Videolaryngoscopy *versus* Fiber-optic Intubation through a Supraglottic Airway in Children with a Difficult Airway

An Analysis from the Multicenter Pediatric Difficult Intubation Registry

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ABSTRACT

Background: The success rates and related complications of various techniques for intubation in children with difficult airways remain unknown. The primary aim of this study is to compare the success rates of fiber-optic intubation *via* supraglottic airway to videolaryngoscopy in children with difficult airways. Our secondary aim is to compare the complication rates of these techniques.

Methods: Observational data were collected from 14 sites after management of difficult pediatric airways. Patient age, intubation technique, success per attempt, use of continuous ventilation, and complications were recorded for each case. First-attempt success and complications were compared in subjects managed with fiber-optic intubation *via* supraglottic airway and videolaryngoscopy.

Results: Fiber-optic intubation *via* supraglottic airway and videolaryngoscopy had similar first-attempt success rates (67 of 114, 59% *vs*. 404 of 786, 51%; odds ratio 1.35; 95% CI, 0.91 to 2.00; $P = 0.16$). In subjects less than 1 yr old, fiber-optic intubation *via* supraglottic airway was more successful on the first attempt than videolaryngoscopy (19 of 35, 54% *vs*. 79 of 220, 36%; odds ratio, 2.12; 95% CI, 1.04 to 4.31; $P = 0.042$). Complication rates were similar in the two groups (20 *vs*. 13%; $P = 0.096$). The incidence of hypoxemia was lower when continuous ventilation through the supraglottic airway was used throughout the fiber-optic intubation attempt.

Conclusions: In this nonrandomized study, first-attempt success rates were similar for fiber-optic intubation *via* supraglottic airway and videolaryngoscopy. Fiber-optic intubation *via* supraglottic airway is associated with higher first-attempt success than videolaryngoscopy in infants with difficult airways. Continuous ventilation through the supraglottic airway during fiber-optic intubation attempts may lower the incidence of hypoxemia. **(ANESTHESIOLOGY 2017; 127:432-40)**

ANESTHETIC-RELATED adverse events in children are often preceded by severe hypoxemia.[1] Multiple tracheal intubation attempts, age, weight, and abnormal airway anatomy have been associated with severe complications such as cardiac arrest in children with difficult airways.[2–4] Intubation techniques with high first pass success rates may reduce these complications, but much of the literature related to tracheal intubation approaches in children with difficult airways is limited to manikin simulations and studies with small sample sizes or single-center data. Identifying techniques with high first pass success rates in a larger population of children with difficult airways is a critical step to improving outcomes for these vulnerable patients.

What We Already Know about This Topic

- Various intubation techniques and devices are currently available in the pediatric anesthesia population, but their clinical usefulness are not well assessed, particularly in children with difficult airways

What This Article Tells Us That Is New

- A clinical registry collecting information of 1,603 pediatric anesthesia cases with difficult tracheal intubation with conventional direct laryngoscopy revealed similar first-attempt success rates for fiber-optic intubation *via* supraglottic airway and videolaryngoscopy, whereas the former was more successful than the latter in infants

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The Pediatric Difficult Intubation (PeDI) Registry is a data repository of airway management techniques and outcomes in children with difficult airways, with entries from 14 academic children's hospitals in the United States.[3] It was created with the specific aim of categorizing complications and comparing various intubation approaches in children with difficult airways. Being the only repository of its kind makes it the ideal resource to study and compare outcomes of various tracheal intubation approaches in children with difficult airways.

Videolaryngoscopy produces better laryngoscopic views and greater intubation success than conventional direct laryngoscopy in adults and children with difficult airways.[5–7] Videolaryngoscopy has become an important and commonly used tool in the management of pediatric airways.[8] Flexible fiber-optic intubation through a supraglottic airway (FOI-SGA) has been advocated as an alternative for difficult pediatric airways, with certain supraglottic airway devices designed specifically for this use.[9,10] Supraglottic airways allow continuous oxygenation and ventilation while serving as a conduit for fiberoptic intubation.[11] This may be particularly advantageous, as hypoxemia is the most common precursor to intubation-related adverse events in children with difficult airways.[1] Small children (less than 1 yr) are particularly vulnerable to hypoxemia and experience more intubation-related complications than older children.[2,3] Fiber-optic intubation through a supraglottic airway may have unique advantages in this younger population. Supraglottic airways also relieve upper airway obstruction and optimize the laryngeal view with a fiber-optic bronchoscope, therefore requiring less kinesthetic skill than unguided fiber-optic bronchoscopy.[12,13] This may be particularly useful in patients with obstructive upper airway syndromes, such as Pierre Robin Sequence or Treacher–Collins syndrome, where both mask ventilation and tracheal intubation may be difficult.[9]

