Cluster cross-over randomised trial of paediatric airway management devices in the simulation lab and operating room among paramedic students

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ABSTRACT

Objectives The objective of this study was to compare paediatric emergency airway management strategies in the simulation lab and operating room environments.
Methods This was a two-part cluster cross-over randomised trial including simulation lab and operating room environments conducted between January 2017 and June 2018 in Portland, Oregon, USA. In simulated infant cardiac arrests, paramedic students placed an endotracheal tube, an i-gel or a laryngeal mask airway in random order. In the operating room, paramedic students placed a laryngeal mask airway or i-gel device in random order in sequential patients. The primary outcome for both portions of the study was time to ventilation. In the operating room portion, we also evaluated leak pressures and average initial tidal volumes.
Results There were 58 paramedic students who participated in the simulation lab and 22 who participated in the operating room study. The mean time to airway placement in the simulation lab was 48.5 s for the i-gel, 68.9 s for the laryngeal mask and 129.5 s for the endotracheal tube. In the operating room, mean time to i-gel placement was 34.3 s with 45.2 s for the laryngeal mask. In multivariable analysis of the simulation study, the laryngeal mask and i-gel were significantly faster than the endotracheal tube, and the i-gel was faster than the laryngeal mask. In the operating room, there was no significant difference in time to placement, leak pressure and average volume of the first five breaths between the i-gel and laryngeal mask.
Conclusions We found that paramedic students were able to place supraglottic devices rapidly with high success rates in simulation lab and operating room environments. Supraglottic devices, particularly the i-gel, were rated as easy to use. The i-gel may be easiest to use since it lacks an inflable cuff and requires fewer steps to place.

Key messages

What is already known on this subject

- Supraglottic devices such as the laryngeal mask airway and the i-gel have an established history of successful use by anaesthesiologists in the operating room. However, it is unknown how these devices perform, and how easy they are to use, after brief training among paramedic students.

What this study adds

- In this two-phase randomised trial, we found that paramedic students were able to place supraglottic devices, including the laryngeal mask airway and i-gel, with high success rates in simulation lab and operating room environments. Paramedic students placed both supraglottic devices more rapidly than an endotracheal tube. The i-gel was the fastest device to place in simulated infant cardiac arrest, and was easier to use by paramedic students with less experience.

INTRODUCTION

Paediatric airway management is a rarely performed yet critical skill for prehospital emergency medical systems (EMS).[1] A previous randomised trial on paediatric airway management in EMS, conducted prior to the availability of supraglottic airways devices (SGA), found no difference in patient outcomes between bag valve mask ventilation and endotracheal intubation (ETI), with trends towards harm in certain patient subgroups treated with ETI.[2] Despite this study, ETI remains the dominant paediatric airway management practice in EMS in the USA.[1,3] However, in selected US states and EMS agencies, as well as many areas of the UK, paramedics do not perform paediatric ETI and rely on SGAs and/or bag-valve-mask ventilation.[4,5] Recently, supraglottic devices have become increasingly common in EMS, especially in the setting of adult cardiac arrest.[6–8] These devices generally require less training, are potentially faster to use, and can ventilate as well as an endotracheal tube.[9,10] These studies may result in fewer intubations being performed in EMS and increased use of SGAs. However, we were unable to identify any studies describing success rates of paramedics inserting supraglottic devices in children.

There are several SGAs that could be used in children in EMS.[11] Laryngeal mask airways that have an inflatable cuff are used in both children and adults in operating rooms worldwide.[12] However, it appears that these types of laryngeal masks have lower success rates than in the operating room when used in prehospital care among adults, though there are limited clinical data.[1,13,14] The i-gel (Intersurgical, Workingham, Berkshire, UK) is another SGA device that is similar to the laryngeal mask, but does not have an inflatable cuff. The i-gel has been studied in the operating room in paediatric patients and has generally found to be comparable to laryngeal mask devices.[15–18] In this paper, we will refer to the broad category of laryngeal mask airways with inflatable cuffs as 'laryngeal mask airways' while referring to the i-gel, distinguished by a non-inflatable cuff by its trade name.

