The Importance of Median Glossoepiglottic Fold Engagement on Laryngeal View and Tracheal Intubation Success in Children

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Study objective: Our study objective was to determine if the location of laryngoscope blade tip placement is associated with clinically important tracheal intubation outcomes in a pediatric emergency department.

Methods: We conducted a video-based observational study of pediatric emergency department patients undergoing tracheal intubation with standard geometry Macintosh and Miller video laryngoscope blades (Storz C-MAC, Karl Storz). Our main exposures were direct lifting of the epiglottis versus blade tip placement within the vallecula and median glossoepiglottic fold engagement versus not when the blade tip was placed in the vallecula. Our main outcomes were glottic visualization and procedural success. We compared measures of glottic visualization between successful and unsuccessful attempts using generalized linear mixed models.

Results: Proceduralists placed the blade tip in the vallecula (indirectly lifting the epiglottis) during 123 (71.9%) of 171 attempts. When compared with indirectly lifting the epiglottis, directly lifting the epiglottis was associated with improved visualization—by percentage of glottic opening (POGO) (adjusted odds ratio [AOR], 11.0; 95% confidence interval [CI], 5.1 to 23.6) and modified Cormack-Lehane (AOR, 21.5; 95% CI, 6.6 to 69.9). When in the vallecula, engagement of the median glossoepiglottic fold was associated with improved POGO (AOR, 3.6; 95% CI, 1.9 to 6.8), modified Cormack-Lehane (AOR, 3.9; 95% CI, 1.1 to 14.1), and success (AOR, 9.9; 95% CI, 2.3 to 43.7).

Conclusions: Emergency tracheal intubation can be performed in children at a high level by directly or indirectly lifting the epiglottis. If indirectly lifting the epiglottis, median glossoepiglottic fold engagement is helpful in maximizing glottic visualization and procedural success. [Ann Emerg Med. 2023;81:658-666.]

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INTRODUCTION

Background

Traditional teaching for emergency tracheal intubation in infants and younger children is that visualization and procedural success are better using a straight laryngoscope blade (Miller) to directly lift and better control the epiglottis. The evidence basis for this teaching, however, is limited, and we currently do not know if direct lifting of the epiglottis during emergency tracheal intubation in children is associated with improved glottic visualization compared with placing the laryngoscope blade tip in the vallecula. Additionally, in one recent pediatric intubation study based on intraoral video recordings, the laryngoscope blade tip was usually placed into the vallecula, regardless of whether a Miller or Macintosh blade was used.[1]

Importance

Once the blade tip is placed in the vallecula, engagement of the median glossoepiglottic fold, which overlies the deeper hyoepiglottic ligament, has been shown to improve glottic visualization in adults.[2] We do not know whether engagement of the median glossoepiglottic fold elicits a similar response in children. More importantly, we do not know whether median glossoepiglottic fold engagement during emergency tracheal intubation improves procedural success in children, who may have less tolerance to prolonged and multiple attempts than adults.

Goals of This Investigation

The objective of this study was to determine if laryngoscope blade tip placement in children is associated

Editor's Capsule Summary

What is already known on this topic

The optimal technique for intubating children is controversial.

What question this study addressed

What is the best laryngoscope blade placement, and what is the role of the median glossoepiglottic fold?

What this study adds to our knowledge

In this prospective study of 171 videotaped pediatric intubation attempts, directly lifting the epiglottis was associated with superior glottic visualization but similar procedural success. When using the vallecula, successful engagement of the median glossoepiglottic fold was associated with superior visualization and success.

How this is relevant to clinical practice

Directly lifting the epiglottis appears to provide superior glottic visualization in children. If using the vallecula technique, engaging the median glossoepiglottic fold enhances success.

with improved visualization and procedural success. We completed an observational study, using intraoral and overhead video recordings, of emergency tracheal intubation in children in a pediatric emergency department (ED). We specifically sought to determine whether median glossoepiglottic fold engagement was associated with both improved glottic visualization and procedural success in children.

