

Comparison of the air-Q intubating laryngeal airway and the cobra perilaryngeal airway as conduits for fiber optic-guided intubation in pediatric patients

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ABSTRACT

Background: One of the methods proposed in cases of difficult airway management in children is using a supraglottic airway device as a conduit for tracheal intubation. The aim of this study was to compare the efficacy of the Air-Q Intubating Laryngeal Airway (Air-Q) and the Cobra Perilaryngeal Airway (CobraPLA) to function as a conduit for fiber optic-guided tracheal intubation in pediatric patients. **Materials and Methods:** A total of 60 children with ages ranging from 1 to 6 years, undergoing elective surgery, were randomized to have their airway managed with either an Air-Q or CobraPLA. Outcomes recorded were the success rate, time and number of attempts required for fiber optic-guided intubation and the time required for device removal after intubation. We also recorded airway leak pressure (ALP), fiber optic grade of glottic view and occurrence of complications. **Results:** Both devices were successfully inserted in all patients. The intubation success rate was comparable with the Air-Q and the CobraPLA (96.7% vs. 90%), as was the first attempt success rate (90% vs. 80%). The intubation time was significantly longer with the CobraPLA (29.5 ± 10.9 s vs. 23.2 ± 9.8 s; $P < 0.05$), but the device removal time was comparable in the two groups. The CobraPLA showed a significantly higher ALP (20.8 ± 5.2 cmH₂O vs. 16.3 ± 4.5 cmH₂O; $P < 0.001$), but the fiber optic grade of glottic view was comparable with the two devices. The CobraPLA was associated with a significantly higher incidence of blood staining of the device on removal and post-operative sore throat. **Conclusion:** Both the Air-Q and CobraPLA can be used effectively as a conduit for fiber optic-guided tracheal intubation in children. However, the Air-Q proved to be superior due to a shorter intubation time and less airway morbidity compared with the CobraPLA.

Key words: Air-Q intubating laryngeal airway, cobra perilaryngeal airway, fiber optic-guided intubation, pediatric airway management, supraglottic airway devices

INTRODUCTION

Using a supraglottic airway device (SAD) as a conduit for tracheal intubation has been described as a method of securing the airway when difficult intubation is encountered in pediatric patients.^[1] The intubating laryngeal mask

airway (iLMA) which was designed for this purpose, is not available in pediatric sizes. There have been previous reports of the successful use of the conventional LMA as a conduit for tracheal intubation.^[2-5] However, certain modifications may need to be done to the LMA or the tracheal tube to allow for the successful insertion of the tracheal tube and removal of the LMA after intubation.^[6-9] Making these modifications in the setting of an unpredicted difficult airway may not be practical.

The Air-Q™ Intubating Laryngeal Airway (Air-Q) (Cookgas, St. Louis, MO, USA) is a SAD that was designed primarily to act as a conduit for the passage of a cuffed tracheal tube during tracheal intubation [Figure 1]. Compared with the LMA, the Air-Q has a shorter airway

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tube. This allows for easy removal of the device after the tracheal tube is inserted.^[10] The airway tube is also wider, curved and more rigid. There is a space above the ventilating orifice for the epiglottis to rest on, which leads to improved epiglottic isolation [Figure 2]. All of these features facilitate the passage of the tracheal tube through the device and into the trachea. Previous studies have shown that the Air-Q functions well as a conduit for fiber optic intubation in children.^[10-12]

The Cobra Perilaryngeal Airway (CobraPLA) (Engineered Medical Systems, Indianapolis, IN, USA) is another SAD that has design features that make it suitable for fiber optic-guided tracheal intubation [Figure 1]. Similar to the Air-Q, it has a wider and shorter airway tube compared to the LMA. It is also more stable than the LMA because of the flat “Cobra head” which lies on the posterior pharynx and prevents the device from rotating [Figure 2].^[13] A previous study has also shown that the glottic views through the CobraPLA are superior to those in the LMA, which also implies easier intubation through the device.^[13] Studies performed on the function of the CobraPLA as a conduit for fiber optic intubation in adults have shown high success rates.^[14,15] Until date, there has only been one report of the successful use of the CobraPLA for this purpose in pediatric patients.^[16]

The aim of this study was to compare the Air-Q and CobraPLA as regards to their clinical performance as a conduit for fiber optic intubation in the pediatric age group.

