

Research Article

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Comparison of the ProSeal™ Laryngeal Mask with or without a 90 Degree Bent by an Intubating Stylet for Airway Management during Cardiopulmonary Resuscitation Simulation

Nobuyasu Komasawa^{1*}, Ryusuke Ueki², Hanako Kohama³, Shin-ichi Nishi³, Chikara Tashiro² and Yoshiroh Kaminoh⁴

¹Department of Anesthesiology, Osaka Medical College, Japan

²Department of Anesthesiology, Hyogo College of Medicine, Japan

³Intensive Care Unit, Hyogo College of Medicine, Japan

⁴Department of Surgical Center, Hyogo College of Medicine, Japan

Abstract

Purpose: The 2010 American Heart Association (AHA) guidelines propose the use of a Laryngeal Mask (LMA) as an alternative to tracheal intubation for Cardiopulmonary Resuscitation (CPR). Use of a ProSeal™ laryngeal mask, bent 90 degrees by an intubating stylet, has been reported to yield definite insertion. We compared speed and success of insertion between the styleted LMA (ProSeal-90D) and the conventional LMA (ProSeal-N).

Methods: A total of 20 novice doctors in our Department of Anesthesia performed insertion of both the ProSeal-N and ProSeal-90D on a manikin, with and without chest compression. Insertion times and successful insertion rate with first attempt were recorded.

Results: Chest compression decreased the ventilation success rate significantly for the ProSeal-N, but did not affect the results for the ProSeal-90D. Moreover, when chest compression was performed, ventilation success rate was significantly higher for ProSeal-90D than the ProSeal-N. Insertion time was lengthened by chest compression for ProSeal-N, but not for ProSeal-90D.

Conclusions: In simulated resuscitation, rapid successful placement was more frequent with the ProSeal-90D than the ProSeal-N during chest compressions.

Keywords: ProSeal™ Laryngeal mask; Intubating stylet; Chest compression; Manikin; Novice doctors

Introduction

Securing the airway during Cardiopulmonary Resuscitation (CPR) is generally difficult, and is influenced by the location and position of the patient as well as rescuer skills [1]. The 2010 guidelines published by the American Heart Association (AHA) suggest the use of a Laryngeal Mask (LMA) as an alternative supraglottic device for tracheal intubation during CPR [2].

The LMA ProSeal™ (ProSeal™; Laryngeal Mask Company, Henley-on-Thames, UK) is a reusable supraglottic airway device equipped with a double-cuff mechanism, and can maintain a high seal pressure [3]. However, due to its large cuff size, insertion success rate on the first attempt is low and insertion times are reportedly longer [4]. As such, the ProSeal™ has not been considered useful for emergent situations.

Recently, the use of the ProSeal™ laryngeal mask bent 90 degrees by an intubating stylet (ProSeal-90D) was reported to yield more rapid and definite insertion relative to an unbent version (ProSeal-N) [5]. We hypothesized that the ProSeal-90D would improve airway management during chest compression when CPR is performed on a patient. To this end, we compared performance of the ProSeal-90D with that of the conventional ProSeal-N insertion device while performing chest compression in a manikin.

Materials and Methods

We obtained approval for this study from the college's Research Ethics Committee. Twenty-two novice doctors with less than a year of experience with anesthesia were invited to participate, and 20 agreed. We asked doctors about their prior experience with general anesthesia and obtained their written consent before conducting the study.

The AirMan® (Laerdal, Sentrum and Stavanger, Norway) was used as the manikin for chest compression and ProSeal™ insertion. We used size 4 ProSeal™ devices. Necessary equipment for each simulation was placed in a box next to the manikin. The polyvinyl chloride Rusch O.D. 5.6 mm (Teleflex, Pennsylvania, USA) was used to modify the ProSeal-90D. The stylet is not provided by the manufacturer of ProSeal™. The research team inserted Rusch stylet at a 90 degree angle measured by the same protractor. Participants were given five minutes to practice insertion and ventilation with the ProSeal-N or ProSeal-90D. Participants performed insertion of the ProSeal-N using a standard method for which we provided guidance with a finger tip. For the ProSeal-90D trials, they chose the upper part of the ProSeal, such as Supreme or Fastrach insertion.

The manikin was placed on a solid table to simulate an 'on the bed' situation. For each simulation, the same Advanced Cardiac Life Support (ACLS) instructor performed chest compressions at a rate of 100 per minute and a depth of more than 5 cm, according to the guidelines [6,7].

To minimize the learning effect, our study employed a randomized

***Corresponding author:** Nobuyasu Komasawa, Department of Anesthesiology, Osaka Medical College, Daigaku-machi 2-7, Takatsuki, Osaka 569-8686, Japan, Tel: +81-72-683-2368; Fax: +81-72-684-6552; E-mail: koma21century@yahoo.co.jp

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cross-over trial design. Each participant inserted either the ProSeal-N or ProSeal-90D with or without chest compression. This randomized process resulted in a total of four interventions per participant (24 potential permutations).

