J Anesth (2010) 24:306–308
DOI 10.1007/s00540-010-0874-9

SHORT COMMUNICATION

Comparison of tracheal intubation by the Macintosh laryngoscope and Pentax-AWS (Airway Scope) during chest compression: a manikin study

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Received: 10 September 2009 / Accepted: 18 November 2009 / Published online: 3 February 2010

Abstract To compare tracheal intubation with the Pentax Airway Scope (AWS) and the Macintosh laryngoscope (McL) during chest compression, 25 anesthesiologists (including 12 specialists having >5 years of experience and 13 trainees having <2 years of experience) performed tracheal intubation using either the McL or the AWS, with or without chest compression, on a manikin. Using the McL, both specialists and trainees took a significantly longer time ($P < 0.01$) to secure the airway with chest compression (17.3 ± 3.7 and 22.5 ± 8.0, respectively) and than without chest compression (11.3 ± 2.9 and 13.9 ± 4.4 s, respectively). No significant difference was observed in time needed to secure the airway using the AWS with or without chest compression in both groups. From the standpoint of experience, time to complete intubation for specialists using the McL during chest compression was significantly shorter than that for trainees. In contrast, the difference in time to complete intubation with the AWS during chest compression was not significantly different between the two groups. Based on these results, we conclude that the use of the AWS may reduce the time needed to secure the airway during chest compression.

Keywords Chest compression · Macintosh laryngoscope · Manikin · Pentax-Airway Scope · Tracheal intubation

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Introduction

The 2005 American Heart Association (AHA) Cardiopulmonary Resuscitation (CPR) Guidelines emphasize minimizing the interruption of chest compression in order to maximize coronary and cerebral perfusion pressure [1]. More specifically, these guidelines suggest that skilled operators should be able to secure the airway either without interruption to chest compression or with only a brief pause to visualize vocal cords in order to allow passage of the tracheal tube [1]. Previous studies have shown that chest compression prolongs the time needed for intubation and increases the risk of esophageal intubation [2].

Direct laryngoscopy using the Macintosh laryngoscope (McL) is the most widely used technique for tracheal intubation. However, the use of the McL for tracheal intubation is a difficult skill for the occasional users to master [3, 4].

The Pentax Airway Scope (AWS; Hoya, Tokyo, Japan) is a new, rigid, video laryngoscope for tracheal intubation which provides a non-sightline view of the airway [5]. Increasing evidence indicates that the AWS may be suitable for tracheal intubation in various clinical settings of difficult airway or emergent status [5–7].

We hypothesized that the AWS may be beneficial for tracheal intubation during chest compression. In the study reported here, we compared the performance of the AWS and McL in terms of the ease of tracheal intubation during chest compression on a manikin.

Methods

Approval for this study was obtained from the Research Ethics Committee of our college. Twenty-eight anesthesiologists

who specialized—and routinely engaged—in the management of anesthesia at our hospital were invited to participate in the study. We excluded initial trainee physicians who work temporarily in the anesthesiology department. Each anesthesiologist was asked about his/her prior experience with general anesthesia. In order to compare the effects of differences in prior experience, anesthesiologists whose clinical experience in general anesthesia was either >5 years or <2 years were recruited. Anesthesiologists having >5 years of clinical experience were categorized as "specialists," whereas those with <2 years of clinical experience were categorized as "trainees." Each anesthesiologist provided written consent before participating in the study.

The time required by each anesthesiologist to secure the airway of an Airman manikin (Laerdal; Sentrum, Stavenger, Norway) using the AWS or McL, both with and without chest compression, was investigated. The size 3 blade of the McL or the standard Intlock blade of the AWS was used in all cases. For each insertion, all airway devices and the manikin's airway were well lubricated in accordance with the instructions of the manufacturer. The internal diameter of the tracheal tube (Portex, St. Paul, MN) was 7.5 mm. The manikin was placed on the stiff table, and all trials were performed at the same level.

Anesthesiologists performed tracheal intubation using either the McL or AWS, with or without chest compression performed by an advanced cardiac life support (ACLS) instructor, on the manikin. In order to minimize any learning effect during the trial, the order of interventions was randomized for each anesthesiologist, who drew numbers from an opaque envelope. This process resulted in a total of four interventions per anesthesiologist.

During each attempt at intubation, the anesthesiologist stood at the head end of the manikin. The equipment necessary for each intervention was placed on the pillow next to the manikin's head. Anesthesiologists were given time to practice intubating the trachea and inserting the tube using the McL or AWS. Each anesthesiologist was instructed to place the airway device, inflate its cuff, connect a self-inflating bag, and attempt to ventilate the lungs of the manikin. There was no requirement to tie the airway device in place. The start-point of the attempt (intervention) was when the anesthesiologist picked up the airway device; the end-point was taken as the point of manual ventilation after insertion. Each attempt was timed using the same stopwatch. An ACLS instructor began chest compressions on the manikin before the anesthesiologist attempted to secure the airway. Chest compressions (frequency 100/min and compression of the chest by 4–5 cm) complied with AHA guidelines [1]. For the attempt at tracheal intubation, the anesthesiologist was given the choice of allowing the compressions to continue or to have the compressions discontinued. The time of compression discontinuation (i.e., "hands-off" time) was recorded.

