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Comparison of three supraglottic airway devices for blind tracheal intubation by novice practitioners: A randomized manikin study

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Abstract:

OBJECTIVES: Supraglottic airway (SGA) devices are good alternatives for failed intubations or difficult airways. The aim of our study was to compare the success of intubation with SGA devices such as LMA Fastrach® (LMA Fastrach), Ambu Aura-i® (Aura-i), and Cookgas Air-Q® (Air-Q) in an airway manikin by novice practitioners.

METHODS: This study was conducted in a randomized crossover design using a manikin model. Following training on the equipment used, 36 6th-year medical students were randomized into six groups. Participants performed three stages of intubation as follows: the first stage (1S) as SGA insertion, the second stage (2S) as intubation through the SGA, and the third stage (3S) as the removal of the SGA over the intubation tube. The primary outcomes were intubation success and duration.

RESULTS: The successful intubation rate (Stage 1S + 2S + 3S) was 100% for LMA Fastrach and Air-Q and 83.3% for Aura-i ($P = 0.002$). The median time to intubation was 54.4 s, 55.8 s, and 58.7 s for LMA Fastrach, Aura-i, and Air-Q, respectively ($P = 0.794$).

CONCLUSION: Our study shows that novice practitioners can proficiently utilize LMA Fastrach, Air-Q, and Aura-i as SGAs in airway management. LMA Fastrach and Air-Q are more successful for endotracheal intubation than Aura-i. While the successful intubation time with SGA is similar for all three devices, the successful SGA insertion time is shorter with LMA Fastrach and Aura-i compared to Air-Q. Practitioners preferred LMA Fastrach and Air-Q more than Aura-i.

Keywords:

Airway management supraglottic airway devices, Ambu Aura-i, Cookgas Air-Q, endotracheal intubation, laryngeal mask, laryngeal mask airway, LMA Fastrach

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Introduction

Endotracheal intubation is the gold-standard practice for patients requiring advanced airway management. The first attempt at direct laryngoscopy-guided intubation in the emergency department is successful in 84% of patients; however, this rate falls to 71% with inexperienced practitioners.[1]

Supraglottic airway (SGA) devices are a good alternative for patients with difficult airways or after failed intubation. In the 2020 American Heart Association-Advanced Cardiovascular Life Support guidelines,

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Box-ED Section

What is already known about the study topic?
- Supraglottic airway devices are good alternatives for patients with difficult airways or after failed intubation.

What is the conflict on the issue? Has it importance for readers?
- Many types of supraglottic airways (SGAs) have been developed in the last 20 years. Therefore, it has become important to evaluate the efficacy and success of these devices and to compare them with other devices
- Although there are several studies in the literature comparing SGAs, there are few studies comparing the success of the use of SGAs by novice users.

How is this study structured?
- This study was a prospective, cross-over design manikin study with 36 6th-year medical school students.

What does this study tell us?
- Novice practitioners can safely use the LMA Fastrach, Air-Q, and Aura-i as SGAs for airway management
- LMA Fastrach and Air-Q are more successful than Aura-i for endotracheal intubation.
- Successful intubation time with SGA is similar for all three devices
- Successful SGA insertion time is shorter with LMA Fastrach and Aura-i than with Air-Q
- Novice practitioners preferred LMA Fastrach and Air-Q more than Aura-i.

endotracheal intubation or the use of SGA has been reported as the first-line option for advanced airway management.[2] SGAs are not permanent airway devices. Aspiration of gastric contents is one of the most important complications. After placement of the SGA, the patient can be temporarily ventilated, but aspiration of gastric contents cannot be adequately prevented.[3] Therefore, SGAs suitable for intubation as a conduit have been developed, allowing the practitioner to intubate the patient after placement of the SGA and establishment of ventilation. Intubation through these devices can be performed by visualizing the vocal cords with a fiberoptic bronchoscope or blindly without visualizing the vocal cords.[4] After the endotracheal tube (ETT) is placed through the SGA, the SGA can be removed.

