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Establishing a definitive airway in the trauma patient by novice intubators: A randomised crossover simulation study

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ABSTRACT

Background: Establishing a definitive airway, defined as a tube placed in the trachea with cuff inflated below the vocal cords, is standard of care in pre-hospital airway management of the trauma patient. However, in this setting, and using manual in-line stabilisation of the neck, success rate of intubation by inexperience providers is suboptimal. The use of supraglottic airway devices that allow blind tracheal intubation has been suggested as an alternative method by the Advanced Trauma Life Support (ATLS) programme of the American College of Surgeons. We aimed to compare intubation with the standard intubation technique (direct laryngoscopy [DL]) with blind intubation through an intubating-laryngeal mask airway (I-LMA) during manual in-line stabilisation of the neck.

Materials and methods: A randomised, crossover manikin study was performed with 29 emergency medical technicians undergoing training for paramedic status. Outcome measures were success rate in one intubation attempt, duration of intubation, and assessment of ease-of-use.

Results: Study subjects had a higher success rate of tracheal intubation with I-LMA than with DL (27/29 vs. 18/29, $p < 0.025$), and I-LMA was assessed as easier to use (4 vs. 3, $p < 0.0001$). Longer duration of intubation was found with I-LMA compared to DL (54.2 vs. 42.8 s, $p < 0.002$). Success rate of correct placement of I-LMA within the airway was 28/29 (96.5%). Time to achieve correct placement of I-LMA within the airway was shorter than duration of tracheal intubation with DL (26.9 vs. 42.8 s, $p < 0.0001$).

Conclusions: Novice intubators had a higher success rate of intubation with I-LMA than with DL, but duration of intubation was longer with I-LMA. Time to achieve correct placement of I-LMA within the airway was shorter than duration of tracheal intubation with DL. Findings of this simulation study suggest that in the presence of manual in-line stabilisation of the neck, I-LMA-guided intubation is the preferred technique for novice intubators.

Introduction

Establishing a definitive airway defined as a tube placed in the trachea with cuff inflated below the vocal cords is standard of care in pre-hospital airway management of the trauma patient [1]. However, previous studies revealed that the success rate of intubation of injured patients using standard intubation technique (direct laryngoscopy [DL]) in the pre-hospital setting is suboptimal [1–4]. Furthermore, the success rate of pre-hospital intubation with DL by providers inexperienced in tracheal intubation is even lower [5].

The use of supraglottic airway devices that allow blind tracheal intubation has been suggested as an alternative method in the last edition of the Advanced Trauma Life Support (ATLS) textbook, of the American College of Surgeons [1,2]. Three types of such devices are currently used in the practice of anaesthesia: the I-gel®, the Air-Q®, and the Fastrach® laryngeal mask airway (intubating-LMA, I-LMA) [6,7]. Previous studies revealed that, as a conduit for

Abbreviations: I-LMALMAFastrach®, intubating laryngeal mask airway; DL, direct laryngoscopy; ETT, endotracheal tube.

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tracheal intubation, I-LMA is superior to the I-gel® and to the Air-Q®, and that I-LMA caused less neck extension at C1-2 and C2-3 than intubation with DL [6–9]. This makes the I-LMA a potentially ideal device for trauma patients in whom cervical spine movement is undesirable [1].

The objective of this simulation study was to compare intubation with DL with blind intubation through I-LMA during manual in-line stabilisation of the neck. We examined the hypothesis that novice intubators would have higher success rates of tracheal intubation with the I-LMA than with DL.

Material and methods

Study design

A randomised, crossover manikin study was performed. We compared participants' performance of intubation using DL with their performance of intubation with I-LMA. The study was conducted at a simulation laboratory of a level-1 trauma care centre. The Institutional ethics committee waived the need for ethical approval for this study.

