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Research Article

Evaluation of Airway Scope at Improving the Success Rate of the First Intubation Attempt by Nonexpert Physicians: A Randomized Crossover Manikin Study

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Purpose. The aim of the study was to assess the performance of Airway Scope (AWS) on the first attempt at intubation in manikins by nonexpert physicians. *Methods*. A randomized crossover trial involving seven scenarios. Participants: residents of a cardiovascular hospital. In group A, the AWS procedure was performed first followed by Machintouch Laryngoscopy (ML), while in group B the ML procedure was performed first and then the AWS. The primary outcome assessed was the success of first intubation attempt in a normal scenario. The secondary outcome assessments were success in six other scenarios, and also elapsed time and dental trauma caused in all scenarios. *Results*. There were 34 participants. All AWS-assisted intubations were successfully completed, but one ML-assisted intubation failed in the normal scenario ($P = 0.32$). The outcomes achieved by the AWS in scenarios involving cervical immobilization ($P = 0.03$), tongue edema ($P \leq 0.001$), pharyngeal obstruction ($P \leq 0.001$), and jaw trismus ($P = 0.001$) were superior to those obtained with the ML. *Conclusions*. Use of AWS-assisted intubation in manikin scenarios results in a significantly high intubation success rate on the first attempt by nonexpert physicians. These findings suggest this new device will be useful for nonexpert physicians in emergency situations.

1. Introduction

Tracheal intubation outside the operation room is often performed by physicians who have less experience in airway management than anesthesiologists. The need for emergency airway management in a suboptimal environment can make intubation difficult, and this may affect patient safety. Direct laryngoscopy and intubation remain a challenge to nonexperts [1, 2].

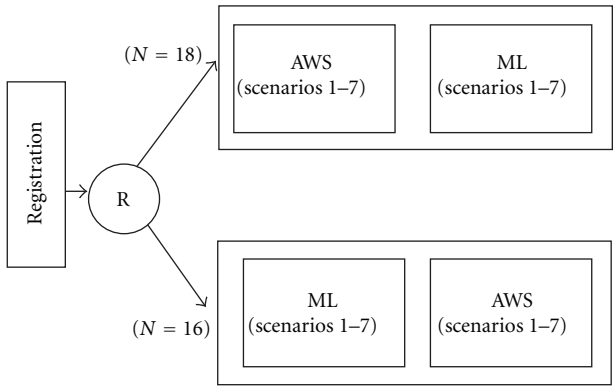
Several different video laryngoscopy devices such as Airway Scope (AWS, Pentax, Tokyo, Japan) provide better laryngeal views than conventional laryngoscopy in controlled setting studies with anesthesiologists [3, 4].

The AWS consists of two components: a display-handle with a fibre-optic scope unit and a disposable blade (Intlock). The shape of the Intlock is designed to provide a view of the glottis without requiring alignment of the oral, pharyngeal, and tracheal axes. Therefore, AWS is thought to be a more useful tool for observing the glottis than a laryngoscope [5].

The aim of the present study was to assess AWS performance in the first tracheal intubation attempt by nonexpert physicians.

2. Methods

2.1. Study Design. This study was designed as an open randomized crossover manikin trial. The participants were divided into two groups (group A, in which the AWS was used for the first procedure followed by the ML for the



R: Randomization
AWS: Airway scope
ML: Macintosh laryngoscope

Figure 1: Participant flow.

second one; group B, in which the ML was used for the first procedure followed by AWS for the second (Figure 1).

The planned total sample size in the design was 40 in order to obtain a statistical power of 90% with a two-sided significance of 5%, based on the expected effect size of a 25% increase over 80% success in the control and drop out cases.

2.2. Participant and Randomization. The eligibility criteria for the study included cardiology medical trainees in the National Cardiovascular Center with a minimum of two-years clinical experience in general medicine, who consented to participate in this research study.

Exclusion criteria were those who could not perform elaborate manual operations or who did not give their consent to participate in the study.