Many types of SGAs have been developed over the last 20 years. Therefore, it has become important to evaluate the effectiveness and success of these devices and compare them with other tools. Although there are several studies in the literature comparing SGAs, few studies have compared the success of the use of SGAs by novice users.

We aimed to compare the different types of SGAs (LMA Fastrach® [LMA Fastrach], Ambu Aura-i® [Aura-i], and Cookgas Air-Q® [Air-Q]) with respect to successful intubation with SGA and time taken to perform tracheal tube placement in an adult airway manikin by novice practitioners. The secondary outcome was participant device preference.

Methods

The study was planned to have a prospective and crossover design. It was conducted at the Department of Emergency Medicine, Dokuz Eylul University, School of Medicine, following approval from the Ethics Committee of the University, School of Medicine (date: July 31, 2019, file number: 4906-GOA, and decision number: 2019/19-37).

Participants

The sample size for the study was determined to be 37 participants out of 350 6th-year medical students, with a 10% margin of error and 80% statistical power. However, as the aim was to randomly assign an equal number of participants to six study groups, 36 participants were included in the study.

Participants who had previously used any type of SGA or who refused to participate in the study were excluded from the study. Written informed consent was obtained from all participants.

Participants were randomly divided into six different groups using Randomizer software (randomizer.org). In this way, each group was allowed to apply the SGA devices in a different order (Group 1: LMA Fasttrach→Ambu Aura-i→Cookgas Air-Q, Group 2: LMA Fasttrach→Cookgas Air-Q,→Ambu Aura-i, Group 3: Ambu Aura-i→LMA Fasttrach→Cookgas Air-Q, Group 4: Ambu Aura-i→Cookgas Air-Q→LMA Fasttrach, Group 5: Cookgas Air-Q→LMA Fasttrach→Ambu Aura-i, Group 6: Cookgas Air-Q→Ambu Aura-i→LMA Fasttrach).

Materials

Three different SGA devices were used in the study: LMA Fastrach® size 4 (Teleflex Medical Europe Ltd. Westmeath, Ireland), Aura-i® size 4 (Ambu Ltd, St Ives, Cambridgeshire, UK), and Air-Q® size 3.5 (Cookgas LLC; Mercury Medical, Clearwater, FL, USA) [Figure 1]. The selected sizes aligned with data from previous manikin studies,[5,6] and were in accordance with the sizes recommended by the manufacturers for a 70 kg adult human. The Simulaids® adult airway manikin (Simulaids, Inc., Saugerties, NY) was used in the neutral position for training in the study. Intubation was performed using a standard 6.0-mm cuffed ETT. The stabilizing rod supplied with the LMA Fastrach was used to remove