The primary aim of this study is to compare tracheal intubation success rates of fiber-optic intubation through a supraglottic airway to videolaryngoscopy in children with difficult airways entered in the PeDI registry. We hypothesize that FOI-SGA will have higher first pass success rates than videolaryngoscopy. Our secondary aim is to compare the associated complications of these two techniques. We additionally aim to compare the success rates of these techniques in our *a priori* defined subgroup, children less than 1 yr of age.

Materials and Methods

The PeDI Registry was created in 2012 by a 48-member special interest group of the Society for Pediatric Anesthesia. The group defined pediatric airway management terminology and relevant outcomes and developed a standard data collection sheet with standard definitions by expert consensus. The prestated goals for the database included quantifying complications related to airway management, comparative analysis of success rates between different techniques (airway devices and equipment and pharmacologic and ventilation strategies), and comparisons of management in various predefined syndromes in the pediatric difficult airway population. With institutional review board approval, a secure, password-protected web-based data entry portal was developed at the data coordinating center, the Children's Hospital of Philadelphia, using Research Electronic Data Capture (REDCap).[14] The portal was extended to 14 academic children's hospitals in the United States. A pediatric anesthesiology attending at each site identified as a project coordinator developed a site-specific compliance plan to ensure 100% data capture and performed monthly audits for data capture and accuracy. Additional information regarding development and maintenance of the database has been previously published.[3]

The study population includes all children (less than18 yr) with difficult airways in whom tracheal intubation was attempted. The following criteria were used to define a difficult airway:

1. Children with difficult laryngeal exposure with conventional direct laryngoscopy (DL) as assessed by the attending anesthesiologist (Cormack and Lehane Classification greater than or equal to 3).[15]
2. Children in whom conventional DL was physically impossible because of anatomical reasons (*e.g.*, severely limited mouth opening or other craniofacial anomalies).
3. Children who had failed conventional DL within the preceding 6 months.
4. Children in whom the attending anesthesiologist deferred conventional DL because of an unfavorable (predictive of a difficult DL) airway physical examination (*e.g.*, neonatal Robin sequence) or the clinical situation where a nonattending clinician obtains an unfavorable view that is unconfirmed with a subsequent conventional DL by the attending.

A standard data sheet was completed by a member of the anesthesia care team after all attempted intubations in children with at least one of the above mentioned difficult airway criteria. Patient care episodes from July 25, 2012, to December 4, 2015, were included in this study. Elective and nonelective intubation attempts in various hospital locations including the operating room, emergency department, and intensive care unit were included. A single intubation attempt was defined as the act of inserting an airway device into the pharynx or naris with the intent to perform tracheal intubation. A single patient may have had multiple attempts before successful intubation or use of an alternative airway management technique. All attempts, successful or unsuccessful, were recorded for each patient. The intubation technique, provider training level, device used, and presence or absence of continuous ventilation were recorded for each intubation attempt. All decisions regarding airway management were made at the discretion of the attending anesthesiologist

and were not dictated by the study design. Complications were categorized as severe and nonsevere, modified from the National Emergency Airway Registry for Children (NEAR-4KIDS) definitions.[16,17] The following were categorized as severe complications: severe airway trauma (glottis or subglottic injury), clinical evidence of aspiration (chest radiograph or bronchoscopy evidence), cardiac arrest, emergent surgical airway, esophageal intubation with delayed recognition, pneumothorax, and death. The following were defined as nonsevere complications: minor airway trauma (dental or lip), pharyngeal bleeding, arrhythmia without hemodynamic consequences, bronchospasm, epistaxis, esophageal intubation with immediate recognition, hypoxemia, laryngospasm, and emesis without aspiration. We defined hypoxemia as a 10% decline from preintubation oxygen saturation for more than 45 s. Additional data collected for each patient included age, weight, sex, presence of atypical airway anatomy, presence of a previously diagnosed syndrome, anticipation of difficult laryngoscopy by the attending anesthesiologist, and American Society of Anesthesiology physical status.