METHODS

Study Design and Setting

This was a retrospective review of prospectively collected observational data of patients undergoing tracheal intubation in an academic pediatric emergency department. The parent institution is the major regional provider of emergency care to children and a level I trauma center, with approximately 62,000 annual encounters. This study was determined to be exempt by the Cincinnati Children's Hospital Medical Center Institutional Review Board.

Emergency tracheal intubation in the pediatric emergency department at our institution has been standardized for approximately a decade, including the use of a procedural checklist and restricting all intubation attempts to no more than 45 seconds. The standard process is applied in more than 90% of patients undergoing tracheal intubation.[3] Most attempts are performed by a pediatric emergency medicine fellow or faculty physician.

A key part of the standard process is using a video laryngoscope equipped with a standard geometry blade (Storz C-MAC, Karl Storz). With the Storz C-MAC, proceduralists have the option for direct laryngoscopy by looking directly into the patient's oropharynx or indirect laryngoscopy by viewing the video screen that can be placed directly over or immediately adjacent to the patient. In our pediatric emergency department, the image displayed on the video screen is also projected on a larger monitor on the back wall of each resuscitation space.

The Storz C-MAC allows video clips to be recorded onto the device's internal storage. Additionally, all of our resuscitation bays are equipped with ceiling-mounted video cameras and microphones. Recording occurs continuously, and overhead video recordings and back wall monitor/endoscopic images can be reviewed using a proprietary software program (LiveCapture, B-Line Medical). This study was conducted and reported following STrengthening the Reporting of OBservational studies in Epidemiology guidelines.[4]

Selection of Participants

All patients who underwent tracheal intubation in our base pediatric emergency department and had adequate overhead video recordings (video available from blade insertion through tube delivery, at minimum) were eligible for inclusion. We excluded both patients intubated using only a direct laryngoscope and patients intubated while undergoing active cardiopulmonary resuscitation. We identified eligible patients using an internal pediatric emergency department quality assurance database. Patients are identified through daily reports generated from our institution's electronic medical record. This system has previously led to greater than 95% capture of eligible patients.[3]

Measurements

We collected most study data by review of intraoral video recordings. Data collected from intraoral video included placement of the blade tip with respect to the epiglottis, engagement of the median glossoepiglottic fold, glottic visualization, location of blade insertion in the mouth, oropharyngeal contents during the attempt, and location of the glottis on the screen. We used the electronic medical record to collect select patient data, including age, risk factors for a difficult airway, and indication for intubation (medical versus trauma). Risk factors for a difficult airway were prior known difficulty with glottis

visualization documented in our electronic medical record, cervical immobilization, or craniofacial anomalies.[5] We used a combination of overhead video and the electronic medical record to collect proceduralist and procedural data, including proceduralist specialty and level of training, laryngoscope blade type, and sedative and paralytic medications. Data collected exclusively by overhead video review included patient vital signs, presence of chest compressions during intubation, cervical immobilization, external laryngeal manipulation, attempt duration, attempt success, and adverse events.

The main exposure of interest was *engagement* of the median glossoepiglottic fold, defined as the blade tip making contact with the fold by intraoral video. We also recorded if the blade tip was centered on the fold, to the right, or to the left. We defined *centered* as any portion of the blade tip in line with the fold. Thus, by definition, if the blade tip was within the vallecula, but the entire blade was to the right or left of the median glossoepiglottic fold, the fold was not engaged (Figure 1C, D). Our main outcomes were glottic visualization on intraoral video, measured by both modified Cormack-Lehane grade and percentage of glottic opening (POGO),[6,7,] and attempt success. An intubation *attempt* was defined as the insertion of the laryngoscope blade, regardless if tube delivery was attempted. Attempt success was determined by capnometry based on overhead video review.

