Which laryngeal mask for fiberoptic-aided wire-guided catheter exchange tracheal intubation? The Classic-LMATM or the Proseal-LMATM: a mannequin study

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Citation

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Abstract

Study Objective: To compare the ease of use, operator preference, time to completion, and failure rates while performing a fiberoptic-aided wire-guided airway exchange tracheal intubation through the the LMA-Classic ™ and LMA-Proseal ™.Design: Prospective, randomized trialSetting: SimulationInterventions: Twenty-five participants of various experience grades performed four intubations each, one hundred intubations total, on an AirSim™ airway trainer through a #3 laryngeal mask using a fiberoptic endoscope and an Arndt Airway Exchange Catheter Set.Measurements: Laryngeal view after LMA insertion was graded by one of the investigators. The time to intubation and any intubation failures were recorded. Participants were asked to rate the ease of performing the intubation through each LMA and which device they preferred.Main Results: Intubation was reported to be easier through the cLMA than the pLMA. Consequently, participants preferred the cLMA for use as an airway conduit. However, the time to completion and failure rates were essentially the same in all groups. First attempt intubation success rate was 92% overall.Conclusion: Fiberoptic-aided wire-guided catheter exchange intubation can be performed successfully through either the cLMA or the pLMA. Personal experience with each device should dictate which device is chosen initially.

GRANTS, SPONSORS, AND FUNDING SOURCES

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INTRODUCTION

Use of a laryngeal mask (LMA) as a conduit for fiberoptic-aided tracheal intubation when unanticipated airway difficulty is encountered has been previously reported. One such technique, which utilizes a pre-packaged, commercially available, wire-guided airway exchange catheter set (Arndt Airway Exchange Catheter Set, Cook Critical Care, Bloomington, Indiana) and an LMA Classic ™ (cLMA, LMA North America, Inc., San Diego, California) as the airway conduit has been reported in the setting of the adult critical airway (1). The cLMA was so chosen by the authors based upon reports of superior visualization of the laryngeal aperture compared to other laryngeal mask devices (2-3). However, the relatively low-pressure pharyngeal seal of the cLMA (median pressure 16-22 cmH_2O) (4) may limit its utility under commonly encountered situations in the intensive care unit (ICU). In contrast, the LMA-proseal™ (pLMA, LMA North America, Inc., San Diego, California) creates a pharyngeal seal that is on average 50% higher than the cLMA (4) and the presence of a built-in esophageal drain tube allows confirmation of the functional separation of the respiratory and alimentary tracts. This may be an advantage in the ICU in the presence of both a difficult airway and when high inflation pressures are needed for effective ventilation (5). Nonetheless, compared to the cLMA, the termination of the airway tube of the pLMA is further back and slightly off-center from the glottic opening, possibly making it more difficult to intubate the trachea with a fiberoptic endoscope (FOS).

Therefore, the primary aim of our study was to compare ease of use, operator preference, time to completion, and failure rates while performing a fiberoptic-aided wire-guided airway exchange tracheal intubation through the cLMA and the pLMA.