The primary outcome in this study was first-attempt success, defined as the rate of successful intubation on the first attempt using FOI-SGA or videolaryngoscopy when this was the first advanced (non-DL) intubation technique used. FOI-SGA or videolaryngoscopy may have been the original intubation technique attempted for the patient or the first technique used after failure of conventional DL. First-attempt success is considered clinically important because the number of intubation attempts has been positively associated with the rate of complications.[3] Overall success was defined as successful intubation with a given technique on any attempt without switching to an alternative technique. A patient may be considered a first-attempt failure but overall success if they were intubated with the same technique on the second or later attempt after adjustment in approach or patient positioning or change in provider. Analysis of success rates using the same method was repeated in the subset of patients less than 1 yr of age.

Statistical Analysis

Statistical analysis was performed with Stata (StataCorp, LLC, USA) version 11.2 and 14.0. Sample size calculation was not made *a priori* due to a set size of airway management episodes using FOI-SGA or videolaryngoscopy in the database during the study period. The study period was determined by the consensus of the collaborative group before reviewing any outcome data, with all cases in the registry sampled at that time. Our analysis plan was: (1) to generate the cohort which utilized either FOI-SGA or videolaryngoscopy as the first non-DL intubating technique, (2) to evaluate the factors associated with either FOI-SGA or videolaryngoscopy use, (3) to evaluate the association between FOI-SGA *versus* videolaryngoscopy use and *a priori* decided outcomes, and (4) to evaluate the association between FOI-SGA *versus* videolaryngoscopy use and outcomes while adjusting for the covariates identified in the second step. We *a priori* decided to conduct two subgroup analyses: (1) to evaluate the cohort with either FOI-SGA or videolaryngoscopy as the first airway device for a given patient (those with no prior DL attempts) and (2) to repeat an analysis for infants less than 1 yr, given the high complication rate in this population.[3] We report summary statistics using counts and proportions (%) and medians with interquartile ranges for nonnormally distributed variables. The effect size was reported by odds ratio (OR) with 95% CI. Univariate analyses were performed by Fisher's exact test for each analytic step described above. No site effects were considered in our analysis. Finally, a multivariable logistic regression model was developed to include potential confounders that were identified in step 2 and also included intubation attempted by the anesthesiology attending (identified *a priori* as an important variable). A model fit was evaluated using the Hosmer and Lemeshow goodness-of-fit test. A $P < 0.05$ was considered statistically significant throughout, except for the goodness-of-fit test in which $P > 0.2$ was considered acceptable.

Results

The 14 centers reported 1,603 difficult airway cases (482 infants, 1,121 older children) between July 25, 2012, and December 4, 2015. FOI-SGA was attempted as the first airway management technique in 90 patients and after failed DL in 24 patients (114 total patients, 35 infants). Videolaryngoscopy was attempted as the first airway management technique in 407 patients and after failed DL in 379 patients (786 total patients, 220 infants). Patient characteristics are represented in table 1. Table 2 shows the specific supraglottic airway and videolaryngoscopy devices used by anesthesia providers in these attempts. The air-Q (Mercury Medical, USA) was the most popular device used for the FOI-SGA technique (98 of 114, 86%).

FOI-SGA was successful on the first attempt in 67 of 114 cases (59%), whereas videolaryngoscopy was successful in 404 of 786 (51%), OR 1.35 (95% CI, 0.91 to 2.00; $P = 0.16$). FOI-SGA was ultimately successful in 101 cases (89%), as compared to 620 cases with videolaryngoscopy (79%), OR 2.08 (95% CI, 1.15 to 23.77; $P = 0.016$). The number of intubation attempts needed for success was not different between these two techniques (table 3).

Multivariable logistic regression analysis for first-attempt success while adjusting for factors associated with the choice of approach (age, anticipated difficult airway, Pierre Robin sequence, and criteria for database entry) and provider level (trainee *vs.* attending) showed a nonsignificant difference in first-attempt success for FOI-SGA *versus* videolaryngoscopy (OR, 1.31; 95% CI, 0.87 to 1.99; $P = 0.194$) (Supplemental Digital Content, http://links.lww.com/ALN/B502).