For every set of 10 patients, each of the primary data collectors (PD, KE, AS) collected data on 3 patients independently. For the 10th patient, each investigator collected data independently, then the group reviewed the independently collected data and resolved discrepancies. We defined *agreement* between investigators as: (1) for

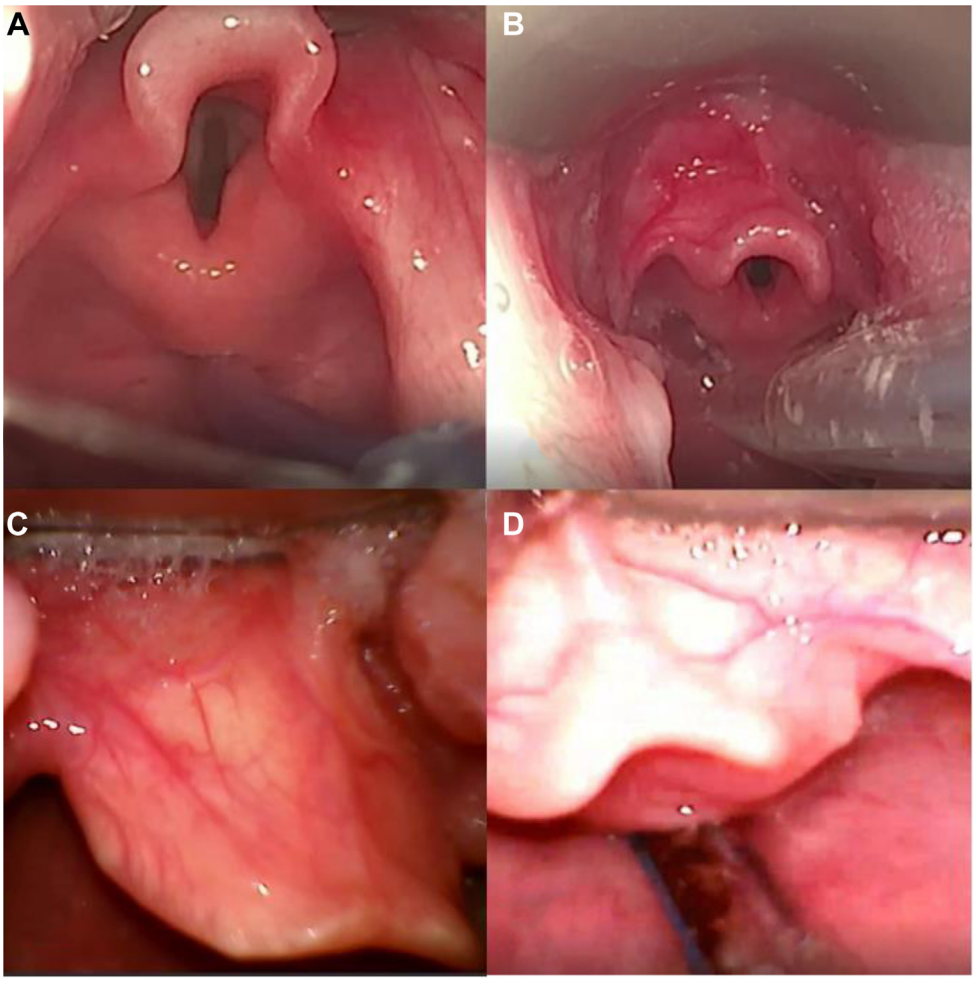

Figure 1. Laryngoscope blade tip placement with respect to median glossoepiglottic fold. *A,* Median glossoepiglottic fold engaged by laryngoscope blade tip. *B,* Median glossoepiglottic fold not engaged by laryngoscope blade tip. *C,* Laryngoscope blade tip placed deep in vallecula but left of median glossoepiglottic fold. *D,* Laryngoscope blade tip placed deep in vallecula but right of median glossoepiglottic fold.

categorical variables, such as modified Cormack-Lehane view, all 3 investigators selecting the same value, and (2) for POGO, an absolute difference of 10% or less. We use this data collection process to optimize, rather than assess, the reliability of data collection. Research Electronic Data Capture was used for data management.[8,9]

Analysis

We first generated descriptive statistics for patient and proceduralist data and the outcomes of interest. The unit of analysis was the intubation attempt. We then examined the distributions of continuous variables to select appropriate measures of central tendency and distribution. We then developed multiple generalized linear mixed models used to evaluate for associations between our exposures of interest (vallecula versus direct lifting of the epiglottis and median glossoepiglottic fold engagement versus not) and outcomes of interest (glottic visualization and success). For evaluating associations between exposures of interest and POGO, we used generalized linear mixed models with Beta distribution. For a POGO value of either 0 or 100, we added ± 0.001 to satisfy the Beta distribution assumption. Zero-One-Inflated Beta regression models were conducted as sensitivity analyses. For associations between exposures of interest and modified Cormack-Lehane view, we used generalized linear mixed models with multinomial distribution. For associations between exposures of interest and procedural success, we used generalized linear mixed models with binary distribution.