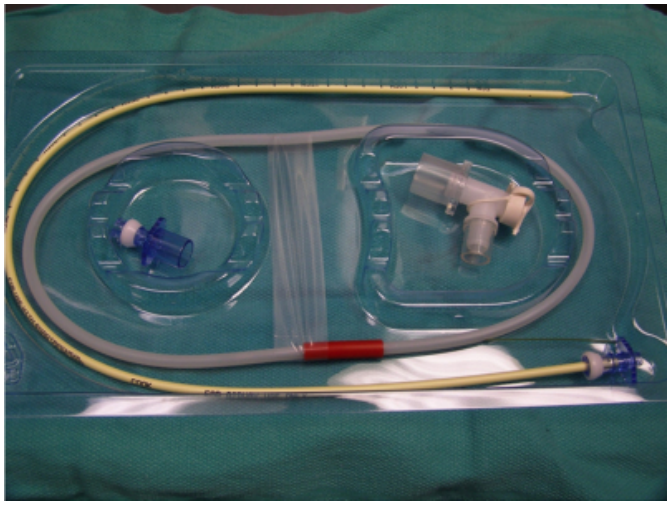
MATERIALS AND METHODS

The University of Wisconsin Health Sciences Minimal Risk Institutional Review Board approved the study. Written informed consent was obtained from all participants. Twenty-five physicians were invited and agreed to participate in the study (5 senior staff, 5 fellows, 5 third-year anesthesia trainees, 5 second-year anesthesia trainees, and 5 first-year anesthesia trainees). The 5 anesthesia staff were chosen for their considerable experience in this technique and served as the reference standard for intergroup comparisons. The least experienced anesthesia trainee had performed > 25 fiberoptic intubations in the operating room prior to participation. Each participant performed 4 intubations, 2 with each LMA.

All intubations were performed on an Airsim™ airway management trainer (Trucorp, Belfast, Ireland) through a #3 cLMA or #3 pLMA using A FOS (Pentax fiberscope FB-15V, 4.9mm outer diameter (OD), Pentax Medical Company, Montvale, NJ.) and an Arndt Airway Exchange Catheter Set (Cook Critical Care, Bloomington, Indiana) (figure 1).

Figure 1

Figure 1. The wire-guided airway exchange catheter set (Cook Critical Care, Bloomington, Indiana) contains a15mm bronchoscope adapter, an airway adaptor, a 160 cm, unmarked, polytetraflouroethylene-coated, 0.038 inch diameter Amplatz guide wire with soft distal tip to minimize tracheal mucosal trauma, and a 70 cm, 4.7mm OD airway exchange catheter with guide markings every centimeter that has a through-lumen design with distal side ports to allow continued ventilation during airway exchange procedures.



After preliminary use of the mannequin by the investigators to pilot the study protocol, the #3 LMA, rather than a #4 LMA was chosen as it was felt to increase the chances of a high-grade laryngeal view after LMA insertion by the participant. Repeated flipping of a coin randomized the order in which each LMA was used. Both the mannequin, the airway tubes of the LMA and the components of the airway exchange catheter set were pretreated with surgical grade silicone spray. Prior to LMA insertion, the posterior LMA cuff was treated with lubricant jelly as recommended by the manufacturer. All participants were similarly briefed regarding the procedure and performed the procedure without any assistance. After placement of the LMA, a 15mm bronchoscope adapter was connected to the LMA. With the FOS at the airway tube orifice, the position of the LMA was graded by one of the authors (AMJ, ECL) as viewed through the eyepiece of the FOS: 1=full view of the vocal cords, 2=partial view of the cords including arytenoids, 3=epiglottis only, or 4=other (LMA, cuff, pharynx, other). Timing was started when the FOS was handed to the participant. The operator passed the FOS via the LMA through the vocal cords and into the trachea. A 160 cm, unmarked, polytetraflouroethylene (PTFE) coated, 0.038 inch (0.96 mm) diameter Amplatz guide wire was then passed through the injection port of the FOS and advanced through the working channel until it could be visualized within the trachea beyond the tip of the scope. The scope was gradually removed with the guide wire under direct visualization using the FOS to assure that the wire remained in position. After the FOS was removed, a 70 cm, 14Fr (4.7mm OD) airway exchange catheter with guide markings every centimeter, was passed over the guide wire through the adapter into the trachea. The airway exchange catheter has a through-lumen design with distal side ports that allows continued ventilation during airway exchange procedures when an airway adapter is attached to the proximal end. The LMA was deflated and removed keeping both the guide wire and airway exchange catheter in the same relative position. A tracheal tube was then passed over the wire and exchange catheter; the airway exchange catheter and the guide wire were then removed, leaving the tracheal tube in place. Timing was stopped after two breaths were given. LMA reinsertion was not allowed once the FOS had been placed in the LMA. Operators were allowed to reposition the LMA over the FOS to improve their view of the vocal cords so long as the FOS stayed inside the airway tube of the LMA. Inability to manipulate the FOS or any other component of the exchange kit through the LMA was considered a failure of the technique. After each intubation attempt, the

participant was asked to rate separately the interaction of the FOS and the LMA and the components of the catheter exchange set and the LMA: 1=easy, no resistance 2=slightly difficult, minor resistance 3=moderately difficult, moderate resistance 4=severe difficulty, severe resistance. Additionally, participants were asked to identify which LMA they preferred. No specific questions were asked other than those already recorded for the ease of intubation, only the overall subjective impression of the participant based on the entirety of their experience for each LMA.