There are limited published data regarding the use of supraglottic devices in children in the prehospital environment despite emerging widespread use.[19] The objective of this study was to compare the relative speed of insertion and ease of use of the i-gel and laryngeal mask airways among paramedic students, first in the simulation lab and then in operating room environments. Our primary hypotheses were that all supraglottic devices would be more rapid to insert than an endotracheal tube and would be easy to place with minimal training.

METHODS

Overall study design

This was a cluster cross-over randomised trial with two phases, one in the simulation lab and another in the operating room. The simulation lab portion of the study took place between three and 6 months before the operating room portion. The two phases were planned to mimic the training and deployment of a supraglottic device in an EMS agency, where training is usually conducted using basic mannequin simulation, and then the device is deployed in the field, often after a significant length of time has passed since training. The design of the study allowed us to determine if the simulation training would translate into success in real patients. Since paediatric advanced airways are rare in practice, and the environment is uncontrolled, for the deployment phase, we used the operating room, which allowed us to make more precise measurements using human subjects.

Study design-simulation lab

Simulations were conducted using two infant mannequins (Laerdal Sim NewB, Gaummard Newborn Hal) at a paramedic school simulation centre and university hospital simulation centre. The student participants used an EMS equipment bag that is standard for one of the large local EMS agencies and was packed the same way for each scenario. The three devices used in the study were the i-gel, the Ambu AuraGain laryngeal mask (Ambu, Columbia, Maryland, USA), and a cuffed endotracheal tube (using a stylette). Participants were instructed to use the Miller 1 laryngoscope blade from the airway kit in the equipment bag and were oriented in advance to the airway devices, simulators, and location of the equipment in the bag.

The study subjects were paramedic students who had not completed the Paediatric Advanced Life Support (PALS) course. The scenario was described as an unresponsive pulseless infant. Participants responded to the scenarios in pairs and started the scenario at a standardised distance from the simulator. They were instructed that one person would perform CPR and the other would perform airway management using the device indicated by the randomisation scheme. We instructed them to not perform vascular access, medications, rhythm analysis or other aspects of PALS and to focus on airway management and Cardiopulmonary Resuscitation (CPR).

Each participant was the airway operator three times, once for each device. The two participants in the team alternated turns as the airway operator. The order of devices was randomised for each participant using the online tool at randomizer.org. The primary outcome was time from initiation of the scenario to successful ventilation through the airway device with a self-inflating bag, which was recorded in real-time during the scenario. The stopwatch started when the participants entered the room and was stopped when first breath was delivered through the device. After the simulation scenarios, students completed a survey regarding the ease of use of all of the study devices. The secondary outcome was ease of use of each device. Based on a previous study, we estimated we had 80% power to detect a 23 s difference in time to ventilation (mean 46 (SD 32) vs 23 (SD 21) s) between ETI and a supraglottic device with 33 participants using a paired t-test.[20] There were insufficient preliminary data to calculate power for analyses comparing the i-gel to the LMA.

Study design operating room

A convenience sample of paramedic students that had completed the simulation portion of the study were recruited for this second phase of the study. The air-Q is the standard laryngeal mask in this hospital. Each student placed an i-gel and an air-Q(Cookgas, St Louis, Missouri, USA), in separate consecutive patients, and the order of device placement was randomised using the online tool at randomizer.org. Eligible patients were <18 years and had a procedure where a supraglottic device was planned by the attending paediatric anaesthesiologist. A research team member enrolled all patients and assigned them to the specific study intervention based on the randomization scheme immediately after consent.

The primary outcome for this portion of the study was the time from cessation of mask ventilation to first end-tidal CO_2 waveform on the anaesthesia machine. Participants were not blinded to the outcome. Secondary outcomes included the leak pressure of the device (cm H_2O) and average tidal volume (mL) of the first five breaths given through the airway device as indicated by the ventilator. Ventilator settings were determined by the attending anaesthesiologist, but in all cases included a pressure support mode with 10–15 cm/H_2O of inspiratory pressure and 5 cm/H_20 of PEEP. A research team member was present in the operating room along with the student and recorded the outcomes in real time. After the operating room cases, students completed a survey regarding the ease of use of the study devices. Based on data from a previous study, we estimated we would have 80% power to detect a 15 s difference (SD 20) using a paired t-test between devices with 22 participants.[21] All analyses were completed using the assigned study arm except where otherwise specified.

