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ORIGINAL ARTICLE

Evaluation of tracheal intubation in several positions by the Pentax-AWS Airway Scope: a manikin study

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Abstract
Purpose In emergency situations, rescuers must occasionally secure the airway while the patient is in a restricted position rather than in the ideal supine position. We hypothesized that the Pentax-AWS Airway Scope (AWS) may be useful for emergent tracheal intubation in such positions.
Methods Thirteen non-anesthesia residents performed tracheal intubation on a simulated manikin in the supine (Supine), left-lateral decubitus (Left-LT), right-lateral decubitus (Right-LT), prone (Prone), and sitting (Sitting) position, respectively, to assess AWS performance.
Results Intubations were successful in all five positions. The time needed to secure the airway did not differ significantly between the Left-LT and Supine positions. Doctors required significantly more time to secure the airway in the Prone, Sitting, and Right-LT positions than in the Supine position. Visual analog scale (VAS) scoring of the subjective difficulty of laryngoscopy was lower in the Supine position rather than in the Right-LT, Prone, and Sitting positions. The VAS score of subjective difficulty of tracheal tube passage through the glottis was significantly higher in the Sitting position than in the other four positions.
Conclusion Although tracheal intubations with AWS in all five positions tested were successful, intubation with the patient in the Sitting, Right-LT, and Prone positions was more difficult and required more time than that in the Supine position.

Keywords Pentax-Airway Scope · Tracheal intubation · Manikin · Body position

Introduction

Oral tracheal intubations can be difficult when the patient is constrained in a posture other than the ideal supine position. During surgery, accidental tracheal extubation is a life-threatening event, and in neurosurgical or cervical spine procedures, patients may be in the prone position with the neck in extreme flexion [1, 2].

Direct laryngoscopy using the Macintosh laryngoscope (McL) is the most widely used technique for tracheal intubation even in difficult positions [3]. Clinical trials of the McL demonstrate that its use for tracheal intubation in non-supine positions is difficult even for well-trained professionals [4].

The Pentax-AWS Airway Scope (AWS; Hoya, Tokyo, Japan) is a new, rigid video laryngoscope for tracheal intubation that provides a non-sightline view of the airway [5, 6]. There is increasing evidence that the AWS may be suitable for tracheal intubation in a variety of clinical settings and emergency situations [7, 8].

We hypothesized that the AWS would be beneficial for tracheal intubation in a variety of patient positions. We compared AWS performance in the supine (Supine),

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left-lateral decubitus (Left-LT), right-lateral decubitus (Right-LT), prone (Prone), and sitting (Sitting) positions.

Materials and methods

Approval for this study was obtained from the Research Ethics Committee of the Hyogo College of Medicine. From November to December 2009, 14 non-anesthesia residents working temporarily in the anesthesia department of the hospital were invited to participate in the study. Thirteen doctors agreed to participate. Each doctor was asked about their prior experience with general anesthesia and gave written consent before participating in the study. No participant had previously enrolled in a manikin study of anesthesia techniques.

We recorded the intubation time of securing the airway of an Airman manikin (Laerdal, Sentrum, Stavenger, Norway) using the AWS in the Supine, Left-LT, Right-RT, Prone, and Sitting positions. The trial took place in an operation room, and manikin positions were established by adjusting the operating bed. The standard Intlock blade of the AWS was used. For each insertion, all airway devices and the manikin's airway were well lubricated in accordance with the manufacturer's instructions. The internal diameter of the tracheal tube (Portex, St. Paul, MN) was 7.5 mm [9].

The trial was a randomized cross-over study. Participants performed tracheal intubation using the AWS on the manikin placed in five different positions (Fig. 1). In order to minimize any learning effect during the trial, the order of interventions was randomized for each participant. The participants drew one card that indicated the order of five trials from an opaque envelope (120 patterns). The 13 participant performed trials in all five positions.

During each intubation attempt, the participant stood at the head of the manikin positioned in the Supine, Left-LT, Right-LT, or Prone position, respectively. For intubation in the Sitting position, the participant stood in front of the manikin. Intubation equipment was placed on the pillow next to the manikin's head. In the Prone position, the same study participant designated as the "second rescuer" held the head of manikin. Participants were given 5 min to practice using the AWS to perform tracheal intubation.

