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ORIGINAL ARTICLE

Comparison of Supreme® and Soft Seal® laryngeal masks for airway management during cardiopulmonary resuscitation in novice doctors: a manikin study

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Abstract
Purpose In the 2005 American Heart Association (AHA) guidelines, the laryngeal mask (LMA) was proposed as an alternative to tracheal intubation for cardiopulmonary resuscitation (CPR). We compared the utility of a newly developed LMA, the Supreme® (Supreme), with a conventional LMA, the Soft Seal® (Soft Seal).
Methods A total of 19 novice doctors in our anesthesia department performed insertion of the Supreme or Soft Seal on a manikin with or without chest compression. Insertion time and number of attempts for successful ventilation were measured. After successful ventilation, the amount of air entering the stomach and maximum ventilation pressure were measured. The subjective difficulty of using the devices was also measured.
Results The ventilation success rate of first insertion did not differ between the Supreme and Soft Seal without chest compression. However, the success rate was significantly lower with the Soft Seal than the Supreme during chest compression. Insertion time was lengthened by chest compression with the Soft Seal, but not with the Supreme. Maximum ventilation pressure was higher with the Supreme than the Soft Seal. The amount of air entering the stomach was significantly lower with the Supreme than the Soft Seal. The Supreme also scored better than the Soft Seal on a visual analog scale of subjective difficulty in insertion.
Conclusions The Supreme is an effective device for airway management during chest compression.

Keywords Laryngeal mask Supreme® · Laryngeal mask Soft Seal® · Chest compression · Manikin · Novice doctors

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Introduction

Securing the airway during cardiopulmonary resuscitation (CPR) is generally difficult and is influenced by the location and position of the patient and skills of the rescuers. The American Heart Association (AHA) 2005 guidelines suggest the laryngeal mask (LMA) as an alternative supraglottic device for tracheal intubation during CPR [1]. There are reports suggesting that conventional LMA has several advantages compared to ordinary tracheal intubation for airway management under emergency situations such as cardiopulmonary arrest [2, 3].

The LMA-Supreme® (Supreme; Laryngeal Mask Company, Henley-on-Thames, UK) is a disposable supraglottic airway device that has the same characteristics as both the LMA ProSeal® (Laryngeal Mask Company) and the LMA Fastrach® (Laryngeal Mask Company) [4, 5]. Because of these features, the Supreme has been reported to be a useful device in emergency situations [4, 5].

We hypothesized that the Supreme may be favorable for airway management during chest compression while performing CPR with a patient on the ground. Thus, we

compared the performance of the Supreme and the conventional Soft Seal® LMA (Smiths Medical, USA) during chest compression with a manikin [6].

Materials and methods

We obtained approval for this study from the college's Research Ethics Committee. In May and June 2010, 21 novice doctors who had less than a year of experience with anesthesia were invited to participate, and 19 doctors agreed. We asked the doctors about their prior experience with general anesthesia and obtained written consent before participating in the study.

The AirMan® (Laerdal, Sentrum, Stavanger, Norway) was used as the manikin for chest compression and insertion of the LMA [7, 8]. Size four Supreme and Soft Seal devices were used. The necessary equipment for each simulation was placed in a box next to the manikin. Participants were given time to practice insertion and ventilation with the Supreme or Soft Seal.

We placed the manikin on a hard and flat floor for the simulation of "on the ground." According to the guidelines, the same advanced cardiac life support (ACLS) instructor performed chest compressions at a rate of 100 per minute [1].

The study was a randomized cross-over trial for minimizing learning effect. Each participant inserted the Supreme or Soft Seal with or without chest compression, respectively. This randomization process resulted in a total of four interventions per participant (24 patterns).

Each participant performed insertion of the airway device (Supreme or Soft Seal), inflation of its cuff with 20 ml air, connection to a bag-valve-mask, and attempted ventilation of the lungs of the manikin. We administered a fixed volume to evaluate the LMA utility in emergent airway management. The amount of 20 ml was decided as a result of the preliminary studies. Insertion times from the start-point to the end-point were recorded; the start-point was when the participant picked up a Supreme or Soft Seal, and the end-point was manual ventilation after insertion, regardless of success or failure in inflating the manikin's lungs. If clear ventilation was not seen, the participant was told to perform the insertion trial again, and the number of trials until successful ventilation was recorded. Successful ventilation was confirmed by visible chest rise of the manikin.