For each experience grade, intubation times between each LMA were compared with Mann-Whitney U. The time from insertion of the FOS to tracheal intubation, between operators and LMA, was compared by one-way analysis of variance (ANOVA) with Bartlett's test for equal variances and Dunnet's multiple comparison test using staff and cLMA as the control. Participant's ratings of the ease of the procedure were compared with Mann-Whitney U and device preferences were compared by chi-squares testing. Unless otherwise noted, data is presented as median (IQR [range]). Statistical significance is defined by a two-sided p-value < 0.05. Statistical analysis was performed using Prism 5.0a (GraphPad Software, Inc., La Jolla, California, USA).

RESULTS

Overall, the median rating for passing a FOS into the trachea was 1 (1-2 [1-3]) through the cLMA and 2 (1-2 [1-4]) through the pLMA (p=0.008). The median rating for passage of the airway exchange catheter through the LMA and removal of the LMA over the airway exchange catheter was 1 (1-1 [1-3]) for the cLMA and 1 (1-2 [1-2]) for the pLMA (p=0.009). Of the 25 participants, 22 (88%) preferred the cLMA over the pLMA (p<0.0001). Operator experience had no effect on ratings of the ease of the procedure through either LMA.

The time to complete the wire-guided catheter exchange intubation is shown in table 1.

Figure 2

Table 1. The time taken to place the tube in the trachea (placement of the FOS in the trachea, passage of the wire through the working channel of the FOS, removal of the FOS over the wire, passage of the airway exchange catheter over the wire, removal of the LMA, passage of the tube into the trachea, and two breaths) for the LMA and LMA. The times are in seconds, median [IQR].

Level of Training	*c*LMA	*p*LMA	p-value*
1st year	165 [165-210]	177 [158-196]	0.469
2nd year	142 [129-167]	185 [133-2240	0.215
3rd year	138 [127-148]	130 [104-173]	0.594
Fellow	177 [157-209]	199 [177-207]	0.688
Staff	130 [109-143] §	182 [142-202]	0.007

*p-value for the effect of LMA within each experience level, §Staff was faster compared to 1st year trainees and fellows by one-way ANOVA (p=0.0007).

Staff intubated faster through the cLMA than the pLMA. In addition, staff intubated faster through the cLMA than first-year anesthesia trainees and fellows. There were no differences among experience grades when intubation was performed through the pLMA (one-way ANOVA, p=0.3). The view of the vocal cords was significantly better through the cLMA compared to the pLMA (grade 2 (1-2 [1-4]), grade 3 (3-4 [1-4]); p<0.001). No correlation was found among views of the vocal cords and the participant's ratings of ease of intubation.

There were 8 failures, 4 with each LMA. No anesthesia staff encountered intubation failure. Two failures were encountered in each of the other experience grades, but no single participant experienced more than 1 failure of their 4 attempts. In 4 cases, the esophagus was intubated. In another 4 cases, the tracheal tube could not be passed after the LMA was removed because of inadvertent dislodgement of the airway exchange catheter and wire from the trachea (2 cases) or airway exchange catheter only resulting in kinking of the wire in the posterior pharynx (2 cases).