Study participants

Study participants were military emergency medical technicians undergoing initial training for paramedic status. Three months prior to the study, participants had completed courses in Advanced Cardiac Life Support (ACLS) and in Pre-Hospital Trauma Life Support (PHTLS) as part of the standard paramedic curriculum. None of the study subjects had prior clinical experience with the I-LMA. However, all had completed a 3-hour workshop with DL during the PHTLS course before the study.

Randomisation

The sequence of device insertion was randomised to either DL-first or I-LMA-first. Using a computerised random-number generator, an allocation sequence was created and course participants were divided into the two groups of the study: DL-first and I-LMA-first.

Study instruments

1) Laerdal® Airway Management Trainer (Laerdal Medical AS, Stavanger, Norway).
2) Laryngoscope with a size 3 Macintosh blade, standard cuffed endotracheal tube (ETT) size 7.0, 10 ml syringe, water soluble lubricant.
3) LMA Fastrach® reusable size 3 (Fig. 1), a polyvinyl chloride (PVC) disposable ETT (LMA® ETT single use), 50 ml syringe, water soluble lubricant.
4) Ambu® oval silicon reusable resuscitator and mask.

Testing technique – blind intubation through I-LMA

First, the cuff was totally deflated and the posterior surface of the mask tip was lubricated with 3–4 ml of gel, to facilitate insertion. Then, the mask tip was carefully positioned so that it was flat against the hard palate. Sliding it backward, the tube curvature closely followed the anatomical curve of the palate and posterior pharyngeal wall [10]. As soon as the I-LMA reached the larynx, the cuff was inflated to a volume of 30 ml. An optimal position was verified by using the two-step Chandy manoeuvre [10]. This is followed by slight rotation of the device in the sagittal plane, using the handle, until the least resistance to bag ventilation is achieved (Fig. 2A). This helps to align the internal aperture of the device with the glottis opening. Just before blind intubation, the I-LMA was slightly lifted away from the posterior pharyngeal wall using the handle. This prevents the tracheal tube from colliding with the arytenoids and facilitates the smooth passage of the tracheal tube into the trachea.

Fig. 1. The intubating Laryngeal Mask Airway (I-LMA, LMA Fastrach®).

Then, a 7.0 mm well-lubricated LMA® ETT was inserted through the I-LMA until it reached the 15 cm depth marker, so that its tip did not enter the mask aperture (Fig. 2B). The tube was then advanced gently to about 1.5 cm past the 15 cm transverse line and, if no resistance was felt, indicating correct tube position, it was passed freely into the trachea to its desired depth, and the cuff was inflated.

Study procedure

Participants received a 30-min lecture on the two techniques used in this study (intubation with DL and intubation using I-LMA), followed by two standardised educational videos on the two techniques and a 10-min demonstration of each technique (LG). Immediately after, each participant in turn practiced the two techniques on a manikin model (Laerdal® Airway Management Trainer without neck immobilisation). Practicing the two techniques was ended when each participant was satisfied with his understanding of the two methods of intubation. Participants were then randomly divided into the two groups (DL-first, I-LMA-first). Immediately after, each participant in turn entered the study room in which the study instruments were placed on a table and two study investigators were present (NB, BL). Each participant was asked by a study investigator to independently perform *one intubation attempt* using the first technique (DL or I-LMA) on the manikin model, while manual in-line stabilisation of the neck was performed by a study investigator (BL) (Fig. 1).

Immediately after performing the first procedure, the participant was asked to perform the second procedure using the second technique (DL or I-LMA). The study investigators (NB, BL) did not intervene with the procedure or provide any consultation or recommendation, and participants were not allowed to watch others perform the procedure. For each intubation attempt with DL, a newly cuffed ETT was used and, for each intubation attempt with the I-LMA, a new LMA® ETT was used.

If a failed intubation occurred, the participant was asked to explain the problem to a study investigator (BL) who recorded this information on a designated data collection sheet. Each procedure was videotaped by one of the study investigators (NB) using a digital video HD camera iPhone 6 (Apple Inc., Cupertino, CA, USA) located at a fixed position 50 cm from the manikin. Recording began 20 s before the procedure (before the participant