A study monitor was required to judge whether any adverse events were study related. The study sponsors did not have any role in the design, implementation or interpretation of the study results. Verbal consent was obtained from all paramedic student participants. Written consent was obtained for all patients by parents or legal guardians.

Descriptive analysis

For the student participants in both the simulation and operating room portion of the study, we calculated descriptive statistics on sex, age, years of prior EMS experience and presence of any previous healthcare degrees. As previous years of EMS experience was highly skewed, for the purpose of analysis, previous years was categorised into four categories of 0, 0 to <3 years, 3 to <5 years and 5+ years. For the students in the operating room study, we further collected data on number of previous attempts in adults during their training (both in cadavers and the operating room), and hours of simulation training and lecture on SGA placements. We further collected and summarised patient age, presence of craniofacial dysmorphy and Mallampati score overall and by device. Outcomes were summarised via descriptive statistics using mean (SD) for continuous data and n (%) for categorical data. Descriptive statistics for ease of use were compared between the i-gel, AuraGain, and ETI in the simulation lab, and i-gel and air-Q in the operating room using the Wilcoxon signed-rank test.

Missing data

All missing data were imputed, and all available data were used in the multiple imputation model. IVEware, callable in SAS, was used for the imputation portion of the analysis (IVEware, Survey Research Center, University of Michigan, USA).

Multivariable analysis

For continuous outcomes, a linear mixed effects model with a random effect for student participant was used to account for the correlation between repeated measurements within student. We further included student characteristics to control for potential bias from including students with a large range of experience both in the field and with particular airway placements. For the analysis of time to insertion during the simulation lab, the primary predictor was type of airway and controlling variables included years of experience, gender, previous healthcare degree and student age. For the operating room portion analysis, outcomes included time to first breath, average volume of the first five breaths and leak pressure. In addition to age, gender, years of prior EMS experience and previous healthcare degree, in the final analysis we also controlled for number of i-gels placed (in operating room or in cadaver lab) and number of laryngeal mask airways placed (any brand) in operating room or in cadaver lab by the individual student. Residual diagnostics and influence statistics were examined for all models.

All analyses were conducted in SAS V.9.4. All tests were two sided, and a statistical significance level of 0.05 was used for all tests.

RESULTS

We enrolled 58 paramedic students in the simulation lab study and 22 students in the operating room study. Missing data for the simulation study included n=9 missing values for gender, age and years of previous experience; n=1 value for previous number of ETIs and SGA placements; and n=1 postlaryngeal mask assessment. Missing data for the operating room study including n=2 missing values for gender, age, years of previous experience, and one missing value for pressure. We did not lose any participants (students or patients) after randomisation. Across both studies, participants were primarily males in the mid-twenties with less than 3 years of prior EMS experience and no previous healthcare degrees (table 1). For participants in the operating room study, the average number of prior i-gel placements was one and laryngeal mask airway placements was five. The average age of children in the operating room portion of the study was 4.6 years (SD 2.3). When stratified by study device, average patient age was similar (mean in i-gel 4.6 (SD 2.1); mean age in AirQ 4.6 (2.5)). Mallampati score was only able to be evaluated in 13 of the 42 paediatric participants due to age and ability to cooperate. Of the 13, three were class two and the remainder were class one. There was only one child with a potential congenital craniofacial problem (trisomy 21, laryngeal mask airway arm). Overall baseline patient characteristics were balanced between groups.(table 2). There was one potential adverse event, clear material coming from the suction port of the i-gel device, and it was not noted to be study related by the independent study monitor.