DISCUSSION

The main findings of our study are that performing fiberoptic-aided tracheal intubation using the Arndt Airway Exchange Catheter Set was subjectively easier through a cLMA than through a pLMA independent of operator experience. The majority of our participants stated a preference for the cLMA over the pLMA. Our objective data, however, support the use of either device. Overall, first attempt success rate was 92% and even the least experienced operators were successful on the first attempt >75% of the time. Further, the number of intubation failures was the same

with each device. This compares favorably with the 95% first attempt success rate reported by Blair and colleagues for fiberoptic Aintree Intubation Catheter-assisted intubations through a pLMA (6). Because of the slightly winding course that the airway exchange catheter must traverse through the pLMA to gain access to the trachea compared with that through the cLMA, we hypothesized that the operator would encounter greater resistance in removing the pLMA over the exchange catheter. We further hypothesized that an increase in resistance to removal of the pLMA would result in the wire, airway exchange catheter, or both, being pulled from the trachea and lead to more intubation failures. While a greater resistance was encountered in removing the pLMA over the airway exchange catheter compared with the cLMA, an increase in intubation failure was not found. When intubating through a LMA, passage of the FOS into the trachea is not the only important factor that determines the ultimate success of tracheal intubation. Difficulty with any step prior to pilot balloon inflation and confirmation of adequate ventilation of the lungs would limit the utility of a particular technique. Thus, we believe subjective data regarding the ease of removal of the airway exchange catheter from the LMA to be an important addition to the data provided by Blair and colleagues (6) and further supports the safety of the pLMA for this task.

The only effect of operator experience was between our reference standard, the experienced anesthesia staff, and first-year anesthesia trainees and fellows when intubating through the cLMA, but not the pLMA. The effect of operator experience on intubating the trachea with a FOS and railroading a tracheal tube through the cLMA has been previously reported using a mannequin model similar to ours (2). The time to confirmed tracheal tube placement in that study (median 77 seconds, IQR 66-98) was much shorter than those we have reported. However, any clinically relevant differences may be explained by differences between the respective study protocols. In the study by Hadzovic et al., participants placed the FOS into the trachea through the LMA, then railroaded a tracheal tube over the FOS and into the trachea. The FOS was withdrawn and 2 breaths were delivered to confirm tube placement. Removal of the LMA over the tube was not part of the study procedure. Our protocol included timing until only the tracheal tube was left in the mannequin. Furthermore, participants performed the intubation without the aid of an assistant. Having an assistant to aid in airway management likely would have reduced recorded intubation times and more closely reflects actual clinical practice. We also noted that our 3rd year trainees passed the tube through the pLMA as quickly as our experienced staff did through the cLMA. We believe that our 3rd year trainees were simply more recently acquainted and experienced with the pLMA for this task. That is to say that trainees make it a priority to gain exposure and expertise with as many airway tools and techniques as possible. Our experienced staff had likely all but eliminated the pLMA from their armamentarium for the technique we describe, thus being less practiced. Therefore, we believe our findings are accurate and reproducible.

Use of a LMA as a conduit for a fiberoptic-aided tracheal tube placement by a modified Seldinger technique is not new. Clinical reports have described a similar technique to ours. Rajan described the use of a 5Fr 60 cm tracheal tube introducer modified by perforating the distal tip with a 16-guage needle and cutting away the proximal 1 cm and a 140 cm 0.35 mm diameter guide wire used in a manner similar to what we described (7). Warrilow reported using a Corpak Nasointestinal feeding tube and guide wire (VIASYS Healthcare Medsystems Division, Wheeling, Il.) in place of an airway exchange catheter and guide wire (8). As with the technique reported by Rajan, modification of the equipment by cutting off the terminating connector and side port so that the tracheal tube could fit over it was required. Additionally, the tracheal tube was finally placed using direct laryngoscopy with Magill's forceps to guide the feeding tube/tracheal tube apparatus over the wire. Neither technique utilized equipment specifically designed for the task. Most distinguishable from our procedure, the techniques of Rajan and Warilow require equipment not readily available in an emergency situation. Most recently, the pre-packaged, wire-guided airway exchange kit we describe has been used successfully in a series of critically ill adults who could not be intubated by direct laryngoscopy (1).