MATERIALS AND METHODS

This prospective randomized trial was performed at the Cairo University Children’s Hospital in the period between January 2013 and May 2013. The study was approved by the research ethics committee and written

informed consent was obtained from the parents of all patients. We enrolled 60 children, American Society of Anesthesiologists (ASA) physical status I or II, aged between 1 and 6 years, undergoing elective surgery under general anesthesia requiring tracheal intubation. Patients with documented or suspected difficult airway, neck or upper respiratory tract abnormalities, facial deformities, history of cardiopulmonary disease and risk of aspiration or any other contraindications to placement of SADs were excluded from the study.

Prior to induction of anesthesia the patients were randomly assigned by sealed envelope to one of two groups, Group Air-Q (*n* = 30) and Group CobraPLA (*n* = 30). In both groups, the trachea was intubated through the assigned SAD under fiber optic guidance. All the anesthesiologists performing the tracheal intubations were experienced in pediatric airway management and had previous experience in the use of both the Air-Q and CobraPLA as conduits for fiber optic-intubation.

All patients were fasted according to standard protocol and premedicated with oral midazolam 0.5 mg/kg 30 min before the procedure. In the operating room, standard anesthesia monitors were attached before induction. Anesthesia was induced with 8% sevoflurane in 100% oxygen, followed by insertion of IV cannula and administration of fentanyl 1 µg/kg intravenously. Neuromuscular blockade was achieved using atracurium 0.5 mg/kg intravenously to facilitate endotracheal intubation. The anesthesiologist waited for at least 3 min after atracurium administration to ensure adequate laryngeal relaxation.

In Group Air-Q, an appropriate sized Air-Q was picked according to the manufacturer’s recommendations (Air-Q size 1.5 [weight 7-17 kg] and size 2.0 [weight 17-30 kg]). Similarly in Group CobraPLA, the manufacturer’s recommendations were used to pick the

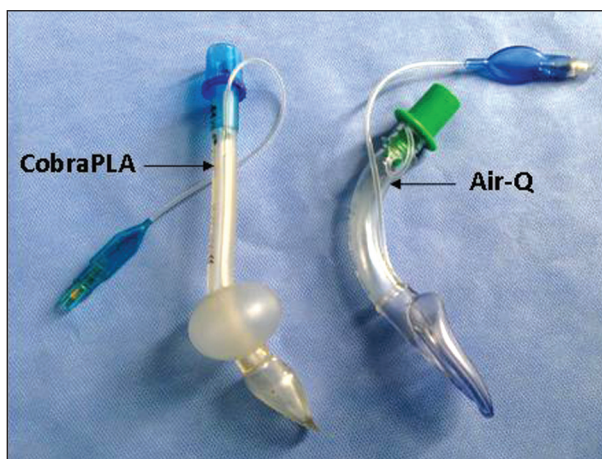


Figure 1: Air-Q and Cobra Perilaryngeal Airway. Lateral view

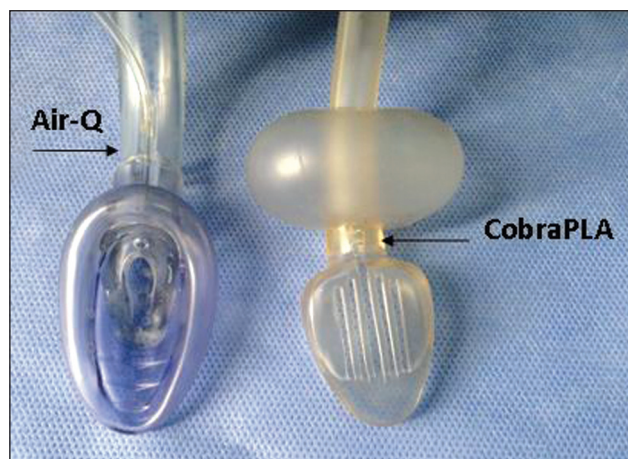


Figure 2: Air-Q and Cobra Perilaryngeal Airway. Ventilating orifice

appropriate sized CobraPLA (CobraPLA size 1.5 [weight 10-15 kg] and size 2.0 [weight 15-35 kg]). All devices were lubricated with a water-based agent before placement and the cuffs were deflated before insertion. Both devices were introduced along the hard palate and slid down in the center of the mouth until a distinct resistance was felt. The cuffs of both devices were inflated until a standardized intra-cuff pressure of 60 cmH₂O was reached using a cuff pressure gauge (VBM Medizintechnik, Sulz, Germany).

