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SHORT COMMUNICATION

Comparison of Pentax-AWS Airwayscope, Airtraq and Miller laryngoscope for tracheal intubation by novice doctors during infant cardiopulmonary resuscitation simulation: a randomized crossover trial

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Abstract Recent guidelines for infant cardiopulmonary resuscitation emphasize that all rescuers should minimize interruption of chest compressions, even for endotracheal intubation. We compared the utility of the Pentax-AWS Airway Scope (AWS) with an infant-sized Intlock (AWS-I), Airtraq laryngoscope (ATQ) and Miller laryngoscope during chest compressions on an infant manikin. Twenty-three novice doctors performed tracheal intubation on an infant manikin using the AWS-I, ATQ and Miller laryngoscope, with or without chest compressions. In Miller laryngoscope trials, one participant failed to secure the airway without chest compressions, while nine failed with compressions ($P < 0.05$). In ATQ trials, none of the participants failed without compressions, while six failed with compressions ($P < 0.05$). In AWS-I trials, all participants succeeded regardless of chest compressions. Intubation time was significantly longer with chest compressions with the Miller laryngoscope and ATQ, but not with the AWS-I. The AWS-I is an effective device for endotracheal intubation during chest compressions in infant simulations managed by novice doctors.

Keywords Video laryngoscope Pentax-AWS Airwayscope · Optic laryngoscope Airtraq · Miller laryngoscope · Chest compression · Manikin · Infant

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The American Heart Association (AHA) cardiopulmonary resuscitation (CPR) guidelines recommend that skilled rescuers should secure the airway without interrupting chest compressions or with only a brief pause [1]. As asphyxia is the most common cause for cardiac arrest in infants, both continuous chest compression and rapid and successful airway management are vital during infant resuscitation [1].

Direct laryngoscopy with the Miller laryngoscope is the most widely used technique for infant tracheal intubation. However, the Miller laryngoscope can be difficult to use even for skilled professionals and could become detrimental in infant emergent situations [2]. We previously reported on the infant-sized Airtraq laryngoscope (ATQ; Prodol Meditec, Vizcaya, Spain) as a more functional alternative to the Miller laryngoscope for intubation during chest compressions by experienced doctors [3].

An infant-sized Intlock blade was recently developed for the Pentax Airway Scope (AWS; Hoya, Tokyo, Japan) (AWS-I), and AWS-I superiority to ATQ by anesthesiologists during infant chest compression has been shown [4]. However, emergency airway management is often performed by less experienced doctors. Therefore, we decided to compare the utility of AWS-I to the optical ATQ and conventional Miller laryngoscope during chest compression by novice doctors in an infant manikin.

Twenty-three novice doctors taking an anesthesiology module at the Hyogo College of Medicine were recruited.

Selected participants had 2.1 ± 0.6 months of clinical experience in anesthesia but no experience with laryngoscope devices for infants. Written informed consent was obtained before the study. This study was approved by the Hyogo College of Medicine Research Ethics Committee.

The ALS Baby Trainer manikin (Laerdal, Stavanger, Norway), designed to accurately represent a 3-month-old infant (weight, 11 pounds), was used in the study simulations to perform intubations and chest compressions [3]. Participants used a tracheal tube (Portex, St. Paul, MN, USA) without a cuff and an internal diameter of 3.0 mm, as well as the AWS-I, the Infant ATQ or the Miller laryngoscope with a size 1 blade.

The manikin was placed on a hard, flat table for "on the bed" simulation. Chest compressions were demonstrated by the same Basic Life Support instructor using the two-thumb technique at a depth of about two inches and a rate of 100 compressions per minute in accordance with present guidelines [1].

Each participant was instructed to insert the tracheal tube, attach a ventilation bag, and attempt to ventilate the lungs of the manikin. Participants were given 5 min to practice intubation, with the instructor available to give advice. Intubation started when the participant picked up the AWS-I, ATQ or Miller laryngoscope and ended at the point of manual ventilation after tube insertion. Intubation times were recorded for both tracheal and esophageal intubations.

Results obtained from each trial were compared using two-way repeated measures analysis of variance for intubation time, and Fisher's exact test for the success rate. Data are presented as mean ± SD. $P < 0.05$ was considered statistically significant.

The study was designed as a randomized crossover trial to minimize the learning-curve effect [5]. The order of intervention was randomized for each participant by random number table, resulting in a total of six interventions per participant.

Results of a nine-doctor preliminary study showed that the time required for successful intubation with the AWS-I was approximately 14 ± 4 s. We considered 5 s is clinically meaningful difference. We estimated that 22 participants would be adequate for two independent groups using $\alpha = 0.05$ and $\beta = 0.2$.

The number of successful tracheal intubations for each device is displayed in Table 1. With the Miller laryngoscope, one participant failed to achieve intubation without chest compressions, and nine failed with compressions ($P < 0.05$). With the ATQ, all intubations were successful without chest compressions, but six participants failed to achieve intubation with compressions ($P < 0.05$). With the AWS-I, all intubations were successful regardless of whether chest compressions were performed.