Based on clinical relevance and our previous work, our models adjusted for 3 covariates with known associations with difficult visualization, attempt failure, or both: patient age, indication for intubation, and suspected difficult airway (prior known difficulty with glottis visualization documented in our electronic medical record, cervical immobilization, or craniofacial anomalies).[5] Proceduralist specialty/level of training and nonfirst attempts were treated as random effects. Multicollinearity between variables was assessed using Spearman correlation coefficients.

We performed multiple secondary analyses. First, we performed secondary analyses to evaluate associations between outcomes and our main exposures of interest (vallecula versus direct lifting of the epiglottis and median glossoepiglottic fold engagement versus not) in patients aged less than 2 years. Second, we compared attempts with direct lifting of the epiglottis to attempts in which the blade tip was placed within the vallecula, *and* the median glossoepiglottic fold was engaged, to evaluate for associations with our outcomes of interest using theoretically ideal blade tip placement. Finally, to account for multiple attempts on the same patient, we performed sensitivity analyses using first attempts only.

Because our sample size was fixed, we did not perform a power calculation. We conducted all analyses using SAS 9.4 (SAS Institute).

RESULTS

Enrollment

From December 31, 2019, through June 30, 2022, a total of 202 patients underwent tracheal intubation in our main pediatric ED. Twenty-two patients met exclusion criteria (12 were intubated during cardiopulmonary resuscitation, 8 were intubated with a direct laryngoscope, and 2 did not have overhead video), leaving 180 eligible patients. There were 230 total intubation attempts performed on the 180 eligible patients. Intraoral video recordings were available for 171 (74%) of 230 intubation attempts (Figure 2). Of the 171 attempts in which intraoral video was available, there were 138 unique patients. For our primary exposures of interest (direct lifting versus indirect lifting, and median glossoepiglottic fold engagement versus not) and primary outcomes of interest (POGO, modified Cormack-Lehane view, and success), our primary data collectors agreed on 91.1% of coreviewed data elements prior to resolving discrepancies.

Characteristics of Study Subjects

First-pass success was 82.8% (95% confidence interval, 76.5% to 89.2%). There were no differences in patient demographics for attempts in which intraoral video was available and those in which intraoral video was not available. The most common proceduralists, in order, were pediatric emergency medicine fellow physicians, anesthesiologists, pediatric emergency medicine faculty physicians, and ED resident physicians (Table E1, available at http://www.annemergmed.com). Proceduralists placed the laryngoscope blade tip into the vallecula more often than directly lifting the epiglottis (Table 1). Patients that had the epiglottis directly lifted were younger. The laryngoscope blade tip was placed in the vallecula in two-thirds of cases in which a curved blade was used. The epiglottis was directly lifted in two-thirds of cases in which a straight blade was used.

Main Results

Vallecula Versus Direct Lifting of the Epiglottis. Direct lifting of the epiglottis was associated with improved glottic visualization (based on both POGO and modified Cormack-Lehane view). Without adjusting for covariates, there were no differences in attempt success or duration