The results obtained from each trial were compared using the non-paired student's t test for the comparison of anesthesia experience and height between specialists and trainees and the two-way repeated measures analysis of variance (ANOVA) for the time to secure the airway. Data were presented as the mean ± standard deviation (SD). A P value < 0.05 was considered to be statistically significant.

Results

Of the 25 anesthesiologists who agreed to participate in the study, 12 were categorized as specialists (208.5 ± 115.7 months of experience) and 13 were categorized as trainees (13.8 ± 7.6 months of experience). The extent of their clinical experience in general anesthesiology was significantly different ($P < 0.01$), but their body height was not (166.9 ± 6.8 vs. 166.5 ± 7.9 cm; $P = 0.44$).

The length of time taken for each group of anesthesiologists to insert the tube is shown in Fig. 1. The time required for intubation during chest compression was significantly shorter with the AWS than with the McL for both specialists (11.0 ± 2.7 vs. 17.3 s ± 3.7 s, respectively; $P < 0.01$) and trainees (11.9 s ± 3.0 vs. 22.5 ± 8.0 s, respectively; $P < 0.01$). Using the McL, both specialists and trainees showed marked delays in intubation during chest compression [11.3 ± 2.9 and 13.9 ± 4.4 s, respectively, in the absence of chest compression vs. 17.3 ± 3.7 and 22.5 ± 8.0 s, respectively, during chest compression; within each group, the difference was significant at $P < 0.01$. This tendency corresponds to the results of previously reported studies on manikins [2]. Using the AWS, neither the specialists nor trainees exhibited marked delays in intubation during chest

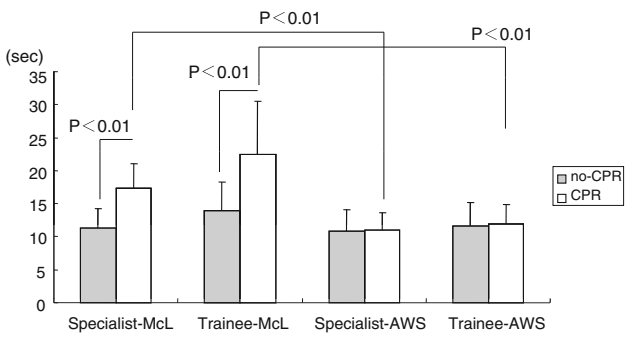

Fig. 1 Comparison of time needed to complete tracheal intubation on a manikin without chest compression (*gray bar*) and with chest compression (*white bar*). *AWS* Pentax Airway Scope, *McL* Macintosh laryngoscope, *CPR* cardiopulmonary resuscitation

compression. The time needed for intubation using the McL was significantly shorter for specialists than for trainees ($P < 0.05$). In contrast, the difference in time required for intubation using the AWS was not significantly different between the specialist and trainee groups. In the McL trial, none of the specialists requested discontinuation of chest compression, whereas two of the 13 trainees requested discontinuation (discontinuation time was 3.6 and 4.3 s). Using the McL during chest compression, none of the specialists and three of the trainees performed esophageal intubation. In contrast, all tracheal intubations by specialists and trainees with the AWS were successful.

Discussion

Our results show that the time needed for specialists and trainees to secure the airway using the McL was significantly delayed during chest compression, as also shown in an earlier manikin study [2]. No significant delay occurred, however, with the AWS. In addition, the time needed to secure the airway during chest compression with the AWS was significantly shorter than that with the McL. Esophageal intubation was not seen with AWS.

In the trial with the McL, the glottis, but not the tube, moved due to chest compression, and the relative positions of the glottis and tube were unstable. Thus, targeting and passing the tube through the glottis was considered to be difficult with the McL. With the AWS, however, the images from the camera monitor showed that the tube and glottis moved simultaneously and that the relative position of the glottis and tube did not change, leading to an easy and safe intubation into the trachea [8, 9]. As the Bullard laryngoscope or Airtrack can be connected to a camera device, future studies should focus on investigating the application of these airway devices during chest compression.

From the standpoint of experience in airway management, the time needed for specialists to secure the airway with the McL during chest compression was significantly shorter than that needed by the trainees. In addition, the success rate of the anesthesiology by the specialists was 100%, whereas three of 13 trainees failed to place the tube into trachea. In contrast, all attempts by specialists and trainees were successful with the AWS.

There is an increasing body of evidence indicating that the AWS is not only suitable for tracheal intubation in various difficult airway management and emergent situations, but that it is also easy for trainees and beginners to use [10, 11]. Our data support this view and further suggest that the AWS requires less operator skill than the McL, as has been reported in previous studies [12, 13], and that it may be a suitable device for securing the airway during chest compression.

The main limitation of our study is that it was performed on a manikin rather than patients. The manikin used in our study was intended for training in simulated chest compressions and airway management [2]. A drawback of using a manikin is that the time needed to perform airway interventions is generally shorter than that required for airway interventions in actual patients. Furthermore, the manikin may not simulate actual conditions of the airway during chest compression of a patient. Randomized trials of AWS or McL use in patients receiving CPR in clinical situations are needed in the future.

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