Each participant was instructed to place the tracheal tube, inflate its cuff, connect a self-inflating bag, and attempt to ventilate the lungs of the manikin. There was no requirement to secure the tracheal tube by tying it in place. Intubation time was measured from the point that the participant picked up the airway device to the point of starting manual ventilation after insertion. Each attempt was timed using the same stopwatch.

After the five intubation attempts, participants rated the difficulty of visualizing the glottis and passing the tube through the glottis in each of the five positions on a visual analog scale (VAS; with 0 mm indicating extremely easy and 100 mm indicating extremely difficult).

Intubation time, VAS score for difficulty visualization of the glottis, and VAS score for degree of difficulty in passing the tracheal tube through the glottis were compared using one-way analysis of variance (ANOVA) and Tukey's multiple comparison test. Data are presented as the mean ± standard deviation (SD). A P value <0.05 was considered statistically significant.

Results

The extent of clinical experience in general anesthesia of the 13 participants was 2.8 ± 1.2 months. The number of previous AWS used was 3.3 ± 0.9.

All intubations were successful in all five positions. The intubation times shown in Fig. 2 clearly reveal that intubation time was significantly shorter in the Supine (14.5 ± 1.9 s) position than in the Prone (30.7 ± 9.6 s), Right-LT (24.2 ± 7.2 s), and Sitting (34.5 ± 9.7 s) position, respectively ($P < 0.01$). Interestingly, there was no significant difference in intubation time between the Supine and Left-LT (17.4 ± 3.1 s) positions.

The VAS score for laryngoscopy or passing the tube through the glottis is shown in Fig. 3. For visualization of the glottis (Fig. 3a), the Supine (15.7 ± 12.2 mm) scored significantly lower than Right-LT (46.9 ± 22.1 mm), Prone (49.6 ± 29.3 mm), and Sitting (68.4 ± 24.6 mm). There was no significant difference between the VAS score for Supine and Left-LT (31.5 ± 11.4 mm).

Strikingly, the subjective difficulty of passing the tube through the glottis (Fig. 3b) was not significantly different between the Supine, Left-LT, Right-LT, and Prone positions. However, this procedure was considered to be significantly more difficult in the Sitting position than in the Supine, Left-LT, and Right-LT positions; there was no significant difference between Sitting position and Prone position (Sitting 55.7 ± 24.8 mm, Supine 18.4 ± 13.2 mm, Left-LT 24.6 ± 11.2 mm, Right-LT 29.2 ± 13.8 mm, Prone 37.3 ± 22.2 mm).

Discussion

Emergent tracheal intubation is sometimes very difficult due to the relative positions of the rescuer and patient. In emergency status, patients are not always in the supine position. Conventional McL is the most widely used instrument for tracheal intubation, but the use of the McL is