Table 1 Paramedic student characteristics In simulation lab and operation room study phases

Student characteristic	Simulation n=58 (100%)	Operating room n=22 (100%)
Male gender, n (%)	29 (59.2)	12 (60.0)
Age, mean (SD)	27.1 (7.4)	25.9 (7.1)
Years of prior EMS experience, n (%)		
None	9 (18.4)	4 (20.0)
>0–3 years	20 (40.8)	12 (60.0)
≥3 years to <5 years	13 (26.5)	3 (15.0)
5+ years	7 (14.3)	1 (5.0)
Previous healthcare degree, n (%)	2 (3.5)	0 (0.0)

Simulation: n=9 values missing for gender, age, years of previous experience; operating room: n=2 values missing for gender, age, years of previous experience.
EMS, emergency medical systems.

The unadjusted results for time to airway device placement in the simulation lab and operating room are displayed in tables 3 and 4 and figure 1. In the simulation lab, the i-gel had the fastest unadjusted placement time as compared with both laryngeal mask and ETI. However, there were no significant differences in unadjusted time to airway placement between laryngeal mask and the i-gel in the operating room analysis.

In multivariable analysis of the simulation data, we found a significant reduction in time to ventilation for the i-gel and AuraGain as compared with ETI ($p<0.01$) (table 3). The adjusted mean difference between the i-gel and ETI was 81 s (95% CI 72.5 to 89.5) and 60.6 (95% CI 52.1 to 69.1) s for the AuraGain vs ETI. Additionally, as compared with the AuraGain, the i-gel showed an adjusted reduction in 20.4 s in time to placement (95% CI 11.9 to 28.8, $p<0.01$). There were no associations between placement time and age, gender, years of prior EMS experience or previous healthcare degree and model diagnostics indicated good model fit.

Of the 22 students in the operating room study, 21 performed both i-gel and air-Q placements on separate paediatric patients. In multivariate analysis of operating room data, there were no significant differences in time to the first breath, average volume of the first five breaths and leak pressure between the i-gel and the air-Q when controlling for the study participant's age, gender, years of experience and previous number of airways placed (table 5, figure 2). Although not statistically significant, the average volume of the first five breaths was higher using the i-gel as compared with the air-Q, with a mean difference of 59.1 mL more volume per breath (95% CI −5.5 to 123.6; $p=0.07$). Overall in the as-randomised analysis average leak pressure was 20.5 for the i-gel and 18.6 for the laryngeal mask. Model diagnostics indicated good model fit for all outcomes, except time to the first breath, which identified one observation as an influential point. This observation was a priori defined as a protocol deviation, and the analysis was repeated without this datapoint. For the per-protocol analysis in which one i-gel observation was removed due to a protocol deviation, as compared with the air-Q, the i-gel had similar results, with the exception of a non-statistically significant mean difference of 3.7 (cm/H_20) (95% CI −0.2 to 7.5; $p=0.06$) favouring the i-gel. Only one patient required more than one placement attempt to ventilate successfully. In this case, an air-Q had to be replaced with a larger size

Table 2 Patient characteristics in operating room phase

	i-gel n=20 (48.8%)	AirQ n=21 (52.2%)	Overall n=41 (100%)
Age, mean (SD)	4.6 (2.1)	4.6 (2.5)	4.6 (2.3)
Craniofacial dysmorphy, n (%)	0 (0.0)	1 (4.8)	1 (2.4)
Mallampati score			
Class 1	5 (25)	5 (23.8)	10 (24.4)
Class 2	0 (0)	3 (14.3)	3 (7.3)
Not applicable	15 (75)	13 (61.9)	28 (68.3)

and the replacement resulted in successful ventilation. Model diagnostics for the per-protocol analysis were all sufficient.

Ease of use

Results for the ease of use ratings are presented in table 6. In the simulation lab, 90% of participants rated the i-gel as one (easiest) to use on a 1–5 scale, while 17% of participants rated the laryngeal mask airway (Ambu) as one, and 7% rated ETI as one. There were significant (p<0.01) differences in all pairwise comparisons: i-gel vs laryngeal masks airway (sign rank S=495), laryngeal mask airway versus ETI (sign rank S=493) and i-gel vs ETI (sign rank S=735). In the operating room, there was no difference in the distribution of ease of use between the i-gel and air-Q (with 73% of responses for i-gel vs 52% for air-Q of 'easiest' ; signed-rank test p=0.22, signed-rank S=34). However, we found ease of use score was significantly associated with years of experience working in EMS. All (100%) of students with 0 years of experience rated the i-gel easiest while only 14% of students with 3+ years of experience rated it easiest. Conversely, 100% of students with 3+ years of experience rated the (air-Q) as easiest as compared with 40% of students with 0 years of experience. As noted above, the majority (83%) of supraglottic experience in the cohort was with a laryngeal mask airway.