After cuff inflation the device was connected to the anesthesia circuit and successful insertion was confirmed by visible bilateral chest expansion with a square-shaped capnography tracing accompanied by an expired tidal volume of ≥ 5 ml/kg. The number of attempts and the time required for successful device insertion were recorded in both groups. Insertion time was defined as the time taken from picking up the device till a square-shaped capnography tracing was obtained. If two insertion attempts failed the device insertion was considered unsuccessful and conventional endotracheal intubation using direct laryngoscopy was performed.

Once successful insertion was confirmed, the airway leak pressure (ALP) was measured using a method validated in pediatric patients.^[17] The head was kept in a neutral position. The expiratory valve was closed at a fixed gas flow of 3 l/min. The ALP was determined when an audible noise was heard over the patient's mouth. Peak airway pressure was limited to 40 cmH₂O to avoid barotrauma.

The airway connector was then removed from the SAD and a size 2.8 mm pediatric fiber optic bronchoscope (FOB) (Karl Storz, Tuttlingen, Germany) with a preloaded appropriate sized uncuffed tracheal tube was inserted through the airway tube. When the FOB tip was just proximal to the ventilating orifice of the device, the fiber optic grading of the glottic view was recorded according to the scoring system proposed by Brimacombe and Berry:^[18] Grade 1, vocal cords not seen; Grade 2, vocal cords and anterior (down folded, lingual surface) epiglottis seen; Grade 3, vocal cords and posterior (laryngeal surface) epiglottis seen; Grade 4, only vocal cords seen. Grades 3 and 4 were considered optimal for fiber optic-guided intubation. Grades 1 and 2 were considered suboptimal and maneuvers were allowed in an attempt to optimize the glottic view and facilitate the passage of the FOB beyond the epiglottis. The following maneuvers were allowed: Gentle withdrawal or advancement of the device, flexion or extension of the neck and jaw thrust.

Once the FOB passed the vocal cords and the carina was visualized, the tracheal tube was passed over the FOB through the SAD and into the trachea. The FOB

was removed and the breathing circuit was reconnected. Successful tracheal intubation was confirmed with visible bilateral chest expansion with a square-shaped capnography tracing. The number of attempts and time required for tracheal intubation were recorded. The time for intubation was recorded from the time the FOB entered the SAD until a capnography tracing was detected. If no capnography tracing was detected at the first attempt, the tracheal tube was removed. The patient was ventilated through the SAD for 30 s then a second intubation attempt was performed. The time of the second intubation attempt was recorded in the same way. If two attempts were needed, the intubation time was the sum of both attempts without the gap time in between.^[19]

The cuff of SAD was then deflated and the device was removed using a second tracheal tube as a stabilizing rod to keep the inserted tracheal tube in place.^[20] The breathing circuit was reattached and ventilation was resumed. The tracheal tube was secured in place after confirmation of bilateral equal air entry by chest auscultation and a square-shaped capnography tracing. The time required for device removal was recorded from the time the breathing circuit was disconnected from the tracheal tube till the time it was reconnected again after the device was removed. Any dislodgement of the tracheal tube during the removal of the SAD was recorded.

If two intubation attempts failed or the tracheal tube was dislodged during device removal, intubation was considered unsuccessful and conventional endotracheal intubation using direct laryngoscopy was performed. Complications including laryngospasm, bronchospasm, post-extubation stridor, desaturation (SpO₂ <85%), or blood staining of the SAD on removal were recorded in all patients. All patients were followed-up for 12 h after the end of surgery for any evidence of airway morbidity in the form of sore throat, dysphagia, or dysphonia reported by the child or his parents.

The primary outcome measures were the success rate and time required for fiber optic-guided intubation through the SAD. Secondary outcome measures included the number of intubation attempts needed, time required for device removal after intubation, as well as the success rate and time required for device insertion. Airway leak pressure, fiber optic grade of glottic view and the incidence of complications were also recorded.