Each participant performed insertion of the airway device (ProSeal-N or ProSeal-90D), inflation of its cuff with 20 mL of air, connection to a self-inflating bag, and attempted to ventilate the lungs of the manikin. Insertion times from the start-point to the end-point were recorded, whereby the start-point was the time at which the participant picked up the ProSeal™ device, and the end-point was considered the time at which manual ventilation was performed with a 3L bag-mask (Laerdal Silicone Resuscitator, Sentrum) after insertion, regardless of whether the manikin’s lungs were successfully inflated or not. Successful ventilation was confirmed by visible chest rise of the manikin. Ventilation times obtained from each trial were compared by two-way repeated measures analysis of variance. Success rates were compared by chi-squared test. Data are presented as mean ± SD. $P < 0.05$ was considered statistically significant.

Results of our preliminary study in 7 novice doctors showed that the time required to ventilate the lungs after successful insertion of the ProSeal-N was approximately 10 ± 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 mean length of clinical experience with anesthesia in our participants was 2.8 ± 1.2 months. All participants had previously used the ProSeal™; mean number of uses was 20.8 ± 8.3 .

Successful insertion rate with first attempt

Table 1 shows the number of successful insertion rate with first attempt. Without chest compression, 19 of the 20 participants succeeded on their first attempts with the ProSeal-N, and all participants did so with the ProSeal-90D (difference not significant). In contrast, with chest compression, 14 of 20 participants succeeded with the ProSeal-N, whereas 19 succeeded with the ProSeal-90D ($P < 0.05$) (Figure 1).

Insertion times

Insertion times are shown in Figure 2. Performing chest compression slightly increased insertion time for the ProSeal-N, but not for the ProSeal-90D (ProSeal-N: 8.5 ± 2.9 s without chest compression vs. 11.2 ± 2.9 s during chest compression, $P < 0.05$; ProSeal-90D: 6.8 ± 2.1 s without chest compression vs. 7.0 ± 1.9 s during chest compression, *n.s.*). Insertion times were significantly longer for the ProSeal-N than the ProSeal-90D during chest compression ($P < 0.05$).

Discussion

Airway management is considered an essential element of both in-hospital and out-of-hospital CPR. The Macintosh laryngoscope is the most widely used device for tracheal intubation, but is considered difficult to use for occasional users [8]. The AHA-ACLS guidelines

	Without chest compression (successful/total attempts)	With chest compression (successful/total attempts)	P-value
ProSeal-N	19/20	14/20	$P < 0.05$
ProSeal-90D	20/20	19/20	N.S.

ProSeal-N, conventional ProSeal™; ProSeal-90D, ProSeal™ bent 90 degrees by intubating stylet

Table 1: Successful insertion rate with first attempt.

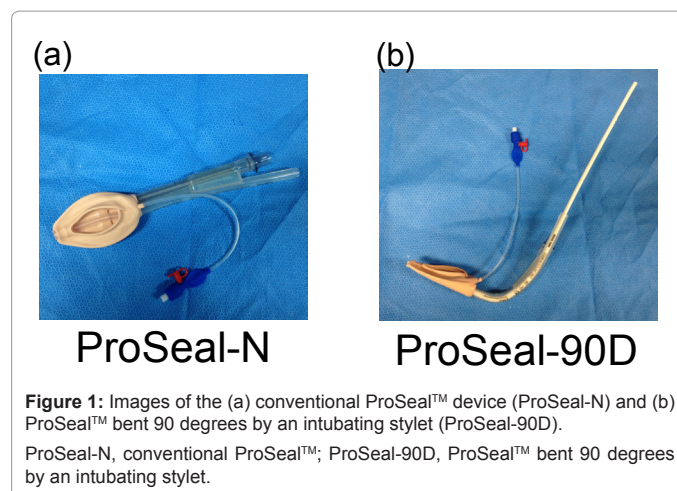


Figure 1: Images of the (a) conventional ProSeal™ device (ProSeal-N) and (b) ProSeal™ bent 90 degrees by an intubating stylet (ProSeal-90D). ProSeal-N, conventional ProSeal™; ProSeal-90D, ProSeal™ bent 90 degrees by an intubating stylet.