Among difficult airway cases in which the first intubation attempt was with FOI-SGA or videolaryngoscopy (no prior DL attempts), first-attempt success rates were 54% with FOI-SGA and 51% with videolaryngoscopy ($P = 0.641$;

Table 1. Patient and Anesthetic Characteristics of Patients in Whom Fiber-optic Intubation through a Supraglottic Airway or Videolaryngoscopy Was the First Attempted Advanced Airway Technique

	Fiber-optic Intubation through Supraglottic Airway (N = 114)	Videolaryngoscopy (N = 786)	*P* Value
Age (median [IQR]), yr	2 (0.7–10.8)	5.4 (0.7–12.1)	0.048
Infant (n), %	35 (31%)	220 (28%)	0.578
Weight (imedian [IQR]), kg	11.7 (6.2–29.5)	17.8 (7.2–34.6)	0.040
Sex (male), n (%)	63 (55%)	483 (61%)	0.219
Criteria for database entry, n (%)			
Failed DL	28 (25%)	381 (48%)	< 0.001
DL not possible	14 (12%)	84 (11%)	0.629
Previous failed DL	17 (15%)	132 (17%)	0.687
DL felt harmful	58 (51%)	231 (29%)	< 0.001
Diagnosed or suspected syndrome, n (%)	86 (75%)	556 (71%)	0.321
Physical exam abnormal, n (%)	101 (89%)	661 (84%)	0.265
Laryngoscopy anticipated difficult, n (%)	106 (93%)	631 (80%)	0.001
ASA physical status, n (%)*			
I	0 (0%)	16 (2%)	0.579
II	26 (23%)	152 (19%)	
III	75 (66%)	513 (66%)	
IV	13 (11%)	96 (12%)	
V	0 (0%)	2 (0%)	
ASA emergency	8 (7%)	49 (6%)	0.686
Number of direct laryngoscopy attempts before first advanced technique attempt, n (%)			
0	90 (79%)	407 (52%)	< 0.001
1	9 (8%)	164 (21%)	
2	6 (5%)	112 (14%)	
3 or more	9 (8%)	103 (13%)	
Neuromuscular blockade use, n (%)	48 (42%)	422 (54%)	0.02
Provider, n (%)†			
Anesthesiology attending	27 (24%)	246 (31%)	0.103‡
Trainee	77(67%)	410 (52%)	
CRNA	10 (9%)	125 (16%)	
Other	0 (0%)	4 (1%)	

*ASA status was missing in seven cases. †Provider data were missing in one case. ‡*P* value was calculated as anesthesiology attending *versus* other providers.

ASA = American Society of Anesthesiologists; CRNA = Certified Registered Nurse Anesthetist; DL = direct laryngoscopy; IQR = interquartile range.

table 3). Tracheal intubation was ultimately successful without switching to a different technique in 90% of FOI-SGA cases and 80% of videolaryngoscopy cases ($P = 0.033$). Tracheal intubation was more likely to be successful in two or less attempts with FOI-SGA than videolaryngoscopy (86 *vs.* 73%; $P = 0.01$).

Among the cases with FOI-SGA as the initial tracheal intubation technique, seven cases (6%) subsequently switched to videolaryngoscopy with success. Among the cases with videolaryngoscopy as the initial technique, 35 cases (4%) subsequently utilized FOI-SGA with success. There were 138 additional cases with failure of either FOI-SGA or videolaryngoscopy as the initial technique. Tracheal intubation was eventually achieved with DL (37 cases), flexible fiber-optic bronchoscope without a supraglottic airway (34 cases), flexible fiber-optic bronchoscope in combination with a videolaryngoscope (20 cases), rigid bronchoscope (12 cases), or other less common techniques (20 cases, with less than 5 cases per individual technique). In 15 cases, tracheal intubation was not achieved, and either the surgical procedure was completed with a supraglottic airway, or the patient was allowed to wake without completion of the procedure.

In infants less than 1 yr, FOI-SGA had a significantly higher first-attempt success rate (19 of 35, 54%) compared to videolaryngoscopy (79 of 220, 36%), unadjusted OR 2.12 (95% CI, 1.04 to 4.31; $P = 0.042$), and adjusted OR 2.17 (95% CI, 1.00 to 4.68; $P = 0.049$) accounting for confounding factors. FOI-SGA also had fewer intubation attempts (median, 1; interquartile range, 1 to 2) compared to videolaryngoscopy (median, 2; interquartile range, 1 to 3; $P = 0.035$; table 4).