Table 3 Results of airway type on time to success in the simulation lab

Unadjusted analysis	Mean (SD)	
Airway		
i-gel	48.5 s (20.6)	
AuraGain	68.9 s (22.1)	
ETI	129.5 s (39.6)	
Adjusted analysis	**Mean difference (95% CI)***	**P value**
Airway		
i-gel	***−81.0 s (−89.5 to −72.5)***	***<0.01***
AuraGain	***−60.6 s (−69.1 to −52.1)***	
ETI	Referent	
Age (years)	0.2 (−0.6 to 1.0)	0.65
Male gender	5.9 (−6.7 to 18.5)	0.36
Years of prior EMS experience		
None	Referent	0.22
>0–3 years	3.1 (−13.3 to 19.4)	
≥3 to <5 years	8.5 (−8.8 to 26.0)	
5+ years	−8.6 (−28.2 to 11.1)	
Previous healthcare degree	−17.7 (−46.7 to 11.3)	0.23

Mixed effects model to control for repeated measurements within student and using methods to incorporate data from multiple imputed data.
Bolded italicised values are significant, p<0.05.
*Difference in i-gel and AuraGain is as follows: as compared with AuraGain, i-gel shows a reduction in seconds of 20.4 (95% CI 11.9 to 28.8, p<0.01).
EMS, emergency medical systems; ETI, endotracheal intubation.

Table 4 Unadjusted statistics of time to success by airway type in the operating room

	i-gel		AirQ	
	N	Mean (SD)	N	Mean (SD)
Operating room	21	34.3 (15.4)	21	45.2 (39.1)
Operating room (per protocol)	20	31.6 (9.2)	20	45.2 (39.1)

DISCUSSION

In this study, we found that the i-gel and laryngeal mask airways were able to be placed more rapidly than endotracheal tubes by paramedic students, and that both were effective at oxygenating and ventilating patients in the operating room. The i-gel had the fastest time to placement in the simulation lab; while in the operating room, time to placement between the laryngeal mask airway and the i-gel was not significantly different. Importantly, students were able to translate the simulation experience to patients and were successful with supraglottic device placements in the operating room. Our results suggest that supraglottic devices, and in particular the i-gel, may be a paediatric airway solution that EMS agencies can deploy with modest training resources among providers with limited paediatric airway experience.

There are several potential reasons for the differences observed in placement times of the two devices between the simulation and operating room. First, the simulation scenario more closely mimicked an EMS patient encounter. Paramedic students had to remove the equipment from pockets of an equipment bag and insert the airway device into the mannequin while CPR was being performed. In contrast, in the operating room the equipment was all prepared prior to the procedure and chest compressions were not being performed during the airway procedure. In the simulation scenarios, participants had to locate a 10 mL syringe to inflate the laryngeal mask cuff in an airway kit, which