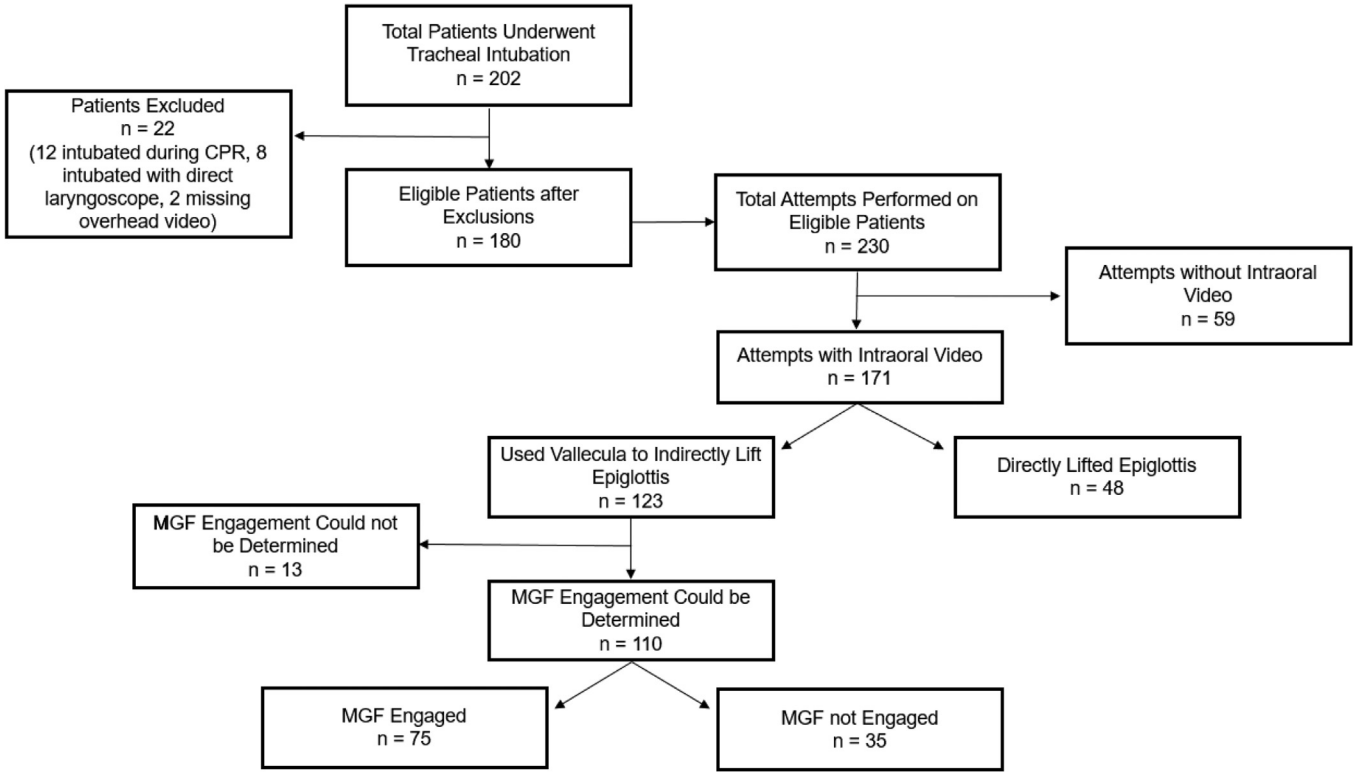

Figure 2. Inclusion and exclusion flow diagram. MGF, median glossoepiglottic fold. CPR, cardiopulmonary resuscitation.

compared with blade tip placement in the vallecula (Table 1). Using a generalized linear mixed model and adjusting for our 3 covariates, direct lifting of the epiglottis was associated with improved glottic visualization (based on both POGO and modified Cormack-Lehane view); however, there was no association with procedural success (Table 2). These findings remained consistent in sensitivity analyses using only first attempts (Table E2, available at http://www.annemergmed.com). These findings also remained consistent in secondary analyses of patients aged less than 2 years (Table E3, available at http://www.annemergmed.com).

Engagement of Median Glossoepiglottic Fold

In attempts in which the laryngoscope blade was placed into the vallecula, median glossoepiglottic fold engagement could be determined in most cases (89.4%). The median glossoepiglottic fold was engaged in 68% of cases and not engaged in 32%. Without adjusting for covariates, median glossoepiglottic fold engagement was associated with improved glottic visualization, improved attempt success, and shorter attempt duration (Table 3). In our generalized linear mixed model, adjusting for our 3 covariates, median glossoepiglottic fold engagement was associated with improved glottic visualization, based on both modified Cormack-Lehane view and POGO and procedural success (Table 4). These associations remained consistent in sensitivity analyses using first attempts only (Table E4, available at http://www.annemergmed.com). In secondary analyses of patients aged less than 2 years, engagement of the median glossoepiglottic fold was associated with improved POGO (Table E5, available at http://www.annemergmed.com).