There was no difference in complication rates between the two techniques: 20% (18 of 90) of patients in whom FOI-SGA was the first airway management technique attempted experienced complications, compared to 13% (53 of 407) of patients in whom videolaryngoscopy was the first technique attempted (OR, 1.67; 95% CI, 0.93 to 3.00;

Table 2. Supraglottic Airway and Videolaryngoscope Devices Used for Intubation Attempts

Device	N (%)
Supraglottic airway (N = 114)*	
Air-Q†	98 (86%)
LMA Unique‡	4 (4%)
AmbuAura Once§	2 (2%)
LMA Supreme‡	2 (2%)
LMA Proseal‡	1 (1%)
Videolaryngoscope (N = 876)	
Glidescope Cobalt‖	481 (61%)
Glidescope AVL‖	82 (10%)
STORZ C-MAC#	70 (9%)
Glidescope GVL 2‖	43 (5%)
McGrath laryngoscope**	43 (5%)
Truview‡	28 (4%)
Airtraq optical laryngoscope‡	13 (2%)
STORZ video laryngoscope DCI with Mac Blade#	13 (2%)
STORZ video laryngoscope DCI with Miller Blade#	13 (2%)

*Supraglottic airway device data were missing for seven cases. †Mercury Medical, Clearwater, Florida. ‡Teleflex, Kenosha, Wisconsin. §Ambu, Ballerup, Denmark. ‖Verathon, Seattle, Washington. #Karl Storz, Tuttlingen, Germany. **Medtronic, Minneapolis, Minnesota.

P = 0.096; table 5). There were no severe complications in the FOI-SGA group. There were 22 nonsevere complications reported with the FOI-SGA technique in 18 patients (four patients experienced more than one complication), with hypoxemia accounting for half of these complications. Of the 90 FOI-SGA patients, 58 received continuous ventilation throughout the intubation attempt, 20 did not receive continuous ventilation, and 12 had no data recorded with regards to continuous ventilation. Four of 58 patients in the continuous ventilation group experienced hypoxemia (7%), whereas 5 of 20 patients without continuous ventilation experienced hypoxemia (25%; P = 0.04).

Discussion

The main finding in this study is that fiber-optic intubation through a supraglottic airway and videolaryngoscopy have similar rates of first-attempt success in children with difficult airways. However, selecting FOI-SGA as the first technique was associated with significantly fewer intubation attempts and changes in airway management strategies, as demonstrated by a higher overall success rate. Furthermore, in children less than 1 yr of age, FOI-SGA is associated with significantly higher rates of first-attempt success. Hypoxemia was significantly less common during the FOI-SGA technique when continuous ventilation was used throughout the intubation attempt.

Children undergoing anesthesia experience higher rates of airway-related complications than adults,[1] with infants being particularly vulnerable.[3,4] There is growing recognition that limiting the number of intubation attempts may prevent airway-related complications.[2,3,17] The results of this study suggest that, while videolaryngoscopy is still the most commonly used advanced intubation technique in children with difficult airways, choice of the FOI-SGA technique may reduce the need for multiple intubation attempts in infants. Multiple factors may contribute to lower success rates of videolaryngoscopy in infants. The cephalad position and anterior angle of the larynx, along with a long, floppy, omega-shaped epiglottis may lead to difficult endotracheal tube placement, even with an excellent view. Videolaryngoscopes may be difficult to use in patients with small mouths or limited mouth openings, and operator focus on the video monitor when inserting a styletted tube may leave the patient vulnerable to airway soft tissue injury.[8] Previous smaller studies have shown that FOI-SGA offers some advantages in the pediatric difficult airway, allowing for oxygenation throughout the intubation attempt and relief

Table 3. First-attempt Success, Overall Success, and Number of Attempts for Fiber-optic Intubation through a Supraglottic Airway *versus* Videolaryngoscopy