Participants were instructed to secure the airway as quickly as possible. However, when participants found insertion of the LMA extremely difficult, they could request discontinuing chest compression for up to 10 s.

After successful insertion, participants were told to perform five ventilations with a 3 l bag-valve-mask (Laerdal Silicone Resuscitator; Sentrum) because the manikin was intended to simulate an adult male. Maximum ventilation pressure was measured with a Resusci Timer (Allied Healthcare, USA). The Resusci Timer was connected between the bag-valve-mask and each LMA, and maximum ventilation pressure was displayed on the digital monitor. The amount of air entering the stomach per five ventilations was measured with a flowmeter (Citizen, Japan) attached to the manikin's stomach.

At the end of the examination, participants were told to rate the difficulty of each LMA usage on a visual analog scale (VAS) from 0 mm (extremely easy) to 100 mm (extremely difficult), with and without chest compression, respectively.

Results obtained from each trial were compared by two-way repeated measures analysis of variance for ventilation time, maximum peak pressure, amount of air entering the stomach, and VAS, respectively. For comparison of success rates, the chi-squared test was used. Data are presented as mean ± SD. A P value <0.05 was considered statistically significant.

Sample size was calculated based on our previous study regarding the time required for intubation in a normal state [8]. The mean (SD) time required to ventilate the lungs after tracheal intubation in a manikin was 13.9 (4.4) s. We estimated that at least 16 operators for each device would be adequate to detect a 33% difference in intubation time with a power of 0.8.

Results

The average clinical experience of participants with anesthesia was 3.3 ± 2.9 months. The number of general anesthesia procedures performed was 68.3 ± 32.2. All participants had previously used the LMA-Proseal; the average number of uses was 35.2 ± 16.7. None had previously used the Soft Seal. Three of the 19 participants had prior clinical experience with the Supreme on one occasion each.

Number of successful ventilations in the first trial

Table 1 shows the number of successful ventilations in the first trial. Without chest compression, 17 of the 19 participants succeeded at the first attempt with the Soft Seal, and all participants did so with the Supreme (no significant difference, n.s.). In contrast, during chest compression, 13 of 19 participants succeeded with the Soft Seal, but 18 succeeded with the Supreme ($P < 0.05$). Of those who failed with the Soft Seal at the first attempt, 5 succeeded on the second attempt and 1 succeeded on the third. With the Supreme trial, the 1 participant who failed on the first attempt succeeded on the second.

Table 1 Number of successful ventilations on the first attempt

	Without chest compression	During chest compression
Soft Seal	17/19	13/19
Supreme	19/19	18/19
P value	n.s.	$P < 0.05$

Values are success number/total number

n.s. not significant, *Soft Seal* Soft Seal laryngeal mask, *Supreme* Supreme laryngeal mask

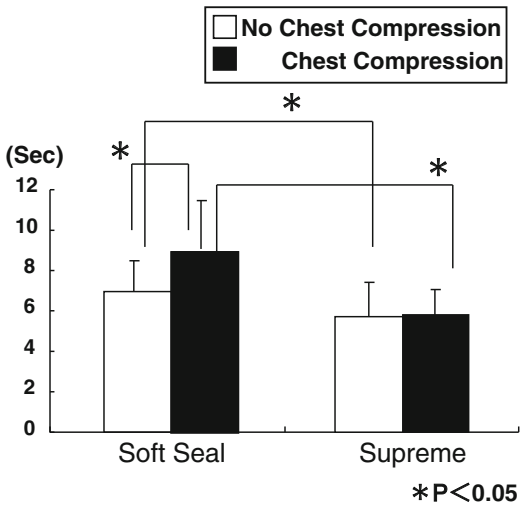

Fig. 1 Insertion times in the first trial of the Supreme or Soft Seal in each simulation. Insertion time was defined as the time from the participant picking up the laryngeal mask (LMA) to the point of manual ventilation after insertion, regardless of success or failure of inflating the manikin's lungs. *Soft Seal*, Soft Seal laryngeal mask; *Supreme*, Supreme laryngeal mask

Insertion times in the first trial

Insertion times are shown in Fig. 1. Insertion time was significantly longer with the Soft Seal than the Supreme regardless of chest compression ($P < 0.05$). Performing chest compression slightly extended insertion time with the Soft Seal but not with the Supreme (Soft Seal: 6.9 ± 1.5 s without chest compression vs. 8.8 ± 2.6 s during chest compression, $P < 0.05$; Supreme: 5.7 ± 1.8 s without chest compression vs. 5.8 ± 1.6 s during chest compression, n.s.). No participant requested an interruption of chest compression.