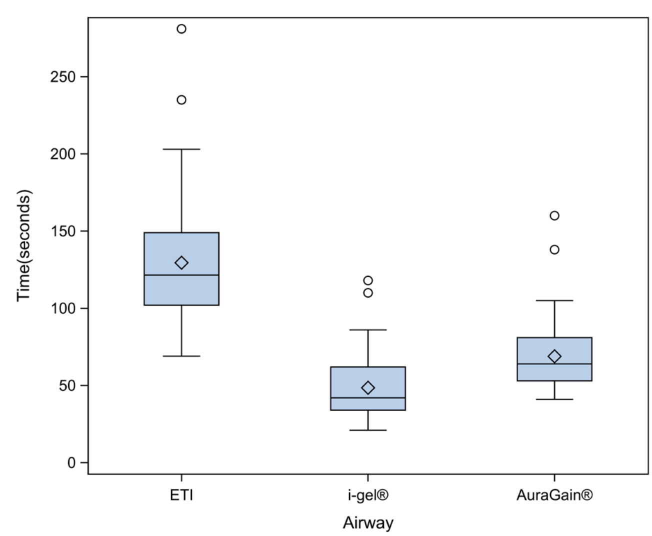

Figure 1 Box plots comparing time to airway placement in the simulation lab between endotracheal intubation, the i-gel and AuraGain. The horizontal line within the box is the median, the diamond is the mean. The box contains the middle 50th percentile of observations. The whiskers represent last observation that is within 1.5 times the box height. The circles represent potential outliers.

Table 5 Results of regression of airway type on outcomes in the operating room

	Time to first breath (seconds)		Average tidal volume of first five breaths (mL)		Leak pressure cm/$H_2$0	
	Slope coefficient (95% CI)*	P value	Slope coefficient (95% CI)	P value	Slope coefficient (95% CI)*	P value
Airway						
i-gel	−3.3 (-21.9 to 15.3)	0.73	59.1 (−5.5 to 123.6)	0.07	3.1 (−0.6 to 6.9)	0.10
Air-Q	Referent		Referent		Referent	
Age	−0.2 (−1.4 to 1.1)	0.77	−0.6 (−4.9 to 3.8)	0.80	0.2 (−0.1 to 0.5)	0.12
Male gender	7.1 (−14.8 to 29)	0.53	−30.3 (−108 to 47.3)	0.44	3.9 (−1 to 8.7)	0.12
Years of prior emergency medical systems experience						
None	Referent	0.47	Referent	0.38	Referent	0.85
>0 to 3 years	−10.9 (−37.8 to 15.9)		−2.9 (−98.4 to 92.7)		0.9 (−5.2 to 7)	
3+ years	−18.7 (−48.3 to 10.8)		54.4 (−50.5 to 159.2)		−0.6 (−7.2 to 6)	
No of previous placements of similar airway	2 (−0.2 to 4.2)	0.07	2 (−5.7 to 9.6)	0.62	***−0.5 (−1 to 0)***	***0.04***

Mixed effects model to control for repeated measurements within paramedic student and using methods to incorporate data from multiple imputed data.
Bolded italicized values are significant, p<0.05.
Findings, as compared to air-Q, i-gel showed a trend toward a higher average of the first five breaths with a mean differences of 59.1 mL (95% CI: −5.5 to 123.6; p=0.07). There was also a significant inverse relationship between number of previous placements and leak pressure with a decrease of 0.5 cm/H20 (95% CI: 0.0 to 1.0; p=0.04) (for each additional airway previously placed.

was kept separate from where the supraglottic devices were kept. We used a commercially available equipment bag packaged according to the standards of the largest EMS agency in our area. Other equipment kits may result in different placement times. Finally, nearly all students tested the cuff of the laryngeal mask in the simulation scenarios, but in the operating room this was typically not done. Our findings suggest that the i-gel and laryngeal mask airways are both able to be placed quickly once the equipment has been prepared, though cuff inflation may result in modest delays in laryngeal mask airway placement. We believe the actual times observed in the study in controlled environments are not likely what would be seen in the field, and that relative differences between devices are likely amplified in a ‘real-world’ environment where stress levels are higher and the environment uncontrolled. Future research should report on supraglottic devices being used in the field, and ideally a prospective randomised trial would be conducted to compare supraglottic devices to ETI and/or bag-valve-mask ventilation.

Overall, the students rated the the i-gel as easier to use, though these differences were only significant in the simulation lab portion of the study. We found that students with less supraglottic device experience rated the i-gel as significantly easier to use than the laryngeal mask airway. The supraglottic device experience in our group was highly weighted towards laryngeal mask placements with an average of five previous laryngeal mask placements compared with one i-gel. Of note, in the simulation lab, the devices were packaged in a standard EMS kit while in the operating room airway devices were prepared and ready before the case began. This likely had a significant effect on ease of use rating differences between the groups since participants in simulation had to locate an inflation syringe and usually tested the inflatable cuff on the Ambu laryngeal mask for leaks.