Statistical analysis

We planned to enroll 30 patients per study group to achieve power of 80% to detect a 20% or more difference in the intubation time, assuming an average intubation time of 24.8 s in the Air-Q group (reported from a previous study).^[10]

Obtained data are presented as mean ± standard deviation, numbers and percentages as appropriate. Between-group comparisons for numerical data were analyzed with the Student's *t*-test. Between-group comparisons for categorical data were analyzed using a Fisher's exact test for data with two categories and a Chi-square test for data with more than two categories. Statistical analysis was performed using the computer programs Microsoft® Office Excel 2010 (Microsoft Corporation, NY, USA) and SPSS 16.0 (SPSS Inc., Chicago, IL, USA). *P* < 0.05 was considered to be statistically significant.

RESULTS

We included 60 children in this randomized study with 30 children in each of the two groups. There were no differences between the two groups as regards to the age, weight, sex distribution, or ASA physical status [Table 1].

The devices were successfully inserted in all 30 patients in the two groups [Table 2]. The two devices were comparable as regards to the number of insertion attempts needed (single insertion attempt was required in 29 patients in Group Air-Q vs. 28 patients in Group CobraPLA) and as regards to the insertion time (12.3 ± 5.3 s in Group Air-Q vs. 13.4 ± 6.3 s in Group CobraPLA, *P* = 0.48). The mean ALP was significantly higher in Group CobraPLA (20.8 ± 5.2 cmH₂O vs. 16.3 ± 4.5 cmH₂O; *P* < 0.001) in comparison to Group Air-Q.

There was no statistically significant difference between the two groups as regards to the fiber optic grading of the glottic view [Figure 3]. A Grade 3 or 4 view (optimal for fiber optic-guided intubation) was recorded in 22 (73.3%) patients in Group Air-Q and in 21 (70%) patients in Group CobraPLA. A Grade 1 or 2 views (suboptimal for fiber optic-guided intubation) was recorded in 8 (26.7%) patients

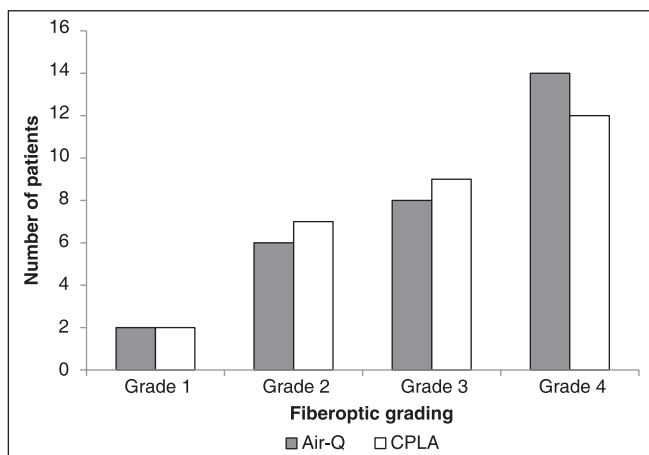


Figure 3: Fiber optic grading of glottic view. CobraPLA: Cobra perilaryngeal airway

in Group Air-Q and in 9 (30%) patients in Group CobraPLA. The patients with a suboptimal view required maneuvers to optimize the glottic view before intubation was attempted. These maneuvers resulted in a clear glottic view in all patients.

In Group Air-Q, fiber optic-guided intubation was successful in 29 (96.7%) patients, with 27 (90%) of these patients successfully intubated on the first attempt. While in Group CobraPLA, intubation was successful in 27 (90%) patients, with 24 (80%) of these patients successfully intubated on the first attempt [Table 3]. All

Table 1: Demographic data

Variable	Air-Q (n = 30)	Cobra PLA (n = 30)	P value
Age (years)	3.9±1.5	4.1±1.6	0.62
Weight (kg)	16.5±3.1	17.1±3.2	0.44
Height (cm)	91.8±11.2	93.2±11.1	0.64
Gender (male/female)	19/11	21/9	0.78
ASA status (I, II)	26/4	28/2	0.67

Values are mean ± SD or number of patients. SD: Standard deviation; ASA: American society of anesthesiologists

Table 2: Device insertion data and ALP

Variable	Air-Q (n = 30) (%)	CobraPLA (n = 30) (%)	P value
Successful insertion (n)	30 (100)	30 (100)	1.00
No. of insertion attempts (n)			
1	29 (96.7)	28 (93.3)	1.00
2	1 (3.3)	2 (6.7)	
Insertion time (s)	12.3±5.3	13.4±6.3	0.48
ALP (cmH ₂ O)	16.3±4.5	20.8±5.2	<0.001*