Maximum ventilation pressure and amount of air entering the stomach

Maximum ventilation pressure and the amount of air entering the stomach for five ventilations are shown in Fig. 2a. Maximum pressure with the Supreme was significantly higher than with the Soft Seal regardless of chest compression ($P < 0.05$). Maximum ventilation pressure did not change with chest compression with the Soft Seal or Supreme (Soft Seal: 8.4 ± 3.2 cmH_2O without chest compression vs. 7.5 ± 4.1 cmH_2O during chest compression; Supreme: 21.1 ± 6.8 cmH_2O without chest compression vs. 20.6 ± 8.6 cmH_2O during chest compression).

The amount of air entering the stomach was markedly smaller with the Supreme than the Soft Seal regardless of chest compression ($P < 0.05$). The amount of air entering the stomach was not influenced by chest compression with the Soft Seal or Supreme (Fig. 2b; Soft Seal: 180.2 ± 123.0 ml without chest compression vs. 214.3 ± 112.7 ml during chest compression; Supreme: 14.6 ± 11.8 ml without chest compression vs. 14.2 ± 5.6 ml during chest compression).

VAS score of insertion difficulty

Visual analog scale (VAS) scores for the Supreme and Soft Seal are shown in Fig. 3. Chest compression worsened the VAS score in the Soft Seal trial ($P < 0.05$) but not with the Supreme (n.s.). The VAS score of the Supreme was not different from that of Soft Seal without chest compression (n.s.), but it was significantly lower than that of the Soft Seal during chest compression ($P < 0.05$) (Soft Seal: 38.4 ± 17.8 mm without chest compression vs. 50.7 ± 16.0 mm during chest compression; Supreme: 23.9 ± 16.1 mm without chest compression vs. 31.8 ± 18.1 mm during chest compression).

Discussion

Airway management is considered as an essential element of both in-hospital and out-of-hospital CPR. Tracheal intubation is the most widely used method for airway management, but it is considered difficult to use for occasional users [9–11]. The AHA-ACLS guideline emphasizes continuous chest compression, and avoiding interruptions as possible, even for airway management [12, 13]. Thus, the guideline does not always recommend tracheal intubation for all rescuers, suggesting the alternative usage of supraglottic devices such as the LMA or Combitube [13].

Laryngeal masks are recommended by professionals for airway rescue in cases of failed intubation, and various models have been used. Conventional types of LMAs, such as the LMA-Classic®, LMA-ProSeal®, or Soft Seal have been reported to be useful for airway rescue [14]. Compared to old types, the Supreme has various enhanced features. Supreme contains a rigid airway tube and reinforced tip

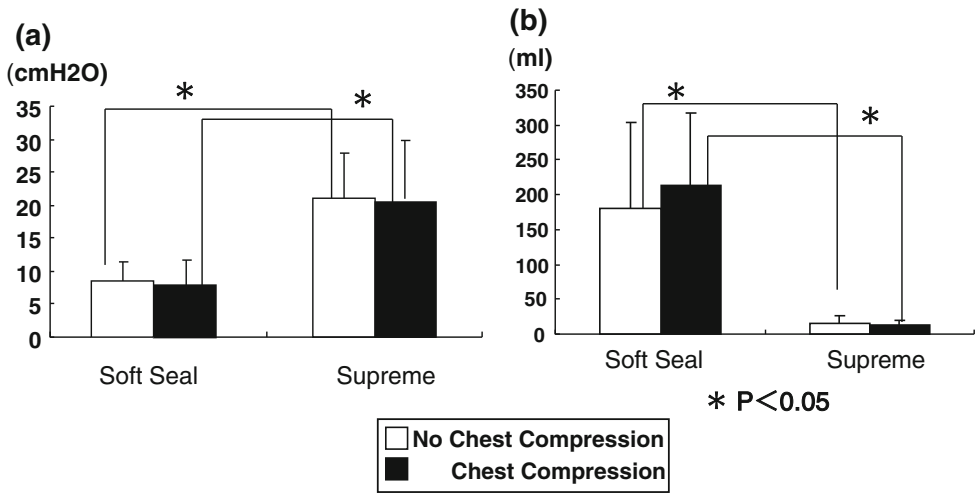

Fig. 2 Average peak pressure and amount of air entering the stomach for each simulation: average peak pressure (**a**), and amount of air entering the stomach in five ventilations (**b**). *Soft Seal*, Soft Seal laryngeal mask; *Supreme*, Supreme laryngeal mask