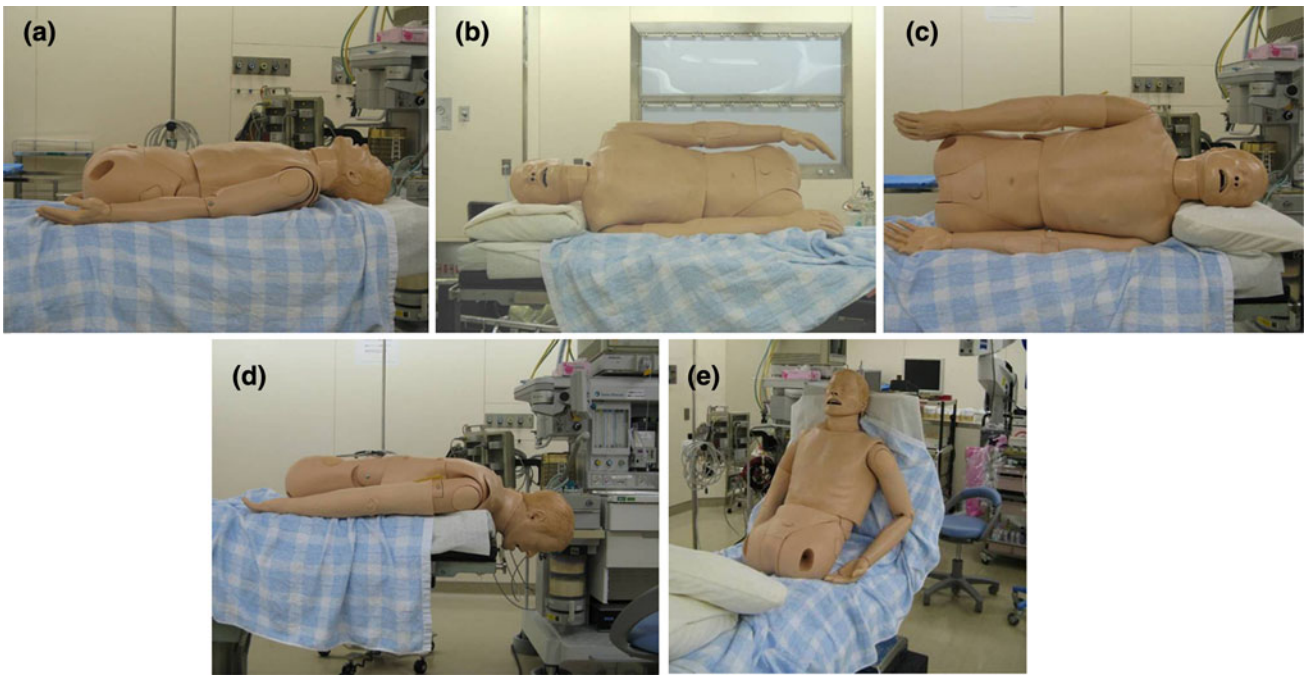

Fig. 1 The five patient positions evaluated in the study: **a** supine (*Supine*), **b** right-lateral decubitus (*Right-LT*), **c** left-lateral decubitus (*Left-LT*), **d** prone (*Prone*), **e** sitting (*Sitting*)

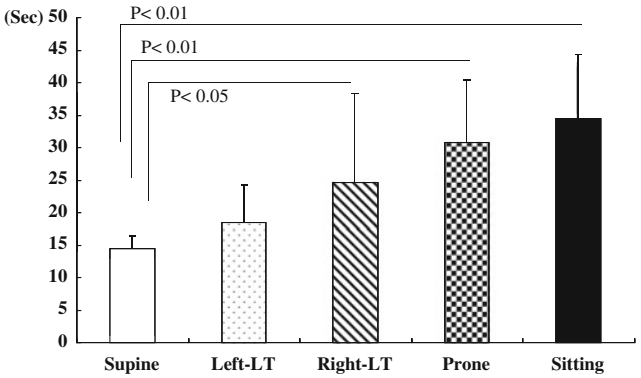

Fig. 2 Comparison of intubation time among the five positions tested *Supine* supine position, *Left-LT* left lateral decubitus, *Right-LT* right lateral decubitus, *Prone* prone position, *Sitting* sitting position

considered to be difficult without proper patient positioning. Tracheal intubation with the McL requires axial alignment of the oral cavity, pharynx, and larynx as well as the manipulation of tracheal tubes. Emergent intubation with the McL is generally very difficult in the lateral, sitting, or prone positions due to the difficulty of achieving axial alignment [10, 11].

The AWS can also be used for tracheal intubations in positions other than the supine [5]. The AWS provides a non-sightline view of the airway [12]. Moreover, a tracheal tube is easily inserted through a built-in conduit. Once the target symbol displayed on the monitor is aligned over the image of the glottis, the tracheal tube can be easily passed through the vocal cords [13].

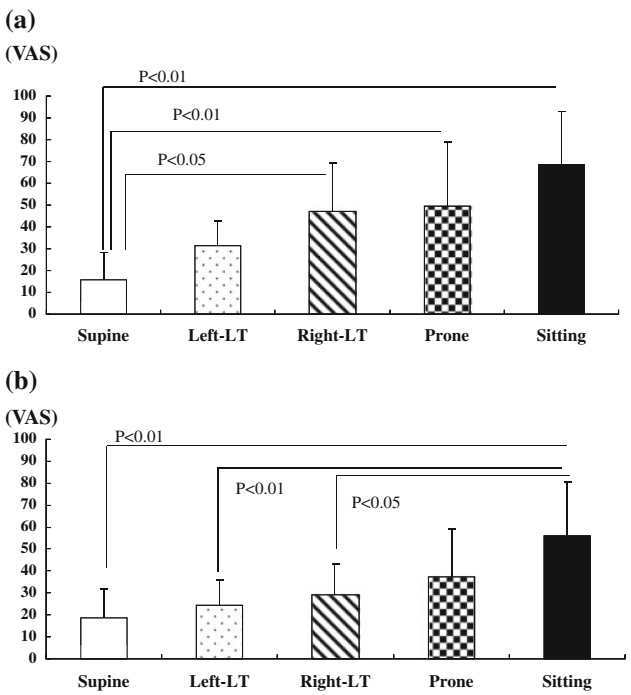

Fig. 3 Comparison of visual analog scale (*VAS*) scores (0 mm = extremely easy; 100 mm = extremely difficult) for subjective difficulty in visualizing the glottis (**a**) and passing the endotracheal tube through the glottis (**b**)