Values are mean ± SD or number (%) of patients, **P* < 0.05 designates a statistically significant difference. SD: Standard deviation; ALP: Airway leak pressure; CobraPLA: Cobra perilaryngeal airway

Table 3: Intubation data

Variable	Air-Q (n = 30) (%)	CobraPLA (n = 30) (%)	P value
Successful intubation (n)	29 (96.7)	27 (90)	0.61
No. of intubation attempts (n)			
1	27 (90)	24 (80)	0.66
2	2 (6.7)	3 (10)	
Intubation time (s)	23.2±9.8	29.5±10.9	0.03*
Device removal time (s)	10.1±2.1	10.6±2.2	0.37
Intraoperative complications			
Laryngospasm	1 (3.3)	2 (6.7)	1.00
Bronchospasm	0	0	1.00
Oxygen desaturation (SpO ₂ <85%)	0	1 (3.3)	0.31
Post-extubation stridor	0	2 (6.7)	0.49
Blood on device	2 (6.7)	9 (30)	0.04*
Post-operative complications			
Sore throat	1 (3.3)	8 (26.7)	0.03*
Dysphagia	0	0	1.00
Dysphonia	0	2 (6.7)	0.49

Values are mean ± SD or number (%) of patients, **P* < 0.05 designates a statistical significant difference. CobraPLA: Cobra perilaryngeal airway; SD: Standard deviation

these differences were statistically insignificant. However, the time required for intubation was significantly longer in Group CobraPLA (29.5 ± 10.9 s vs. 23.2 ± 9.8 s; $P < 0.05$) compared to Group Air-Q. All the devices were successfully removed in the two groups with no tracheal tube dislodgement. The device removal time was comparable in both groups.

Group CobraPLA showed a significantly higher incidence of blood staining of the device on removal with 9 (30%) patients compared with 2 (6.7%) patients in Group Air-Q ($P < 0.05$). Post-operative sore throat also occurred more commonly in Group CobraPLA (8 [26.7%] patients vs. 1 [3.3%] patients in Group Air-Q; $P < 0.05$).

DISCUSSION

Our results showed that both the Air-Q and the CobraPLA can be used as conduits for fiber optic intubation in pediatric patients. Both devices were easily inserted with a success rate of 100%. The fiber optic grading of the glottic view was comparable in the two groups, with both devices showing an optimal view for fiber optic intubation in the majority of patients. Both devices showed a high success rate for fiber optic intubation and the devices were removed easily without tracheal tube dislodgement. However, the Air-Q showed a significantly shorter intubation time and less airway morbidity compared with the CobraPLA.

We demonstrated a high success rate of 96.7% for fiber optic intubation through the Air-Q, with 90% of the patients intubated successfully on the first attempt. This is consistent with previous reports of the use of this device for the same purpose in pediatrics. Jagannathan *et al.*^[10] evaluated the use of the Air-Q as conduit for fiber optic intubation in 100 children aged 6 months to 8 years. They reported an overall success rate of 100%, with a first attempt success rate of 97%. Sinha *et al.*^[12] also performed a similar study including 20 infants and reported an overall success rate of 95%. However, Sinha *et al.* in their study have reported a first attempt success rate of only 65%. This may be due to the different anatomical structure of the larynx in infants. This explanation is supported by the fact that 30% of the infants studied had a Grade 1 glottic view with the vocal cords not visible. This may be due to the fact that infants have a large and floppy epiglottis preventing visualization of glottis. That is why we chose to exclude infants < 1 year of age from our study.

The only reference to the use of the CobraPLA as a conduit for tracheal intubation in children was a case report published by Szmuk *et al.*^[6] about the successful fiber optic intubation through the device in a child with

neck instability. However, two studies have been performed in adults with very promising results. Darlong *et al.*^[15] performed a comparison between the intubating LMA and the CobraPLA as an aid to blind endotracheal tube insertion in adult patients. They found the success with the CobraPLA to be 87% compared with 90% when using the intubating LMA. They concluded that the CobraPLA can be used as an effective conduit for blind endotracheal intubation with comparable efficacy to the intubation LMA. Lee *et al.*^[14] also evaluated the CobraPLA as an airway conduit in 49 adult patients. They reported a success rate of 83% for fiber optic-guided intubation through the device. The results of these two studies are in agreement with our results that showed a high success rate of 90% for fiber optic guided intubation through the CobraPLA in pediatric patients.