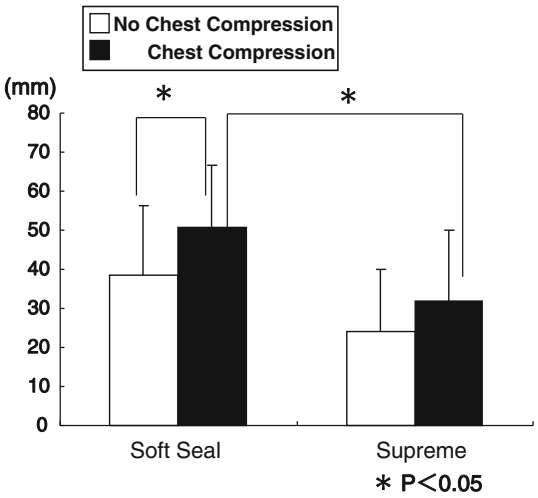

Fig. 3 Visual analog scale (VAS) score for usability of each LMA in the four simulations. *Soft Seal*, Soft Seal laryngeal mask; *Supreme*, Supreme laryngeal mask

for prevention of kinking and folding. The large cuff and gastric access can improve protection of the airway and avoid inflation of the stomach. Furthermore, the elliptical cross-sectional design of the airway tube facilitates reliable insertion [15, 16]. According to these features, Supreme shows higher success rates than conventional LMA [17]. In our study, all participants were successful with the Supreme on their first attempt without chest compression and only one participant failed during chest compression. Compared with the Soft Seal, participants had a higher success rate, shorter insertion times, and lower VAS score with the Supreme.

There is a risk of expansion of the stomach with LMA because of the difficulty of completely securing the trachea. Stomach expansion leads to potential gastric fluid regurgitation or aspiration pneumonia [18]. Interestingly, the LMA-Supreme promoted a sealed airway and also permitted gastric access in all ventilated patients [19, 20]. In this study, maximum peak pressure was significantly higher with the Supreme than with the Soft Seal, leading to a smaller amount of air in the stomach with the Supreme. This finding is consistent with the high performance of the Supreme in sealing the airway [19, 20].

Another advantage of the LMA is their usability by novice operators. In an emergency situation, airway management is often performed by less experienced physicians. There are reports that application of LMA requires less professional skill and is suited for novice or occasional operators [21, 22]. In this study, although participants had no or very limited experience with the Supreme in clinical patients, their performance was significantly better with the Supreme than with the conventional Soft Seal. A short-term training with the Supreme for novice doctors may be meaningful for emergent airway management [23].

From the point of view of the location of victims, rescuers cannot obtain an ideal position for tracheal intubation with the Macintosh laryngoscope (McL) when the victims are lying on the ground [24]. Axial alignment of the oral cavity, pharynx, and larynx is prerequisite for tracheal intubation with the McL. We have previously reported the difficulty of tracheal intubation with the McL in patients on the ground [25]. As LMA do not need such axial alignment, they may be especially useful for airway resuscitation for patients on the ground.

Laryngeal mask is valuable in difficult airway management (DAM), especially in a "cannot intubate, cannot ventilate" situation [26]. The concept of "difficult airway management" includes physical difficulties associated with the patient, such as a small jaw and restricted opening of the mouth [27]. It also includes several situations that make airway management more difficult. Airway management during CPR is often performed under restricted situations resulting from severe head and neck trauma, hemorrhage in

the airway, and position of the victim [28]. LMA may be useful not only for physically difficult airways but also for such situation-induced difficult airways [29, 30].

This study has several limitations. Use of the Supreme may be impaired in patients with a severely restricted mouth opening and foreign body or tumor in the mouth. Furthermore, the present study was performed on a manikin, not in real patients [31]. The manikin in our study was intended for training in simulation of chest compression and airway management. There is one case report on the application of the Supreme in chest compression [32]. Accumulation of clinical use data with the Supreme in emergency airway management during resuscitation is needed. We conclude that the Supreme is an effective tool for emergency airway management during chest compression.

Conflict of interest The authors have no affiliation with any manufacturer of any device described in this article and declare no financial interest in relationship to the material described here. Financial support for the study was provided by our institution and department.

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