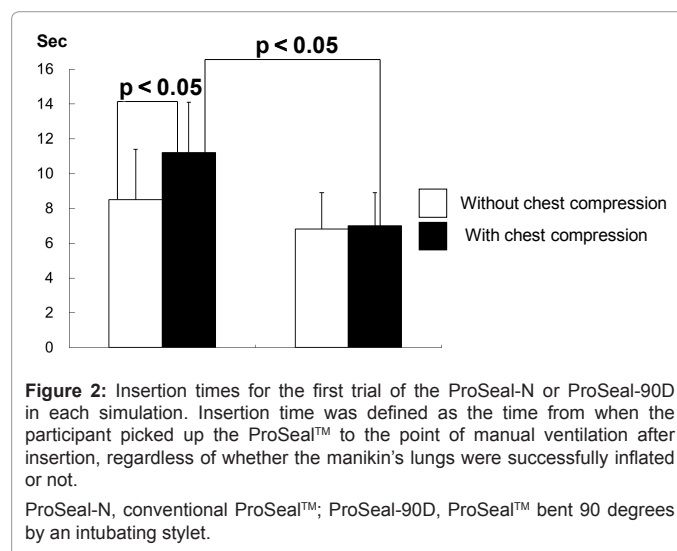


Figure 2: Insertion times for the first trial of the ProSeal-N or ProSeal-90D in each simulation. Insertion time was defined as the time from when the participant picked up the ProSeal™ to the point of manual ventilation after insertion, regardless of whether the manikin’s lungs were successfully inflated or not. ProSeal-N, conventional ProSeal™; ProSeal-90D, ProSeal™ bent 90 degrees by an intubating stylet.

emphasize continuous chest compression with as few interruptions as possible, even for airway management. Thus, the guidelines do not recommend that rescuers always perform tracheal intubation, and instead recommend using alternative supraglottic devices such as the LMA or laryngeal tube [1,2].

LMAs are recommended by professionals for airway rescue in cases of failed intubation, and various models have been used. ProSeal™ has various enhanced features, and differs from original models of laryngeal masks such as the LMA-Classic™ and LMA-SoftSeal® [9]. ProSeal™ is equipped with a double cuff mechanism and can maintain a high seal pressure, which allows for safe performance of positive-pressure ventilation. In addition, suction of gastric contents through the drain tube helps to prevent aspiration. However, due to the large cuff volume, insertion of ProSeal™ can be difficult, especially in emergent cases requiring CPR.

Recently, new laryngeal masks such as the Ambu® Aura-i™, Supreme™ or the air-Q™ have been developed, and are designed to fit the oral and pharyngeal anatomy [10-12]. The most effective character of these devices is the 90 degree angulation in the part of the tube closest to the junction between the tube and laryngeal mask. Bending the ProSeal™ with an intubating stylet allows even novice doctors to

easily insert the ProSeal™ during chest compression, as the curvature is form-fitted to the anatomy.

Given the difficulty in securing the trachea, the use of LMA poses the risk of gastric expansion, which can lead to gastric fluid regurgitation or aspiration pneumonia. The ProSeal™ promotes a sealed airway and also permits gastric access in all ventilated patients. In a previous study, we found that the Supreme™, similar to the ProSeal™ in that it allows gastric access, showed significantly less air accumulation in the stomach relative to the classic type LMA SoftSeal™ [13]. The ProSeal™ may effectively prevent gastric expansion by allowing air to drain from the stomach through the gastric access which classic type LMA does not contain. Furthermore, the double-cuff mechanism and large cuff volume may contribute firm fit to the glottis leading to smaller movement or malposition by chest compression compared to classic LMA. In the future study, evaluation of LMA movement and malposition each by long-time chest compression may be significant.

Another advantage of LMA is their ease of use for novice operators. In emergent situations, airway management is often performed by less experienced physicians. Application of LMA has been reported to require less professional skill and is suited for novice or occasional operators [14-16]. Our study participants had relatively small experience with the ProSeal™ in clinical patients, but their performance was significantly better with the ProSeal-90D than the ProSeal-N. Short-term training with the ProSeal-90D for novice doctors may be helpful to improve emergent airway management.

LMAs are valuable for difficult airway management, especially in “cannot intubate, cannot ventilate” situations. “Difficult airway management” can include physical difficulties associated with the patient, such as a small jaw or a restricted opening of the mouth. It can also be due to a situation that makes airway management more problematic [7]. Airway management during CPR is often performed under restricted situations, some of which involve severe head and neck trauma, hemorrhaging in the airway, or sub-optimal positioning of the victim. LMAs may be useful not only for physically difficult airways, but also for these types of difficult airways.

This study has several limitations. First, use of the ProSeal™ may not be ideal for patients with severely restricted mouth openings or those with a foreign body or tumor in the mouth. Second, the present study was not performed on real patients, but rather on a manikin, the purpose of which is for training simulations of chest compression and airway management [17]. More data regarding clinical use of the ProSeal™, particularly during emergency airway management during resuscitation, is required. Third, successful ventilation was confirmed by visible chest rise of the manikin in this study. More objective confirmation would be desired.

We conclude that the ProSeal-90D is an effective tool for emergency airway management during chest compression by novice doctors in manikin simulation.

Conflict of Interest and Source of Funding Statements

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

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