Direct Lifting of Epiglottis Versus Blade Tip in Vallecula With Glossoepiglottic Fold Engagement

We performed secondary analyses comparing attempts in which the epiglottis was directly lifted to attempts in which the blade tip was placed in the vallecula, *and* the median glossoepiglottic fold was engaged. Direct lifting of the epiglottis was associated with both improved glottic visualization, based on both the modified Cormack-Lehane view and POGO. There was no association with procedural success (Table 5).

LIMITATIONS

Our results should be interpreted in the context of several limitations. First and most importantly, this was a single-center study in a pediatric emergency department in which intubation is highly standardized. In particular, we use a video laryngoscope for nearly all pediatric emergency

Table 1. Demographics and outcomes. Data are reported as median (IQR) or n (%).

Characteristic	Blade Tip Placed in Vallecula (n=123)	Blade Tip Used to Lift Epiglottis Directly (n=48)	Difference (95% CI)
Age (months)	41.2 (7.0, 117.3)	10.4 (2.3, 98.5)	30.7 (7.7-53.6)
Indication for intubation, n (%)			
Medical	96 (78)	38 (79.2)	−1.1 (−14.7 to 12.5)
Trauma	27 (22.0)	10 (20.8)	1.1 (−12.5 to 14.7)
Suspected difficult airway, n (%)	36 (29.3)	20 (41.7)	−12.4 (−28.5 to 3.7)
Blade type, n (%)			
Miller	37 (30.1)	31 (64.6)	−34.5 (−50.3 to −18.7)
Macintosh	84 (68.3)	17 (35.4)	32.9 (17.0-48.7)
Cannot determine	2 (1.6)	0	1.6 (−0.6 to 3.9)
Sedative, n (%)			
Etomidate	87 (70.7)	36 (75.0)	−4.3 (−18.9 to 10.4)
Ketamine	22 (17.9)	8 (16.7)	1.2 (−11.3 to 13.8)
Fentanyl	9 (7.3)	2 (4.2)	3.2 (−4.1 to 10.4)
Midazolam	2 (1.6)	0	1.6 (−0.6 to 3.9)
None	3 (2.4)	2 (4.2)	−1.7 (−8.0 to 4.5)
Paralytic, n (%)			
Succinylcholine	25 (20.3)	6 (12.5)	7.8 (−3.9 to 19.6)
Rocuronium	94 (76.4)	40 (83.3)	−6.9 (−19.8 to 6.0)
None	4 (3.3)	2 (4.2)	−0.9 (−7.4 to 5.5)
POGO	80 (60, 100)	100 (100, 100)	−20 (−40 to 0)
Modified CL View, n (%)			
1	38 (31.1)	43 (89.6)	−58.4 (−70.4 to −46.5)
2a	76 (62.3)	5 (10.4)	51.9 (39.7-64.1)
2b	5 (4.1)	0	4.1 (0.6-7.6)
3	3 (2.5)	0	2.5 (−0.3 to 5.2)
Success, n (%)	96 (78.0)	39 (81.3)	−3.2 (−16.4 to 10.0)
Attempt Duration (sec)	23 (18, 38)	26 (20, 47)	−3.0 (−11.2 to 5.2)

IQR, interquartile range; *CI*, confidence interval; *POGO*, percentage of glottic opening; *CL*, Cormack-Lehane.

department intubations, which is higher than reported in the literature.[10] Second, our pediatric emergency medicine airway training program is unique, consisting of dedicated 1:1 simulation-based education for pediatric emergency medicine fellows, recurring airway didactics, and regular review of both external overhead intubation videos and intraoral intubation videos. As such, tracheal intubation in our pediatric emergency department may differ in important ways from other EDs, in particular, our performance of laryngoscopy. Third, there is the potential for selection bias as those in the direct versus indirect lifting of the epiglottis groups may have been in those groups because of unique anatomic features or because the opposite group provided an inadequate view. That said, it was relatively uncommon for proceduralists to switch between direct and indirect lifting during a single attempt, as this occurred in only 19/171 (11.1%) of attempts. Fourth, intraoral video recordings were missing for one-quarter of eligible patients. We noted, however, few differences between patients in which intraoral video was available and those in which intraoral video was not. Fifth,

Table 2. Multivariable models comparing direct lifting of the epiglottis versus blade tip within the vallecula.

