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# Exchange of supraglottic airways for endotracheal tube using the Eschmann Introducer during simulated child resuscitation

## A randomized study comparing 4 devices

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**Abstract**

**Background:** The aim of this study was to examine the application of the Eschmann tracheal tube introducer (ETTI) with 4 types of supraglottic airway devices (SADs) using a child-manikin.

**Methods:** A total of 79 paramedics were asked to exchange the 4 SADs for an endotracheal tube with the ETTI in 3 different scenarios using a randomized crossover study format: normal airway without chest compression; normal airway with uninterrupted chest compression; and difficult airway with uninterrupted chest compression. The primary outcome was time to SAD exchange, with the secondary outcome measuring the success of SAD exchange. Each attempt was assessed by a trained assistant.

**Results:** The mean exchange times for LMA, Cobra PLA, Air-Q, and SALT were as follows: 21, 23, 21, and 18, respectively for Scenario A; 23, 27, 22.5, and 21 for Scenario B; and 23, 28, 23, and 23 for Scenario C. The percent efficacy of SADs exchange with LMA, Cobra PLA, Air-Q and SALT were 98.7%, 94.9%, 100%, and 100% for scenario A; 98.7%, 88.6%, 98.7%, and 97.5% for scenario B; and 93.7%, 87.3%, 94.9%, and 93.7% for scenario C.

**Conclusions:** In this model of pediatric resuscitation, the SAD exchange using an ETTI has (LMA, Cobra PLA, Air-Q and SALT) proved to be effective in paramedics with no previous experience. Furthermore, experimental findings indicated that SAD exchange can be achieved without interrupting chest compression.

**Abbreviations:** CPR = cardiopulmonary resuscitation, ETTI = Eschmann tracheal tube introducer, SAD = supraglottic airway device, SALT = supraglottic airway laryngopharyngeal tube.

**Keywords:** cardiopulmonary resuscitation, child, endotracheal intubation, simulation, supraglottic, tracheal tube

## 1. Introduction

In emergency medicine, paramedics are often challenged with the intubation of children. Thus, ensuring adequate airway management, ventilation and oxygenation are crucial in the practice of emergency medicine and resuscitation of pediatric patients. Evidence for this lies in the fact that respiratory failure is the leading cause of cardiac arrest in this population.[1–3] Although extensively discussed, international cardiopulmonary resuscitation (CPR) guidelines have designated endotracheal intubation as the criterion standard for definitive airway management in adults and children alike.[1,2,4,5] These guidelines also strongly recommend limiting the interruption of chest compressions, as this may impact tissue perfusion. Outside of the hospital, the ability of paramedics to perform direct laryngoscopy in children has been moderately effective, ranging from 63% to 80%.[6–8] Alternative airway management methods, such as Supraglottic Airway Devices (SADs), may be useful in an emergency medical situation[9–11] (Fig. 1). Several studies in the adult population indicate that once an SAD is successfully placed, it may be exchanged using an Eschmann introducer. However, there is a lack of evidence supporting this exchange in pediatric airways.

Therefore, the aim of this study was to compare 4 different SADs—the Laryngeal Mask Airway Laryngeal Mask Airway classic, Cobra Perilaryngeal Airway, air-Q Masked Laryngeal Airways Disposable, and Supraglottic Airway Laryngopharyngeal Tube—and their ability to be changed using the Eschmann introducer in a pediatric manikin study.

## 2. Methods

### 2.1. Study and participants

This prospective, randomized, crossover trial was approved by the International Institute of Rescue Research and Education's

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*The authors report no conflicts of interest.*

*Ethical approval: This open, prospective, randomized, crossover manikin trial was approved by the Institutional Review Board of the International Institute of Rescue Research and Education (Approval 15.2015.03.05 on March 2nd, 2015).*

*Informed consent was obtained from all individual participants included in the study.*

