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Simulation and education

Effect of cardiopulmonary resuscitation on intubation using a Macintosh laryngoscope, the AirWay Scope, and the gum elastic bougie: A manikin study☆

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ABSTRACT

Background: Physicians could encounter difficult intubation during cardiopulmonary resuscitation (CPR) in trauma patients due to the patient's movement from continuous chest compression and to cervical stabilisation. Therefore, first, we evaluated the impact of chest compression with or without cervical stabilisation on intubation with a Macintosh laryngoscope. Next, we compared difficulty in intubation among the Macintosh laryngoscope, AirWay Scope (AWS), and gum elastic bougie (GEB) with the Macintosh laryngoscope in three simulated CPR scenarios in a randomised, controlled, cross-over study design.
Methods: Twenty-three anaesthetists intubated the trachea of a manikin (ALS Skill Master, Laerdal Medical Japan, Tokyo, Japan) using the Macintosh laryngoscope, AWS, and GEB in the control scenario, chest compression scenario, and chest compression with cervical stabilisation scenario. Difficulty in intubation was rated on a 5-point scale and the intubation time was measured.
Results: Continuous chest compression increased difficulty in intubation with the Macintosh laryngoscope, compared with the control scenario. Concurrent application of cervical stabilisation further increased the difficulty, compared with application of chest compression alone. Of the three devices compared, the AWS facilitated the easiest intubation, and the GEB facilitated the second-easiest intubation in all scenarios, though the intubation time was slightly longer with the GEB than with other devices.
Conclusion: CPR employing continuous chest compression with or without cervical stabilisation caused difficult intubation with the Macintosh laryngoscope. The AWS and GEB facilitated the easiest and second-easiest intubation, respectively, even during CPR employing continuous chest compression with or without cervical stabilisation in a manikin.

1. Introduction

Intensive care of trauma patients begins with airway management, because they are at risk for airway obstruction and inadequate respiration.[1] A recent guideline for Advanced Life Support (ALS) emphasises that when mechanical ventilation is required, personnel without sufficient experience in tracheal intubation should use supraglottic ventilatory devices, including a laryngeal mask and a laryngeal tube, to avoid intubation-related complications.[2] In the in-hospital settings, however, tracheal intubation by experienced physicians remains the gold standard in airway management in trauma patients,[1,3] since any supraglottic ventilatory device does not protect the patients from risks of aspiration or airway obstruction as effectively as the tracheal tube.[1,4] Tracheal intubation is specifically indicated in several trauma-related conditions, including cardiac or respiratory arrest.[1] Meanwhile, all blunt trauma victims should be assumed to have an unstable cervical spine until this condition is ruled out.[1] Stabilisation of cervical spine would generally occur in the prehospital environment, with the patient arriving at a hospital with a rigid cervical collar already in place.[1] Therefore, physicians may encounter an urgent opportunity to intubate the trauma patient while providing cardiopulmonary resuscitation (CPR) and cervical stabilisation.

The ALS guideline emphasises that interruptions in chest compression should be minimised during CPR, since interruptions in chest compression (for example, to give rescue breaths) have a detrimental effect on survival.[2] Therefore, it would be more favourable to intubate the trachea while chest compression is continued than interrupted, if any method for easy and fast intubation is available. In such situations, however, physicians might encounter difficult intubation due to the patient's movement and cervical stabilisation. There is one retrospective study investigating the impact of the training level of airway providers on the intubation time and complications related to intubation during CPR.[5] To

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Fig. 1. Photograph of the AirWay Scope® (AWS). A disposable polycarbonate introducer blade (Intlock®) is attached to the main unit, and the tracheal tube is placed in the side channel of the Intlock®.

date, however, there is no systematic prospective study evaluating the impact of continuous chest compression with or without cervical stabilisation on tracheal intubation with a Macintosh laryngoscope.