Outcome	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
POGO	11.1 (5.2-23.9)	11.0 (5.1-23.6)
Modified CL View	19.7 (6.3-61.5)	21.5 (6.6-69.9)
Success	1.5 (0.6-3.8)	2.5 (0.9-7.2)

Model adjusts for patient age, indication for intubation (medical vs trauma), and suspected difficult airway. Proceduralist level of training/specialty and nonfirst attempts treated as random effects.
OR, odds ratio; *CI*, confidence interval; *POGO*, percentage of glottic opening.

Table 3. Engagement of median glossoepiglottic fold.

Characteristic	Engaged (n=75)	Not Engaged (n=35)	Difference (95% CI)
POGO	90.0 (60.0, 100.0)	60.0 (30.0, 90.0)	30.0 (6.67-53.3)
Modified CL Grade 1 or 2a, n (%)	72 (96.0)	31 (88.6)	7.4 (−4.0 to 18.9)
Modified CL View, n (%)			
1	29 (38.7)	6 (17.1)	21.5 (4.9-38.2)
2a	43 (57.3)	25 (71.4)	−14.1 (−32.8 to 4.6)
2b	2 (2.7)	2 (5.7)	−3.0 (−11.6 to 5.5)
3	1 (1.3)	2 (5.7)	−4.4 (−12.5 to 3.7)
Success, n (%)	67 (89.3)	20 (57.1)	32.2 (14.4-50.0)
Attempt Duration	21.0 (17.0, 32.0)	34.0 (20.0, 49.0)	−13.0 (−23.6 to −2.4)

Data are reported as median (IQR) or n (%).
CI, confidence interval; *POGO*, percentage of glottic opening; *IQR*, interquartile range.

median glossoepiglottic fold engagement can be difficult to ascertain as the laryngoscope blade tip can obscure a view of the fold in some cases. That said, the determination of engagement was based on video recordings and not still images, allowing for assessment of the depth of blade placement. Importantly, we had 94.1% agreement on median glossoepiglottic fold engagement between the 3 data collectors on attempts that were coreviewed. Sixth, data collectors were not blinded to the outcome of attempts, which may have introduced bias. Seventh, though we included suspected difficult airways as a covariate, it is likely that there were clinically difficult airways that were not predicted to be difficult based on our definition of a suspected difficult airway. This may have impacted procedural technique, glottic visualization, and procedural success. Eighth, although we included provider specialty as a random effect in our models, we did not adjust for within-provider correlations and postgraduate year specifically.

DISCUSSION

In our study based on intraoral video recordings, we found that proceduralists more commonly placed the laryngoscope blade tip into the vallecula and indirectly lifted the epiglottis in children, even in a third of cases in which a straight blade was used. We found that direct lifting of the epiglottis was associated with improved glottic visualization compared with all attempts in which the laryngoscope blade tip was placed into the vallecula. In cases in which the blade tip was placed in the vallecula, we found that engagement of the median glossoepiglottic fold was associated with improved visualization and procedural success.

It may be surprising that proceduralists chose to indirectly lift the epiglottis in most cases, as conventional teaching has emphasized direct lifting of the epiglottis in young children because of a floppy and, at times, difficult-to-control epiglottis in this age group. This finding is consistent with a previous analysis of intraoral video recordings during emergency tracheal intubation in an academic pediatric emergency department.[1] Although we cannot say with complete certainty, we believe that in some attempts in which a straight blade was used to indirectly lift the epiglottis, the proceduralist was planning to directly lift the epiglottis; however, they obtained an adequate view of

Table 4. Multivariable models comparing blade tip engagement of the median glossoepiglottic fold versus not.