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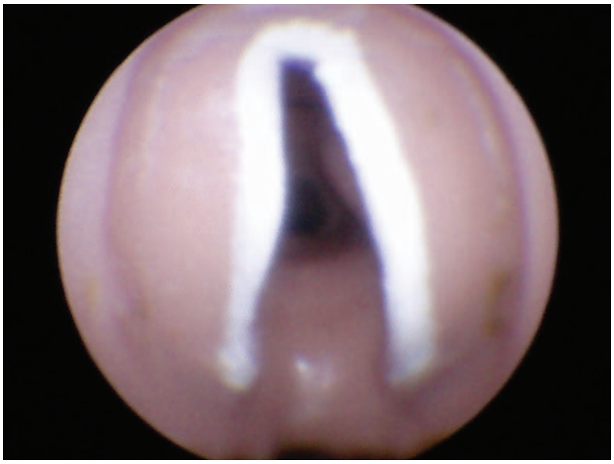

**Figure 1.** Fibreoptic view through LMA.

IRB (Approval 15.2015.03.05 on March 2rd, 2015). Seventy-nine paramedics were recruited using the criteria that they had no experience with pediatric intubation and had performed <100 adult intubations by direct laryngoscopy. Furthermore, these paramedics had no training in endotracheal intubation using SADs before the study.

### 2.2. Devices

The four SADs used were the Laryngeal Mask Airway classic (Laryngeal Mask Airway, size 2½, Teleflex, Buckinghamshire, UK), the Cobra Perilaryngeal Airway (COBRA PLA, size 2, Palmodyne, Indianapolis IN), the air-Q Masked Laryngeal Airways Disposable (Air-Q, size 2.0; Mercury Medical, Clearwater, FL), and the Supraglottic Airway Laryngopharyngeal Tube (SALT, ECOLAB, GA).

The SAD was exchanged using a 70-cm long, 10-French Gauge flexible ETTI with a J angle at its distal tip (Portex, Smiths Medical, Keene, NH). All intubations were performed using an endotracheal tube with 5.0 ID (Portex, Smiths Medical, Keene, NH). AMBU resuscitator bags (AMBU, Copenhagen, Denmark) were readily available for the participants.

### 2.3. Pre-test training

An introductory course on the anatomy and physiology of the pediatric airway, along with a demonstration of the SAD/endotracheal intubation exchange procedure using the ETT, was given by experienced anesthesiologist. After the session, participants practiced the procedure with the 4 SADs for 20 minutes.

### 2.4. Scenario simulation

Each participant performed intubations on a PediaSIM CPR training manikin (FCAE, HealthCare, Sarasota, FL) designed to represent a 6-year-old child. PediaSIM may be programmed to represent either an easy or difficult airway. Paramedics participated in 3 airway scenarios with the manikin on the floor in a neutral position:

(1) Scenario A: Normal airway scenario without chest compressions during intubation.
(2) Scenario B: Normal airway with continuous chest compression at a rate of 100 per minute to a depth of 4 to 5 cm using the LUCAS-2 mechanical chest compression system (Physio-Control, Redmond, WA).
(3) Scenario C: Difficult airway with chest compressions applied using Lucas-2 and a simulator featuring tongue edema to generate Mallampati-grade 3.

### 2.5. Study protocol

Upon finishing the audiovisual lecture and the hands-on training, each paramedic was asked to perform airway interventions using the four different SADs in scenario A, followed by scenarios B and C, respectively. The sequence of the 4 SADs within each scenario was randomized using www.researchrandomizer.org. Participants were allotted a 10-minute break between each airway intervention performance. They were blinded from watching others attempt intubation during this time to prevent observational learning.

### 2.6. Measurements

The primary outcome of the study was SAD time exchange. This was defined as the time from picking up the Eschmann tracheal tube introducer (ETTI) to the first ventilation, as confirmed by visual expansion of the manikin's lungs. The secondary outcome was the success rate of intubation, defined as exchange from SAD to endotracheal tube. An additional secondary outcome included the SAD subjective ease of intubation, assessed by a 10-point visual analogue scale ranging from 1 (easy) to 10 (impossible).

### 2.7. Statistical analysis

A total of 79 participants were required to detect a moderate difference in exchange time between the four SADs using a $P$ value of <.0125 via the Statistica Statistical Package 12.0 for Windows (StatSoft, Tulsa, OK). Owing to abnormally distributed data, nonparametric analysis was used. SAD exchange times were compared using the Wilcoxon signed rank test. McNemar test was used to detect possible differences in success rate for SAD exchange for endotracheal intubation. The Visual-Analogue Scale was assessed using a 1-way analysis of variance with a post hoc (Schiffe) test. All results are shown as a percentage, mean, and standard deviation (±SD) or median and interquartile range (IQR). Correction for multiple testing was performed according to Šidák.[12] A $P$ value of <.0125 was considered statistically significant.