To the best of our knowledge, this is the first study that compares the Air-Q and CobraPLA as conduits for fiber optic intubation in the pediatric age group. Although the success rates of device insertion and fiber optic-guided intubation were comparable with the two devices, there are two reasons that made us conclude that the Air-Q was superior to the CobraPLA in this study. The first reason is that with the Air-Q the intubation time was significantly shorter than with the CobraPLA. In their study on adults, Darlong *et al.*^[15] similarly reported a longer intubation time with the use of the CobraPLA than with the use of the intubating LMA. This difference might be due to the longer time needed to maneuver the FOB and the tracheal tube through the grills at the ventilating orifice of the CobraPLA which sometimes leads to changing of the direction of the bronchoscope tip. The Air-Q on the other hand does not have a grill at its ventilating orifice which allows easier and quicker passage of the FOB and tracheal tube through it. The increased intubation time was not accompanied by increased incidence of oxygen desaturation in the CobraPLA group in our study. However, this may be of concern if this technique is used in infants whose low functional residual capacity causes them to desaturate more rapidly when apneic.

The second reason is that the CobraPLA was accompanied by a higher incidence of airway morbidity as evidenced by more frequent blood staining of the device on removal, as well as a significantly higher incidence of post-operative sore throat. The cuffs of all the SADs in the two groups were inflated to the same pressure level (60 cmH₂O). This cuff pressure has been shown to provide safe mucosal pressures.^[21] Therefore, it is safe to assume that the increased airway morbidity observed with the CobraPLA is not due to high cuff pressures. Previous studies comparing the CobraPLA with other SADs have similarly shown higher incidences of airway morbidity

with the use of the CobraPLA.^[22-24] The most likely reason for this finding is that the “Cobra head” of the CobraPLA is more stiff in comparison with the cuff of other SADs including the Air-Q. When this head is pushed against periglottic structures it may lead to more mucosal injury. This problem will definitely be exacerbated if the device is maneuvered to obtain a better anatomical fit or to allow better visualization of the glottic opening during fiber optic intubation.

Our results showed that the ALP of the CobraPLA was significantly higher than that of the Air-Q. The values we showed in our results are comparable to previous leak pressures reported with the CobraPLA^[13,25] and the Air-Q.^[10,26] It has been previously shown that a higher airway sealing pressure does not imply a better anatomic position of the SAD.^[27] Since the fiber optic glottic views obtained with both devices were comparable, it is clear that the higher ALP produced by the CobraPLA is not due to better anatomic fitness of the device. Our explanation for this significantly higher ALP is the design of the CobraPLA, which has a circumferential cuff located proximal to the “Cobra head” of the device. When inflated this cuff exerts pressure all the way around the pharynx at the base of the tongue. This leads to a better air seal thus increasing the leak pressure. This difference between the two devices clearly had no effect on their performance as conduits for fiber optic intubation. However, this difference presumably means that the CobraPLA would be a better option during controlled ventilation if high peak airway pressures are reached.

We chose to perform fiber optic-guided and not blind intubation through the SADs. Previous studies have shown that there is a higher incidence of epiglottic down folding in smaller children.^[10,28] Although this problem may significantly decrease the success rate if blind intubation was attempted, it can be easily overcome during fiber optic-guided intubation by passing the bronchoscope below the down folded epiglottis to obtain a clear glottic view. That is why attempting blind intubation through SADs in children has been cautioned against.^[29,30]

Our study has several limitations. First, all the children included had normal airways. Further work should be done to compare these two devices in patients with difficult airways. Second, we did not include infants below 1 year of age in our study. This age group has anatomical differences in the structure of their larynx and epiglottis that could significantly affect the results if a similar study was performed on infants. Third, because of the age group studied we used uncuffed tracheal tubes. The presence of the pilot balloon may interfere

significantly with both the insertion and removal of the SAD. This is an important issue since recent studies are suggesting the safe use of cuffed tubes even in very small children.^[31,32]

CONCLUSION

We have found that both the Air-Q and CobraPLA can be used successfully as a conduit for fiber optic-guided intubation in pediatric patients. Both devices were successfully and easily inserted, with a good anatomical fit to the glottic opening. Fiber optic-guided intubation was achieved with a high success rate with both devices. The two devices were removed easily and rapidly after tracheal intubation. However, the longer intubation time and higher incidence of airway morbidity with the CobraPLA suggest that the Air-Q is the better option.

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