The AWS also enables rescuers to perform tracheal intubation other than in supine position. Because the video image can be seen from various angles by adjusting the

position of the display screen, it is theoretically unnecessary for the rescuer to stand close to the patient's head [5, 14]. Application of the AWS in a face-to-face approach with the patient in a sitting position has been reported in morbidly obese patients and in patients with bilateral giant thyroid tumors [15, 16]. In our study, time to intubation with the AWS was significantly different with the manikin in the different patient positions, but all intubations performed by the non-anesthesia residents participating in the study were successful.

Intubation time did not differ significantly between Supine and Left-LT positions, but it was significantly longer in the Right-LT position than in the Supine position. This observation suggests that the AWS is more beneficial for intubation in the Left-LT position than in the Right-LT position. The orientation of the AWS Intlock blade, which has the camera on the left side and the tube guide on the right, may contribute to the ease of intubation in the Left-LT position. Another possibility for left-side superiority may be due to the limited space in Right-LT position.

The VAS scores of subjective difficulty of laryngoscopy were significantly lower in the Supine position than in the Right-LT, Prone, and Sitting positions, but the former did not significantly differ from scores for the Left-LT position. This observation correlates with the intubation times. In contrast, VAS scores of subjective difficulty for tracheal tube passage through the glottis did not significantly differ among the Supine, Left-LT, Right-LT, and Prone positions, suggesting that the difficulty in visualizing the glottis adversely affected intubation times. These results suggest that it is relatively difficult to visualize and align the glottis on the AWS screen and that it takes more time to do so in the Right-LT, Prone, and Sitting positions. Once the glottis has been visualized and aligned on the screen, the built-in conduit for passage of the tracheal tube allows intubation with the same ease in all postures except the Sitting position. Thus, it is likely that the difference in intubation time among the five positions is due mainly to the use of the AWS to visualize and fix the glottis on the screen. The Sitting position scored significantly worse in terms of subjective difficulty in tracheal tube passage than the other four positions. In the Sitting position, the upside-down image of the anatomy may increase the difficulty of both laryngoscopy and tracheal tube passage.

We believe that the most important observation emerging from our study is that none of the participants failed to intubate in any of the five positions, despite differences in subjective difficulty level and intubation time. Although novice doctors took longer and had more difficulty in the Right-LT, Sitting, and Prone positions than in the Supine position, these data also suggest that safe and secured tracheal intubation can be performed in several positions with AWS. One possible reason for the prolonged time and greater difficulty in the Right-LT, Sitting, and Prone positions is that the participants in this study usually perform tracheal intubation in the Supine position. Therefore, sufficient training in other positions with AWS may improve their intubation time and ease of intubation.

Fiber-optic bronchoscopy (FOB) intubation remains a safe and effective method in experienced hands. FOB remains the "gold standard" for both anticipated and unanticipated difficult intubations, and the use of FOB for intubation in the sitting and prone positions has been evaluated in clinical trials [17, 18]. Compared to FOB, the AWS blade offers easier navigation through soft tissue and enables enhanced direct elevation of the epiglottis for visualization of the vocal cords. AWS also provides a clearer view of patient anatomy, thus lowering the risk of laryngeal damage from forceful and inappropriately guided advancement of tubes. Furthermore, it has been demonstrated that AWS can be used appropriately by unskilled operators.

The main limitation of this study is that it evaluated intubation of a manikin rather than of patients. The manikin used in our study was designed for training in airway management with medium difficulty for intubation. Another limitation of this study is that this trial was performed in only one manikin. One addition drawback of using a manikin is that the time needed to perform airway intervention is generally shorter than that required for actual patients. More studies are needed to evaluate AWS use in a variety clinical situations and patient positions.

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Conflict of interest The authors have no affiliation with any manufacturer of any device described in the manuscript and declare no financial interest in relation to the material described in the manuscript.

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