All medical trainees attended a five-minute lecture on the ML and AWS by an experienced instructor. Each participant was then allowed three practice intubations of the AirMan (Laerdal, Norway) using the ML and the AWS.

The participants were randomly divided into two groups (group A and group B) using the permuted block method [6].

Randomization was managed by the registration center, which was independent from the investigators.

2.3. Interventions and Scenarios. The interventions used in study were the AWS and the ML. The ML is a standard tool for tracheal intubation in general practice. A size 3 Macintosh blade (Penlon UK) was used in this study.

Using an AirMan manikin, this study was performed to evaluate the efficacy of the ML and the AWS. All intubations were performed using a 7.5 mm cuffed tracheal tube (Portex, UK).

The following seven scenarios were used for assessment: (1) Normal: a normal airway in the supine position, representing tracheal intubation in normal conditions. (2) Head raised: a normal airway with the head in a raised position in order to manage pulmonary edema. In this scenario, it is difficult to align oral and pharyngeal-tracheal axes. (3) cervical immobilization: cervical immobilization indicates a situation in which the oral axis cannot be aligned with the pharyngeal-tracheal axis because of rheumatoid arthritis. (4) Tongue edema: tongue edema represents a situation in which the volume of the tongue is increased by angioedema, and sometimes develops in patients who are taking angiotensin-converting enzyme inhibitors [7]. (5) Pharyngeal obstruction: pharyngeal obstruction indicates a situation in which obstruction is caused by allergic swelling of the pharynx or lingual tonsil hyperplasia [8]. (6) Jaw trismus: Jaw trismus indicates cases involving temporomandibular arthritis. (7) Repeat Normal: Repeated intubation of a normal airway in the supine position.

2.4. Outcomes and Assessments. The primary outcome measure was the rate of success of tracheal intubation on the first attempt in the normal scenario. The secondary outcome measures were success in the six difficult scenarios, the elapsed time to successful tracheal intubation on the first attempt, and the frequency of dental trauma caused by tracheal intubation in all scenarios.

We measured the success of tracheal intubation, the elapsed time to successful tracheal intubation, and the frequency of dental trauma on the first attempt in each scenario for all study participants. Successful tracheal intubation was evaluated as follows: the tracheal tube passed through the vocal cords and was placed in the trachea, allowing visual confirmation by the investigator. A failed tracheal intubation attempt was defined as an attempt in which the tracheal tube was not placed into the trachea or intubation of the trachea required >120 seconds to perform. Successful tracheal intubation attempts are defined as the number of successes.

The time elapsed until successful tracheal intubation was evaluated was as follows: the time taken from insertion of the blade between the teeth until the tracheal tube was placed in the trachea. The participants told the investigator that tracheal intubation was completed when the tracheal tube was placed in the trachea. The final tracheal tube position was verified in all cases by the investigator.

Dental trauma was evaluated as follows: the number of times the blade made contact with the teeth during intubation. When dental trauma was found, an investigator drew the participant's attention to it and let them remove the blade from the tooth. This measure evaluated the safety of tracheal intubation.

2.5. Statistical Analysis. All analyses were based on the intention to treat principle. The participants' baseline and outcomes were reported as mean (SD), median (minimum-maximum), frequency (percentage), and their 95% confidence intervals. We determined the rate of tracheal intubation the median time elapsed until successful tracheal intubation and the median of frequencies of dental trauma by group in each scenario.

Outcomes for the frequency of tracheal intubation, the time elapsed until successful tracheal intubation, and the

Table 1: Number of successful intubations.