Outcome	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
POGO	3.6 (1.9-7.0)	3.6 (1.9-6.8)
Modified CL View	3.6 (1.1-12.3)	3.9 (1.1-14.1)
Success	6.3 (1.9-20.7)	9.9 (2.3-43.7)

Model adjusts for patient age, indication for intubation (medical vs trauma), and suspected difficult airway. Proceduralist level of training/specialty and nonfirst attempts treated as random effects.
OR, odds ratio; *CI*, confidence interval; *POGO*, percentage of glottic opening.

Table 5. Multivariable models comparing direct lifting of the epiglottis versus blade tip placed in vallecula with median glossoepiglottic fold engaged.

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
POGO	8.9 (4.1-19.3)	9.2 (4.2-20.2)
Modified CL View	13.8 (4.2-45.0)	14.1 (4.0-49.3)
Success	0.8 (0.2-2.9)	1.3 (0.3-5.6)

Model adjusts for patient age, indication for intubation (medical vs trauma), and suspected difficult airway. Proceduralist level of training/specialty and nonfirst attempts treated as random effects.
OR, odds ratio; *CI*, confidence interval; *POGO*, percentage of glottic opening.

the glottis with the blade tip in the vallecula and proceeded to tube delivery. This may be especially likely in our care setting because we limit the duration of intubation attempts to 45 seconds, and proceduralists may have felt pressure to move on to tube delivery to complete the intubation attempt within our time constraints, as opposed to attempting to optimize the view further.

To our knowledge, Miller et al[1] performed the only study using intraoral videos to compare direct lifting of the epiglottis with blade tip placement in the vallecula during emergency tracheal intubation in children. Our study differs in several ways. First, our study treated glottic visualization as an outcome, finding improved glottic visualization with direct lifting of the epiglottis. Second, Miller et al[1] found an association between placing the blade tip in the vallecula and procedural success, whereas we found no association between procedural success and direct versus indirect lifting of the epiglottis.

To our knowledge, no study has examined the association between median glossoepiglottic fold engagement and glottic visualization or procedural success in children. Driver et al[2] found that median glossoepiglottic fold engagement was associated with improved glottic visualization in adults. We similarly found that engagement of the median glossoepiglottic fold is associated with an improved glottic view in children, based on both modified Cormack-Lehane view and POGO. In a secondary analysis of children aged less than 2 years, median glossoepiglottic fold engagement was associated with improved POGO. This is an important finding given conventional teaching regarding the optimal way to visualize the glottis in children.

More important than improved glottic visualization, we found improvement in procedural duration and the most critical intubation outcome, procedural success, with median glossoepiglottic fold engagement. This is highly relevant to improving outcomes and reducing the risk associated with tracheal intubation, as children are less likely to tolerate multiple and prolonged intubation attempts. It should be noted that we did not find an association between median glossoepiglottic fold engagement and procedural success in a secondary analysis of children aged less than 2 years (adjusted odds ratio, 8.7; 95% CI, 0.6 to 123.7); however, this lack of association may have been influenced by the overall number of attempts in these patients.

When comparing attempts in which the epiglottis was directly lifted to attempts in which the blade tip was placed in the vallecula, *and* the median glossoepiglottic fold was engaged, we found improved glottic visualization with direct lifting of the epiglottis but no difference in procedural success. This is an important finding, demonstrating that with ideal blade tip placement, emergency tracheal intubation in children can be performed with a similar level of success with either direct or indirect lifting of the epiglottis.

Our findings can be incorporated into future airway training programs and airway-based educational interventions for children. Clinically, our findings may help guide real-time feedback from supervising physicians/airway coaches during intubation attempts in children performed with a video laryngoscope.

In conclusion, direct lifting of the epiglottis is associated with improved glottic visualization; however, procedural success is similar when compared with attempts in which the blade tip is placed in the vallecula, especially when the median glossoepiglottic fold is engaged. These results suggest that proceduralists can perform emergency tracheal intubation in children at a high level by either directly or indirectly lifting the epiglottis; however, if indirectly lifting the epiglottis, median glossoepiglottic fold engagement is helpful to maximizing glottic visualization and procedural success.

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