## 3. Results

The study was conducted between March and May of 2015, using 79 paramedic participants. 51 of the subjects were on emergency medical service teams (EMS) and 28 worked in emergency-departments. The mean age was $30 \pm 6$ years and the mean work experience was $5 \pm 4$ years. The time to SAD exchange for each of the scenarios are shown in Table 1. The success rate exceeded 98% with all devices. In scenario A, median exchange times ranged from 18 seconds with the SALT to 23 seconds with the Cobra PLA. In scenario B, median exchange time ranged from 21 seconds with the SALT to 27 seconds with the Cobra PLA. In scenario C, median exchange time ranged from 23 seconds with the SALT to 28 seconds with the Cobra PLA.

**Table 1**

**Results of time to SADs exchange using each device in each scenario.**

| Scenario | LMA | Cobra PLA | Air-Q | SALT | P |
|---|---|---|---|---|---|
| Scenario A: normal airway without chest compression | 21 (19–24) | 23 (21–27) | 21 (20–25) | 18 (15–21) | Not significant |
| Scenario B: normal airway with chest compression | 23 (20–25) | 27 (24–29) | 22 (19–25) | 21 (18–24) | .011 |
| Scenario C: difficult airway with chest compression | 23 (21–25) | 28 (23–33) | 23 (21–26) | 23 (19–26) | .007 |

Data are reported as median (interquartile range). Air-Q = the air-Q Masked Laryngeal Airways Disposable, Cobra PLA = the Cobra Perilaryngeal Airway, LMA = the Laryngeal Mask Airway LMA classic, SAD = supraglottic airway device, SALT = the Supraglottic Airway Laryngopharyngeal Tube.

The success rate of SAD exchange using ETTI during scenario A ranged from 95% with the Cobra PLA to 100% with the Air-Q and SALT. In the scenario B, exchange success rate was 89% with the Cobra PLA compared to 99% with the Laryngeal Mask Airway and Air-Q. In scenario C, the success rate of SAD exchange was 87% with the Cobra PLA and 95% with the Air-Q. The success rate of SAD exchanges in the given scenarios is presented in Table 2.

Assessment of subjective ease of use using the 4 airway devices is presented in Table 3.

## 4. Discussion

Effective airway management is an essential, yet challenging procedure during CPR.[1,2] The optimal airway management for pediatric out-of-hospital CPR by paramedics is still an openly debated topic. The efficacy of first attempt tracheal intubation by paramedics with direct laryngoscopy in children ranges from 45% to 82%, similar to that of nonanesthesiologists and emergency medicine physicians at 50% to 75%.[6–8,13] Unsuccessful or prolonged intubation attempts may cause airway trauma, possibly leading to swelling and bleeding, desaturation, bradycardia, and even death. Minor swelling and bleeding is an important concern to monitor in pediatric airways, as it can cause severe problems in ventilating and oxygenating the pediatric patient.[14]

Several studies have reported that SAD use by personnel with minimal training in a number of clinical situations is both feasible and safe.[9–11,14] However, at high inspiratory pressures, SADs do not ensure airway sealing. Furthermore, SADs are not recommended in the practice of asynchronous resuscitation owing to the risk of regurgitation and aspiration of gastric contents. Under the pretense of an emergency resuscitation scenario, beginning airway management with the placement of a SAD before endotracheal intubation may be rational.[10,15]

In the pediatric-emergency CPR setting, SADs could help to achieve initial safe airway management, especially for less experienced paramedics. Once an SAD is in place and oxygenation of the patient is secured, the SAD could serve as a conduit for introducing an airway exchange catheter, such as the ETTI. The SAD could then be removed such that the ETTI may then be able to guide the endotracheal tube into the trachea. There are many airway introducers commercially available[16,17]; however, no literature is available to support their use in the pediatric CPR setting.