With the Miller laryngoscope, tracheal intubation took significantly longer with chest compressions (27.8 ± 6.7 s) than without compressions (21.3 ± 4.9 s; $P < 0.05$) (Fig. 1). Similarly, intubation time increased significantly with chest compressions (28.9 ± 6.7 s) compared to without compressions (17.4 ± 5.7 s; $P < 0.05$) with the ATQ. In contrast, chest compressions increased intubation time slightly, but not significantly, with the AWS-I (with compressions, 18.8 ± 6.1 s; without compressions, 16.9 ± 2.9 s).

Intubation time without chest compressions was significantly longer with the Miller laryngoscope than AWS-I, but not compared to the ATQ. The time required for intubation with the ATQ and AWS-I did not significantly differ without chest compressions; however, the intubation

Table 1 Tracheal intubation success numbers for three laryngoscope types with and without chest compressions

	Mil	ATQ	AWS-I
Without Compression(n=23)	22	23	23
With Compression(n=23)	14	17	23

Mil conventional Miller laryngoscope, *ATQ* Infant Airtraq, *AWS-I* Pentax Airway Scope with an infant-sized Intlock

Differences were analyzed with Fisher's exact test. * $P < 0.05$

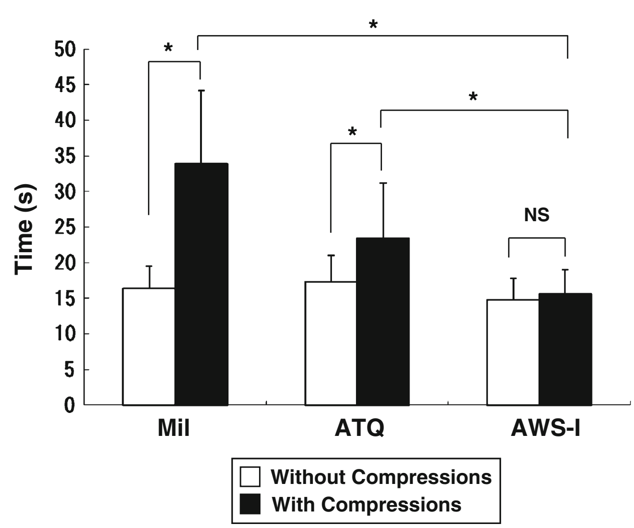

Fig. 1 Time elapsed for simulated infant tracheal intubation with and without chest compressions between three laryngoscope types. *Mil* conventional Miller laryngoscope, *ATQ* Infant Airtraq, *AWS-I* Pentax Airway Scope with an infant-sized Intlock. Results were expressed as mean ± SD and analyzed with two-way analysis of variance. *NS*: no significant difference; *$P < 0.05$

time was significantly shorter with chest compressions with the AWS-I than with the ATQ or Miller laryngoscope.

We demonstrated that the success rate of intubation with the Miller laryngoscope and ATQ decreased during chest compressions, with a significant increase in intubation time. Intubation time did not significantly increase with the AWS-I, and all novice doctors were successful in intubating with the device during chest compressions. One probable reason for difficulties experienced with the Miller laryngoscope is that the glottis, but not the tube, moved during chest compressions, and the relative positions of the glottis and tube were thus unstable. With a non-sightline laryngoscope like AWS or ATQ, the tube and glottis could move simultaneously while their relative positions remained the same, leading to easy and safe tracheal intubation [5].

In our previous reports of infant CPR simulations with experienced doctors, all performed successful tracheal intubation during chest compressions with the ATQ [3]. But in the present study with novice doctors, the success rate and intubation time with ATQ worsened with chest compressions. Furthermore, a recent study about AWS-I and ATQ for experts showed AWS-I superiority to ATQ for intubation during chest compression [4]. These data are compatible with our present result for AWS-I and ATQ comparison in novice doctors.

There are several reasons for the superior AWS-I performance over ATQ for intubating infant manikins by novice doctors during chest compressions. One probable reason for the success of the AWS-I is the presence of a target mark and built-in conduits. Once the target mark on the AWS-I is aligned with the glottis as shown in the monitor, the tracheal tube can be pushed through the vocal cords [6, 7]. The second probable reason is the wide field of vision offered by the AWS-I, which allowed novice doctors to easily manipulate the tracheal tube. The third probable reason is the thinner and narrower infant AWS blade (9.0 mm thick, 15.5 mm wide) when compared with the ATQ (12.5 mm thick, 21.0 mm wide).

This study has limitations worth noting. First, the simulations do not account for factors such as blood, vomit or secretion in the oropharynx. Secondly, the chest compressions and intubation were performed on an infant manikin, which leads to shorter airway intervention times than that required for actual patients. Clinical experience accumulation and randomized trials of AWS-I, ATQ and Miller laryngoscope use with actual patients receiving CPR are needed in the future.

We conclude that in infant simulations managed by novice doctors, the AWS-I performed better than the ATQ or standard Miller laryngoscope for endotracheal intubation with chest compressions.

Conflict of interest The authors have no affiliation with the manufacturers of any of the devices described in the manuscript and declare no financial interest in the material described in the manuscript. Financial support for the study was provided by our institution and department.

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