The AirWay Scope® (AWS) (Pentax, Tokyo, Japan) is a new video laryngoscope consisting of two major parts: (1) a handle that has a monitor and a flexible image tube with a camera and light source mounted at the tip; and (2) a disposable blade (Intlock®) with a channel to enclose and protect the image tube, a groove to hold and guide a tracheal tube, and a separate channel for a suction catheter (Fig. 1). The tip of the Intlock is positioned posterior to the epiglottis to lift it, while the target cross-mark on the monitor helps alignment of the Intlock with the glottis for tracheal intubation. A number of reports and studies have shown that the AWS is useful in managing difficult intubation.[6–13] Also, a gum elastic bougie (GEB) with a Macintosh laryngoscope is a useful option in management of difficult intubation.[1,14–18] To date, however, there is no systematic study investigating efficacy of the AWS or GEB in tracheal intubation when chest compression with or without cervical stabilisation is applied during CPR. Because no previous study was available and the assumed situation was extremely critical, it would be prudent and ethical to begin with a simulation study with a manikin.

In the present randomised, controlled, cross-over study, we first evaluated the impact of chest compression with or without cervical stabilisation on intubation with the Macintosh laryngoscope in a manikin. We then compared efficacies of the Macintosh laryngoscope, GEB, and AWS in three simulated CPR scenarios.

2. Materials and methods

This study was approved by the ethics committee of the International Medical Center, Saitama Medical University. Written informed consent was obtained from all anaesthetists who participated in the study.

2.1. Subjects

Twenty-three anaesthetists participated in the study. A manikin (ALS Skill Master, Laerdal Medical Japan, Tokyo, Japan) was used to simulate intubation during CPR. A size 8.0 cuffed tracheal tube, lubricated with silicon aerosol (Silik'on 4, Novatech S.A. Cedex, France), was used for intubation. A metal stylet of the tube was not used to compare difficulty of intubation among the airway devices.

2.2. Study protocol

Operators intubated the trachea using the following three devices: (1) the Macintosh laryngoscope with a size 3.5 blade, (2) the GEB with the Macintosh laryngoscope, and (3) the AWS; in an order randomised for each operator using the envelope method at the beginning of the study; in the following three scenarios: in the order of (a) the control scenario, where neither chest compression nor cervical stabilisation was applied during intubation, (b) the chest compression scenario, where continuous chest compression alone was applied, and (c) the chest compression with cervical stabilisation scenario, where both chest compression and cervical stabilisation were applied. Therefore, each operator performed nine intubations.

In the scenarios (b) and (c), only a single investigator (MK), certified as an instructor of Advanced Cardiovascular Life Support, provided chest compression at a rate of 100 min^{-1} to a depth of 4–5 cm during all intubation procedures, in order to keep the depth and rate of chest compression as consistent as possible. To avoid fatigue of the provider, operators were asked to complete every intubation within 2 min, and the study was conducted only in 2 operators a day at an interval of 60 min. In the scenario (c), cervical stabilisation was achieved by placement of a rigid cervical collar (Stifneck Select, Laerdal Medical Japan, Tokyo, Japan). Prior to the study in the scenario (c) by each operator, the chest compression provider fixed the collar with a Velcro strap at the same position so that he could see only the posterior commissure of the larynx with direct laryngoscopy without exerting an extra force on the laryngoscope handle.

For intubation with the Macintosh laryngoscope alone, operators were asked to see the glottis opening (a Cormack–Lehane grade 1 or 2 view[19]) wide enough to advance the tube through the cords into the trachea. For GEB-aided intubation, operators were asked to see the glottis opening (a Cormack–Lehane grade 2 view[19]) minimally enough to thread the GEB (Eschmann Introducer, SIMS Portex, Hythe, UK) using the Macintosh laryngoscope and then to advance the GEB into the trachea. With the GEB properly positioned, an assistant loaded a tracheal tube onto it, and then the operator advanced the tube over it into the trachea, with the operator maintaining laryngoscopy and the assistant steadying the GEB.[13] For AWS-aided intubation, the device, preloaded with a tracheal tube, was inserted into the mouth, the glottis opening was positioned at the cross-mark on the monitor, and the tube was advanced into the trachea.[13]

At the end of each scenario using three devices, each operator was asked to rate the subjective difficulty of each method on a 5-point rating scale, defined as (1) very easy; (2) easy; (3) moderate; (4) difficult; and (5) very difficult. We employed this simple scale because it was already used by the other investigators,[10] and because any previous scoring system regarding intubation difficulty did not allow for assessment of a component of difficulty resulting from the glottis movement during continuous CPR. The order of the devices to be used was randomised for each operator, and each operator rated difficulty only after completing each sce-