Our study demonstrated a success rate >90% by paramedics using all 4 SADs in the 3 tested airway scenarios, allotting support toward a clinical trial. Blinded intubation studies through SADs with an ETTI in either a simulated-controlled, or real-uncontrolled scenario, have not been conducted so far. There are only a few studies with a small sample size investigating the use of introducers through SADs to facilitate tracheal intubation for difficult airway management. Furthermore, these studies mainly investigated SAD exchange using the fibreoptic bronchoscope, not SAD exchange for an ETTI.[18–21]

In the normal airway without chest compressions scenario, participants were able to exchange all SADs with an ETTI in a median time of <24 seconds. The longest median time for an exchange of the Cobra PLA was 27 seconds (IQR, 24–29) and the fastest time with the SALT was 21 seconds (18–24). A similar correlation was found in the difficult airway with chest compression scenario. The slower replacement time with the SALT for an endotracheal tube may be because of the SALT's lack of a cuff, thus eliminating the time for cuff emptying. For comparison of the

**Table 2**

**Success rates of supraglottic airway device exchange according to each device in each scenario.**

| Scenario | LMA | Cobra PLA | Air-Q | SALT | P |
|---|---|---|---|---|---|
| Scenario A: normal airway without chest compression | 99% | 95% | 100% | 100% | Not significant |
| Scenario B: normal airway with chest compression | 99% | 89% | 99% | 98% | .008 |
| Scenario C: difficult airway with chest compression | 94% | 87% | 95% | 94% | Not significant |

Data are reported as number (%). Air-Q = the air-Q Masked Laryngeal Airways Disposable, Cobra PLA = the Cobra Perilaryngeal Airway, LMA = the Laryngeal Mask Airway LMA classic, SALT = the Supraglottic Airway Laryngopharyngeal Tube.

**Table 3**

**Subjective opinion of participants about difficulty of use of each device in each scenario.**

| Scenario | LMA | Cobra PLA | Air-Q | SALT | P |
|---|---|---|---|---|---|
| Scenario A: normal airway without chest compression | 3 ± 1 | 3 ± 1 | 3 ± 1 | 1 ± 1 | .011 |
| Scenario B: normal airway with chest compression | 3 ± 1 | 3 ± 2 | 3 ± 1 | 3 ± 1 | Not significant |
| Scenario C: difficult airway with chest compression | 3 ± 1 | 4 ± 2 | 3 ± 1 | 3 ± 2 | Not significant |

Data are reported as mean ± standard deviation. Air-Q = the air-Q Masked Laryngeal Airways Disposable, Cobra PLA = the Cobra Perilaryngeal Airway, LMA = the Laryngeal Mask Airway LMA classic, SALT = the Supraglottic Airway Laryngopharyngeal Tube.

simulated child CPR studies by Szarpak et al,[22] intubation efficacy using the Miller laryngoscope was 55% with a mean duration time to intubation of 37 seconds. Beleña et al evaluates replacing the laryngeal tube and the Ambu AuraOnce laryngeal mask for an endotracheal tube using the Frova introducer. As a result, all devices could be exchanged on the first attempt with an exchange time of the laryngeal tube (27 ± 1 seconds) and AuraOnce laryngeal mask (17 ± 1 seconds).[23] The time to replace the AuraOnce laryngeal mask in by Beleña et al's study is shorter than the findings of our study. This may be attributed to intubating adults, rather than pediatric airways.

There are several limitations to be noted in our study. First, it was conducted in a simulation airway model. Although manikin studies can never fully replace clinical trials, performing such an assessment in real patients would be difficult based on ethical standards.[24] Paramedics in our study had no previous SAD exchange experience and thus can be speculated that the results may not be generalizable to other who hold more SAD exchange experience. There may also be a potential learning effect during the study and could slightly influence the results of the study. However, this study was not designed in such a way as to investigate any learning effect. The results of this study cannot be generalized, as there might be some type clinical scenarios where endotracheal intubation is not warranted and instead, patients should be ventilated by the supraglottic airway device. This study also has strengths. These include the fact that between the study was designed as a randomized crossover, as well as a multitude of scenarios research. Manual chest compression in many cases, as shown by the research is insufficient[25,26]; therefore, to minimize bias resulting from differences in managing the chest compression mechanical chest compression system was used.

## 5. Conclusions

In a pediatric manikin model simulation, inexperienced paramedics were able to successfully exchange 4 SAD devices (LMA, Cobra PLA, Air-Q, and SALT) by an endotracheal tube using an ETTI. The procedure was successful in both the manikin at rest with normal airway and in ongoing mechanical chest compressions for both easy and difficult airways. As a result, these laboratory findings encourage an evaluation in the clinical setting.

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