	Used as the First Non-DL technique (N = 900)				Used as the First Airway Technique (N = 497)			
	Fiber-optic Intubation through Supraglottic Airway (N = 114)	Videolaryngoscopy (N = 786)	Odds Ratio (95% CI)	*P* Value	Fiber-optic Intubation through Supraglottic Airway (N = 90)	Videolaryngoscopy (N = 407)	Odds Ratio (95% CI)	*P* Value
First-attempt success	67 (59%)	404 (51%)	1.35 (0.91–2.00)	0.160	49 (54%)	208 (51%)	1.14 (0.72–1.80)	0.641
Overall success	101 (89%)	620 (79%)	2.08 (1.15–3.77)	0.016	81 (90%)	327 (80%)	2.20 (1.07–4.51)	0.033
Number of attempts, median (IQR)	1 (1,2)	1 (1,2)	Not applicable	0.052	1 (1,2)	1(1,3)	Not applicable	0.180

The left side of the table demonstrates the cohort with either fiber-optic intubation through a supraglottic airway or videolaryngoscopy as the first non-DL technique attempted. The right side of the table demonstrates only the subgroup where fiber-optic intubation through a supraglottic airway or videolaryngoscopy was the first airway technique attempted, without any previous DL attempts. Overall success reflects cases in which fiber-optic intubation through a supraglottic airway or videolaryngoscopy were successful without switching to an alternative intubation technique, regardless of whether the successful intubation occurred on the first or subsequent attempts. First-attempt success and overall success rates were compared by Fisher's exact test. The number of attempts was compared using Wilcoxon rank-sum test.

DL = direct laryngoscopy; IQR = interquartile range.

Table 4. Subgroup Analysis: First-attempt Success, Overall Success, and Number of Attempts for Tracheal Intubation with Two Techniques: Fiber-optic Intubation through Supraglottic Airway *versus* Videolaryngoscopy in Infants Less than 1 yr Old

	Used as the First Non-DL technique (N = 255)				Used as the First Airway Technique (N = 116)			
	Fiber-optic Intubation through Supraglottic Airway (N = 35)	Videolaryngoscopy (N = 220)	Odds Ratio (95% CI)	*P* Value	Fiber-optic Intubation through Supraglottic Airway (N = 21)	Videolaryngoscopy (N = 95)	Odds Ratio (95% CI)	*P* Value
First-attempt success	19 (54%)	79 (36%)	2.12 (1.04–4.31)	0.041	9 (43%)	37 (39%)	1.18 (0.46–3.01)	0.807
Overall success	28 (80%)	149 (68%)	1.91 (0.81–4.47)	0.170	17 (81%)	63 (66%)	2.16 (0.70–6.61)	0.297
Number of attempts, median (IQR)	1 (1,2)	2 (1,3)	Not applicable	0.035	2 (1,3)	2 (1,4)	Not applicable	0.510

The left side of the table demonstrates the less than 1-yr-old cohort with either fiber-optic intubation through a supraglottic airway or videolaryngoscopy as the first non-DL technique attempted. The right side of the table demonstrates only the subgroup where fiber-optic intubation through a supraglottic airway or videolaryngoscopy was the first airway technique attempted, without any previous DL attempts. Overall success reflects cases in which fiber-optic intubation through a supraglottic airway or videolaryngoscopy were successful without switching to an alternative intubation technique, regardless of whether the successful intubation occurred on the first or subsequent attempts. First-attempt success and overall success rates were compared by Fisher's exact test. The number of attempts was compared using Wilcoxon rank-sum test.

DL = direct laryngoscopy; IQR = interquartile range.

of upper airway obstruction.[9,11,12,18–24] This is the first large study to examine success rates of the technique across multiple institutions and providers.

The FOI-SGA technique allows for continuous oxygenation and ventilation throughout the intubation attempt. Despite this, our data reveal that this advantage is not always employed and suggest that hypoxemia may be more common during intubation attempts with FOI-SGA without continuous ventilation than with videolaryngoscopy. Smaller children have higher oxygen consumption rates and closing capacity volumes than adults, leading to shorter times to oxygen desaturation with apnea. The FOI-SGA technique may take longer to successfully intubate than videolaryngoscopy, which may explain increased rates of hypoxemia in children when continuous ventilation is not utilized. The use of continuous ventilation throughout FOI-SGA attempts significantly reduced the incidence of hypoxemia and should be used in any patient at risk for precipitous oxygen desaturation with the FOI-SGA technique.