We acknowledge that studies performed on airway mannequins gives limited insight into actual clinical practice. However, the mannequin used in our study is reported to be a high fidelity model for LMA insertion (9) and has accurate airway anatomy. In addition, we studied the two LMA devices most commonly used for airway rescue, the cLMA and pLMA, in order to add clinical relevance to our results. The observation that laryngeal views varied among insertions and LMAs with overall lower quality views through the pLMA is in contradistinction to a previous

mannequin study (6). The laryngeal masks and airway anatomy of the mannequin are constant, so why should the view change? One possible explanation is that insertion technique, which was not standardized our study protocol, varied slightly among operators. This had little impact on the views obtained through the cLMA, through which some part of the vocal cords could be seen in 46 of 50 (92%) insertions and is consistent with reported rates (10). In the case of the pLMA, no part of the vocal cords could be visualized in 25 of 50 (50%) insertions and is in stark contrast to previous reports (4, 6, 10). We speculate that the volumes of air used to inflate the cuff and not insertion technique is responsible. Recently, inflating the cuff of a pLMA with volumes recommended by the manufacturer has been reported to result in cuff pressure exceeding 60 cmH_2O and consequent overinflation of the edges causing them to invaginate toward the midline, obscuring the vocal cords (11). Additionally, while we asked the participants which LMA they preferred, we did not ask them to clarify further the reason or reasons why. Thus, we cannot completely discount a negative effect of worse laryngeal views upon participant's ratings of ease of use for each LMA despite a lack of statistical association between the two.

In summary, operators with varying degrees of experience are able to perform tracheal intubation by wire-guided catheter exchange with little difficulty through both the cLMA and the pLMA. Although intubation was easier through the cLMA than the pLMA, the difference was small; for the most part only the difference between easy and slightly difficult. In addition, this difference was entirely a subjective one. Our objective data, the time to intubation and failure rates, were essentially the same in every group supporting the use of either device. Thus, in actual clinical practice under the circumstances in which this procedure would be necessary, namely in the setting of emergency airway management, operators may consider insertion of the pLMA as a first choice based upon its superior ability as a ventilation device. Ultimately, airway managers should choose whichever device they are most practiced with the understanding that intubation through either device may be performed successfully.

References

1. Joffe AM, Arndt G, Willmann K. Intubation by wire guided catheter exchange after failed direct laryngoscopy in critically ill adults. J Clin Anesth (in press).
2. Hodzovic I, Petterson J, Wilkes AR, Latto IP. Fiberoptic intubation using three airway conduits in a mannequin: the effect of operator experience. Anesthesia; 2007; 62: 591-97.
3. McNeillis NJD, Timberlake C, Avidan MS, Sarang K, Choyce A, Radcliffe JJ. Fiberoptic view through the laryngeal mask and the intubating laryngeal mask. Eur J Anesthesiol; 2001; 18: 471-75.
4. Cook TM, Lee G, Nolan JP. The ProSeal laryngeal mask airway: a review of the literature. Can J Anaesth; 2005; 52: 739-60.
5. Thomas M, Cook TM. Which is the logical supraglottic airway device for use on ICU? Anesthesia; 2007; 62: 1075-6.
6. Blair EJ, Mihai R, Cook TM. Tracheal intubation via the ClassicTM and ProsealTM laryngeal mask airways: a mannequin study using the Aintree Intubating Catheter. Anesthesia; 2007; 62: 385-387.
7. Rajan GR. Fiberoptic wire-guided transoral and through the LMA intubation technique using modified gum elastic bougie. Anesth Analg; 2005; 100: 599-600.
8. Warilow S. Difficult intubation managed using standard laryngeal mask airway, flexible fiberoptic bronchoscope and wire guided enteral feeding tube. Anaesth Intensive Care; 2005; 33: 659-661.
9. Silsby J, Jordan G, Bayley G, Cook TM. Evaluation of four airway training mannequins as simulators for inserting the LMA Classic TM. Anesthesia; 2006; 61: 576-79.
10. Lopez-Gil M, Brimacombe J, Garcia G. A randomized non-crossover study comparing the ProSeal and Classic laryngeal mask airway in anaesthetized children. Br J Anaesth; 2005; 95: 827-30.
11. Chiew EC, Alsaleem S, Joffe AM. The view of the vocal cords may be obscured by overinflation of the Proseal-LMATM. Anesthesia; 2009;64:578-9.

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