Scenario[a]	ML[b]	AWS[b]	*P* value
1	33 (9.1% [85.1–99.5])	34 (100% [89.9–100])	0.3165
2	33 (97.1% [85.1–99.5])	34 (100% [89.9–100])	0.3165
3	29 (85.3% [69.9–93.6])	34 (100% [89.9–100])	0.0309
4	1 (2.9% [5.2–14.92])	33 (97.1% [85.1–99.5])	<0.0001
5	14 (41.2% [26.4–57.8])	30 (88.2% [73.4–95.3])	0.0007
6	21 (61.8% [45.0–76.1])	34 (100% [89.9–100])	0.0004
7	32 (94.1% [80.9–98.4])	34 (100% [89.9–100])	0.1759

Data are shown as actual figures (%: proportion, [95% confidence intervals]).
[a]Scenario: (1) Normal, (2) Head raised, (3) Cervical immobilization, (4) Tongue edema, (5) Pharyngeal obstruction, (6) Jaw trismus, (7) Repeated Normal.
[b]ML: Macintosh laryngoscope, AWS: Airway Scope.

frequency of dental trauma were analyzed using Wilcoxon signed rank test for difference from paired data [6]. Statistical significance was set at $P < 0.05$ for comparisons. P values were not corrected for multiple comparisons in secondary outcomes. SAS 9.1 and JMP 6.0 were used for statistical analyses.

2.6. Ethical Considerations. All procedures were conducted according to the Declaration of Helsinki. The participants provided their written informed consent prior to participation. This study was approved by the Institutional Review Board of the National Cardiovascular Centre of Japan.

This trial was registered with UMIN in Japan under number UMIN000000580.

3. Results

3.1. Characteristics of Participants. Thirty-four medical trainees (30 men and 4 women) participated in this study from October 2006 to October 2007. Their mean age was 29 ± SD years. None of the medical trainees had any experience with the AWS.

After randomization, group A and group B contained eighteen and sixteen participants, respectively (Figure 1). There was no missing data and no participant drop out.

3.2. Success Rates. For the primary outcome, there was no difference in the rate of success between the AWS and ML groups ($P = 0.32$) in scenario 1.

In scenarios #3, #4, #5, and #6, the success rate was significantly higher in the AWS group than in the ML group, but no differences were observed for scenarios 2 or 7 (Table 1).

In the AWS group, the observed success was 100% for scenarios 1, 2, 3, 6, and 7 (Table 1).

3.3. Elapsed Time. In scenarios 2, 4, 5, 6, and 7, the intubation time was significantly shorter in the AWS group than in the ML group, but it did not differ in scenarios #1 and #3 (Table 2).

Table 2: Elapsed time to successful intubation (sec).

Scenario[a]	ML[b]	AWS[b]	*P* value
1	12.3 [10.8–16.8] (5.5–120.0)	12.0 [10.9–13.5] (4.7–29.3)	0.1668
2	11.8 [10.0–16.0] (6.8–120.0)	10.4 [8.91–11.6] (5.8–19.7)	0.0056
3	19.6 [17.0–39.0] (8.7–120.0)	18.8 [14.2–21.7] (9.4–35.0)	0.0625
4	120.0[c] (18.0–120.0)	29.1 [22.6–43.0] (1.1–120.0)	<0.0001
5	120.0[c] (11.5–120.0)	23.0 [16.0–30.5] (1.0–120.0)	<0.0001
6	27.2 [18.9–45.8] (8.9–120.0)	16.11 [13.4–20.2] (8.0–37.5)	<0.0001
7	10.0 [8.3–12.2] (5.2–120.0)	7.5 [6.8–9.0] (3.6–12.6)	0.0001

Data are median duration times, [95% confidence intervals] by Kaplan-Meier method and range (minimum–maximum).
[a]Scenario: (1) Normal, (2) Head raised, (3) Cervical immobilization, (4) Tongue edema, (5) Pharyngeal obstruction, (6) Jaw trismus, (7) Repeated Normal.
[b]ML: Macintosh laryngoscope, AWS: Airway Scope.
[c]95% CI were impossible calculated, median calculated by descriptive.

Table 3: Frequency of dental trauma.