There are relatively few studies of supraglottic devices being placed by paramedics in paediatric scenarios. Previous studies have evaluated supraglottic devices when used by paramedics in adults. After brief training, i-gel airway devices were more successful and rapid to place in adult mannequins compared with laryngeal mask airways or endotracheal tubes among

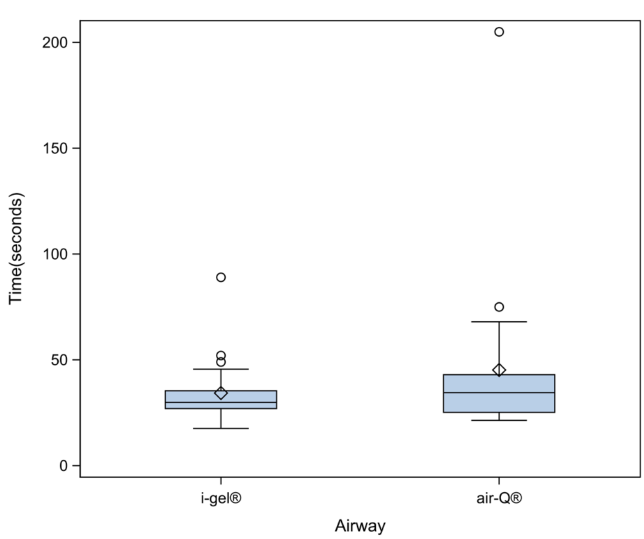

Figure 2 Box plots comparing time to airway placement in the operating room between the i-gel and the air-Q. The horizontal line within the box is the median, the diamond is the mean. The box contains the middle 50th percentile of observations. The whiskers represent last observation that is within 1.5 times the box height. The circles represent potential outliers.

Table 6 Ease of use ratings

	Simulation lab results*			Operating room results‡	
	i-gel	AuraGain	ETI	i-gel	AirQ
	n=58, %	n=58, %	n=58, %	n=22, %	n=21, %
1-easiest	52 (90)	10 (17)	4 (7)	16 (73)	11 (52)
2	5 (9)	36 (62)	12 (21)	5 (23)	9 (43)
3	0	11 (19)	14 (24)	1 (5)	1 (5)
4-hardest	1 (2)	1 (2)	28 (48)	0 (0.0)	0 (0)

One student in the operating room arm did not perform both i-gel and AirQ.
*P<0.01 for pairwise comparisons: i-gelvs AuraGain (sign rank S=495), AuraGain vs ETI (sign rank S=493), and i-gelvs ETI (sign rank S=735).
†P=0.22 for i-gelvs AirQ comparison.
ETI, endotracheal intubation.

experienced paramedics.[22] Another simulation study similarly found that novice paramedics had greater success and better skill retention with supraglottic devices compared with ETI after brief training.[23] One randomised trial found that adults with out-of-hospital cardiac arrest had improved survival when a laryngeal tube was used as the initial airway.[7] The relative benefits of supraglottic devices may be accentuated in children compared with adults since the even the most extensive training programmes and well-designed EMS systems have limited exposure to paediatric airway procedures.[24 25] The resources required for EMS agencies to maintain high levels of competency with supraglottic devices is likely significantly less than ETI.

This study took place in controlled environments and may not reflect field performance. This also does not address managing an airway with a supraglottic device in the presence of significant secretions. The paramedic students in the study did not have prior field experience with these devices. However, they did have recent lab training, primarily with the laryngeal mask, which could affect the results. We did not include any laryngeal tube devices in the study since they were not available in comprehensive paediatric sizes at the time the study was developed. Finally, we used different brand laryngeal mask airways between the two portions of the study which could also affect results.

CONCLUSIONS

We found that paramedic students were able to place supraglottic devices rapidly with high success rates in simulation lab and operating room environments. Supraglottic devices, particularly the i-gel, were rated as easy to use. The i-gel may be easiest to use since it lacks an inflable cuff and requires fewer steps to place.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval The study was approved by the Oregon Health & Science University (OHSU) Institutional Review Board numbers 00016591 and 00016813.

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