the Airway Scope occurred when the introducer blade was initially introduced into the mouth and were related to the bulkiness of the introducer blade rather than the limited mouth opening of the patients. In contrast, the McCoy laryngoscope, which is less bulky (especially in the width of the blade), did not cause lip injury.

Mouth opening and neck mobility were both decreased by application of a rigid cervical collar. The average 20-mm mouth opening in our patients was similar to that reported previously with the same rigid cervical collar [13, 14]. In the current study, the cervical collar generated Cormack and Lehane grade 3 or 4 views in 68% of patients assigned to the McCoy laryngoscope group (in the Macintosh configuration), which is similar to that reported with the Philadelphia and other cervical collars [9, 14–16], although no modified Cormack and Lehane 3b or 4 views were observed in the current study. Diversity among these studies may be related to the specific collars that were used in each of these studies or how they were positioned.

The McCoy laryngoscope has been previously tested in difficult airway scenarios simulated by application of a rigid cervical collar [9] or manual in-line stabilisation [10]. With a cervical collar in place the McCoy laryngoscope improved the Cormack and Lehane laryngoscopic view by at least one grade in 45% of patients [9], which was similar to the 42% improvement we observed. However, 92% of those patients with grades 3 or 4 views improved to grades 1 or 2 after activation of McCoy blade, which was substantially more improvement than the 62% we observed. A single skilled user conducted all McCoy laryngoscopies so inadequate mastery of the technique is unlikely to explain the system’s poorer performance in our patients. It is more likely that the difference simply reflects the types of collars used, their sizes in relation to the patients, and how they were applied. Laurent et al. reported that Cormack and Lehane laryngoscopic views improved at least one grade in 49% of patients whose necks were kept in the neutral position with manual in-line stabilisation [10]. They also found that 86% of grade 3 or 4 views improved to grade 1 or 2 views with activation of the McCoy blade, which is a greater improvement than the 62% improvement we observed. A better response may result because manual in-line stabilisation restricts anterior dislocation of the tongue and mandible less than a rigid collar.

We supplemented the modified Cormack and Lehane laryngoscopic grade with the POGO score because it is continuous and might provide greater sensitivity for subtle improvements in laryngoscopic view resulting from activation of the McCoy blade. In most of our patients, though, the modified Cormack and Lehane grade remained 2b or above even after McCoy blade activation. Consequently, the POGO scoring proved less useful since it remains zero at all Cormack and Lehane grades exceeding 2b.

Other approaches to intubation have been evaluated in patients with restricted neck mobility. In a previous similar study, for example, we showed that the tracheas of
most such patients can be intubated with a gum elastic bougie and Macintosh laryngoscope [14]. However, intubation with a gum elastic bougie is a two-step process (first insert the bougie into the trachea, then thread the tracheal tube over it into the trachea) and takes longer than intubation with either the Airway Scope or McCoy laryngoscope. Our study design did not permit correlation between Airway Scope efficacy and the modified Cormack and Lehane laryngeal view because direct laryngoscopy was not required with the Airway Scope. However, assuming similar laryngeal view grades in each of the randomised groups, it is reasonable to speculate that the Airway Scope is effective for a grade 3a laryngeal view. Interestingly, we did not observe any grade 3b and 4 views and were thus unable to evaluate the McCoy laryngoscope under those conditions. Our study did not include a third study arm comparing the Macintosh laryngoscope (the most commonly used intubation modality) to the other two intubation techniques. We avoided intubating with a Macintosh laryngoscope because previous studies indicate that application of a cervical collar frequently produces Cormack and Lehane 3 or 4 views [14–16], and that the success rate of intubation with a Macintosh laryngoscope is only about 60% [17]. Instead, we reported laryngoscopic views provided by the Macintosh blade configuration when the McCoy laryngoscope was used. We also avoided a study arm with an intubating laryngeal mask airway because we have previously demonstrated that while the technique has a 96% success rate, it is much slower (60 s) than either system tested in the current study [18]. The Bullard laryngoscope was not included because its reported success rate is < 90% [16].

In conclusion, both the Airway Scope and the McCoy laryngoscope offer high success rates when difficult airways are simulated by application of a rigid cervical collar. However, the Airway Scope was ~ 10 s faster and less likely to result in oesophageal intubation than the McCoy laryngoscope. The Airway Scope thus appears preferable, especially when accidental oesophageal intubation is best avoided.

Competing interests
No corporate funds supported this project. The Airway Scope was loaned to the investigators by the manufacturer. None of the authors has a personal financial interest in the outcome of this research.

References