Table 5. List of Complications in Difficult Airway Management with Fiber-optic Intubation through a Supraglottic Airway or Videolaryngoscopy as the First Device

First Airway Technique	Fiber-optic Intubation through Supraglottic Airway (N = 90)	Videolaryngoscopy (N = 407)	*P* Value
No complications	72 (80%)	354 (87%)	0.096
Any severe complications*	0 (0%)	7 (1.7%)	0.360
Cardiac arrest	0 (0%)	5 (1.2%)	
Severe airway trauma	0 (0%)	3 (0.7%)	
Death	0 (0%)	0 (0%)	
Aspiration	0 (0%)	1 (0.3%)	
Pneumothorax	0 (0%)	0 (0%)	
Esophageal intubation with delayed recognition	0 (0%)	0 (0%)	
Any nonsevere complications*	18 (20%)	50 (12%)	0.062
Hypoxemia	11 (12.2%)	30 (7.4%)	
Minor airway trauma	4 (4.4%)	10 (2.5%)	
Esophageal intubation immediately recognized	2 (2.2%)	3 (0.7%)	
Laryngospasm	1 (1.1%)	11 (2.7%)	
Epistaxis	0 (0%)	4 (1.0%)	
Bronchospasm	3 (3.3%)	1 (0.2%)	
Pharyngeal bleeding	1 (1.1%)	7 (1.7%)	
Arrhythmia	0 (0%)	1 (0.2%)	
Emesis	0 (0%)	1 (0.3%)	

*"Any severe complications" and "Any nonsevere complications" refers to number of patients experiencing at least one complication in that category. Individual patients may have experienced more than one complication in a given category or both severe and nonsevere complications.

Other authors have described difficulty with the FOI-SGA technique, especially with passage of cuffed endotracheal tubes through the supraglottic airway and with removal of the supraglottic airway device after successful intubation.[25,26] The air-Q is specifically designed for use as a conduit for cuffed endotracheal tubes, and multiple previous authors have described improved experiences using the FOI-SGA technique with this device.[10,23,24,27,28] The majority of FOI-SGA attempts in our database used the air-Q, whereas only a small number involved other supraglottic airway devices. This limited our ability to compare success rates of the different supraglottic airway devices or reach conclusions regarding the suitability of specific devices for the FOI-SGA technique.

Our study has several limitations: (1) This was an observational trial with all airway management decisions left to the attending anesthesiologist. Patients were not randomized to videolaryngoscopy or FOI-SGA, and we may not have been able to account for possible confounders that could affect success or complication rates in these two populations. For example, providers may be more likely to use the FOI-SGA technique in patients at higher risk for respiratory decompensation, because this technique allows for continuous oxygenation and ventilation during intubation attempts. This may make multiple attempts or complications more likely with this technique due to a higher risk patient population. Multivariable logistic regression analysis including patient and provider characteristics that differed between patients managed with FOI-SGA or videolaryngoscopy did not show a significant difference in first-attempt success rates between the two techniques. (2) Because complications were reported for the entire airway management episodes rather than individual intubation attempts, there may have been instances where the first technique was videolaryngoscopy or FOI-SGA, but a complication occurred after transition to a different airway management technique. In these cases the complication would have been attributed to the first technique attempted. Because of limitations in the way the registry data are documented, we are unable to be more granular about complications as they relate to particular devices. (3) A disproportionate number of cases using the FOI-SGA technique may have come from a smaller number of hospitals or providers with greater experience using this technique, which may limit generalizability. However, all 14 centers contributed data to the registry regarding use of this technique. Ultimately, the number of cases from each individual hospital remained too small for meaningful comparative analysis. (4) Although a standard operational plan with rigorous data collection and audit processes was established, cases could have been missed if difficult intubation cases were not reported or adequately documented by the care team. Occasionally data points were missing for individual patients (*i.e.*, use of continuous ventilation during FOI-SGA attempts). Data entry is still dependent on human factors, and as we move to greater interfacing capability and autopopulating with the electronic medical record, this inherent bias in data collection will be reduced.

In conclusion, although both the FOI-SGA and videolaryngoscopy techniques had similar first-attempt success rates in all children with difficult airways, FOI-SGA demonstrated a higher rate of first-attempt success in children younger than 1 yr of age. Our future studies will attempt to identify specific populations (*e.g.*, patients with Pierre Robin sequence or Goldenhar syndrome) that may benefit from this technique. Further refinement in provider practice and device design may help to reduce complications with advanced airway management techniques.

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Competing Interests

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