Scenario[a]	ML[b]	AWS[b]	*P* value
1	3 [2-3] (0–10)	1 [1-1] (0–3)	1.0000
2	3 [2-3] (0–10)	1 [1-2] (0–4)	1.0000
3	5 [5–8] (2–18)	3 [2–4] (0–12)	0.0625
4	19 [13–22] (0–28)	8 [5–8] (1–23)	<0.0001
5	15 [12–19] (0–25)	5 [3–8] (1–25)	<0.0001
6	8 [5–12] (2–30)	4 [3–5] (0–12)	0.0002
7	3 [2–4] (0–3)	1 [0-1] (0–3)	0.5000

Data are shown as median [95% confidence intervals] and range (minimum-maximum).
[a]Scenario: (1) Normal, (2) Head raised, (3) Cervical immobilization, (4) Tongue edema, (5) Pharyngeal obstruction, (6) Jaw trismus, (7) Repeated Normal.
[b]ML: Macintosh laryngoscope, AWS: Airway Scope.

3.4. The frequency of Dental Trauma. In scenarios 4, 5, and 6, the number of dental traumas in the AWS group was significantly lower than in the ML, but no differences were observed for scenarios 1, 2, 3, and 7 (Table 3).

4. Discussion

Tracheal intubation attempts by non-expert physicians can produce complications, including hypoxemia, esophageal intubation, regurgitation, airway trauma, bradycardia, or

even cardiac arrest. These complications are associated with multiple tracheal intubation attempts [9]. Multiple tracheal intubation attempts by non-expert physicians prolong interruption of chest compression during cardiopulmonary resuscitation [10]. various devices are available for tracheal intubation. The AWS provides better laryngeal views than conventional laryngoscopy [3, 4]. We examined whether use of the AWS by non-expert physicians improved the success of tracheal intubation in the first attempt.

The most important variable measured in this study was the success of tracheal intubation in the first attempt. For the primary outcome, there was no difference between the AWS group and the ML group. All tracheal intubations were successfully completed in the AWS group, but one intubation failed in the ML group. Cardiology medical trainees should easily be able to perform tracheal intubation on normal airways using the ML; therefore, we were unable to demonstrate the superiority of the AWS using the primary outcome. Our study showed a higher intubation success rate on the first attempt in the AWS group than in the ML group in all other scenarios (Table 1). The AWS was more effective than the ML on the first attempt by non-expert physicians.

In the difficult airways use of the AWS improved the success rate of tracheal intubation in the first attempt. Intubation failures occurred in the tongue edema scenario 4, the pharyngeal obstruction scenario 5, and the jaw trismus scenario 6. The AWS group had a shorter elapsed time to intubation and lower frequency of dental trauma in comparison to the ML group (Tables 1, 2 and 3). The AWS was more useful in helping non-expert physicians to achieve successful tracheal intubation in the first attempt, required less time to intubation, and caused less dental trauma in scenarios involving tongue edema, pharyngeal obstruction, and jaw trismus. The cervical immobilization scenario 5 showed a significantly higher intubation success in the AWS than the ML group (Table 1). The results were influenced by the differences between the AWS and the ML. It has been reported that AWS required less movement of the upper cervical spine and was a more useful laryngoscope than the ML in the cases involving limited cervical spine movement [11]. Use of the AWS in scenarios with cervical immobilization resulted a greater success rates at intubation on the first attempt by non-expert physicians. In the difficult airways, the existing data indicates that the higher intubation success rates can be achieved using the AWS rather than the ML.

In a recently published manikin study involving normal airways, Miki et al. compared the use of the AWS with that of the ML by nurses [12]. Participants were given 10 tracheal intubation attempts. The AWS was significantly better than the ML in all parameters (intubation success, intubation time, and number of dental traumas). They did not examine the rate of successful tracheal intubation on the first attempt, and their participants were not non-expert physicians. In another manikin study [13], participants included 10 residents, 10 students, and 10 nurses. There was no significant difference in the time taken for tracheal intubation between the AWS and ML. The number of teeth clicks was less when the AWS was used. The number of tracheal intubation attempts was not recorded. There was no report as to whether the non-expert physicians succeeded in tracheal intubation on the first attempt.

In conclusion, the AWS was provided a higher tracheal intubation success rate on the first attempt than the ML in all scenarios. The AWS is more useful for non-expert physicians than the ML. These findings suggest this new device will be useful for non-expert physicians in emergency situations.

Conflict of Interests

There is no conflict of interests to declare.

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