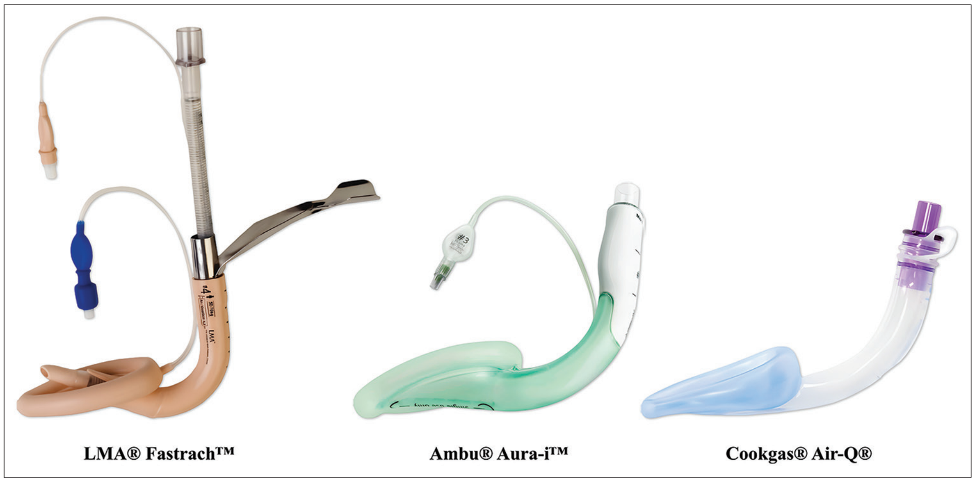

Figure 1: Materials

the SGA over the intubation tube. The duration of each stage of intubation was measured with a stopwatch on a Samsung® Note 5 mobile phone. A toolkit, including lubricant, injectors, and a balloon valve mask (BVM), was made available beside the airway manikin for practice sessions. The lubricating gel was applied to all SGAs and ETTs before the start of the practice.

Practice and calculations

Participants received 30 min of standard training on basic airway anatomy, physiology, pathophysiology, and advanced airway management from an emergency medicine instructor. Subsequently, hands-on training was provided with the SGA devices used in the study. It was ensured that each participant successfully inserted all SGAs into the airway manikin at least once. The study was conducted 4 weeks after this training.

Each participant was allowed a maximum of three intubation attempts for each SGA. The swelling of the manikin's lungs by visual observation was accepted as "successful intubation." The swelling of the manikin's stoma or inability to intubate within 60 s was accepted as "intubation failure."

The first stage (1S) of SGA intubation was the SGA insertion, the second stage (2S) was intubation through the SGA with ETT, and the third stage (3S) was the removal of the SGA over the intubation tube for permanent intubation. Stage 1S started upon command and ended when the participant started ventilating the manikin with the BVM after inserting the SGA and inflating the cuff. Stage 2S started when the participant detached the BVM from the tip of the SGA and ended when the participant started ventilating the manikin with the BVM after inserting the ETT through the SGA and inflating the ETT cuff. Stage 3S started with the detachment of the BVM from the tip of the ETT and ended when the participant ventilated the manikin with the BMV after the SGA was removed using the stabilizing rod over the ETT. Participants were asked to proceed to the next stage after each successfully completed stage. If intubation was unsuccessful, the participant was restarted with Stage 1S. Application times were recorded on the data collection form after the successful completion of each stage. The next SGA application was started according to the order in the group after the three stages of intubation.

After the applications, the participants were asked about their device preferences, and the difficulty level of the application for each SGA was scored on a five-point Likert scale ("very difficult": 1, "hard": 2, "neutral": 3, "easy": 4, and "very easy": 5).

The primary outcomes included the successful intubation rate and successful ETT placement times (Stage 1S, 2S, 3S, 1S + 2S, and 1S + 2S + 3S) [Figure 2]. Secondary outcomes were participant satisfaction and device preferences.

Statistical analysis

The study data were analyzed in the "Statistical Package for the Social Sciences for Windows 25.0" software (IBM Corporation, Armonk, New York, United States). The normal distribution of numerical variables was tested with the Kolmogorov–Smirnov test. The Friedman test was used to compare SGA application times and satisfaction levels of SGAs between three groups, and the Wilcoxon test was used to compare two groups. Categorical variables were analyzed using the Chi-square test. Variables were analyzed at a 95% confidence level, and $P < 0.05$ was considered significant.

Results

Thirty-six 6th-year medical students participated in this study. The median age was 24 years (interquartile range [IQR]: 23–25), and 20 of the participants (55.6%) were male. Primary and secondary outcomes were not significantly different between the genders ($P > 0.05$).

All participants were able to successfully intubate (Stage 1S + 2S + 3S) with LMA Fastrach and Air-Q, and only 30 (83.3%) participants successfully used Aura-i [Table 1]. The success rate of the intubation was higher with the LMA Fastrach and the Air-Q compared to the Aura-i ($P = 0.002$). The median successful intubation time (Stage 1S + 2S + 3S) was calculated to be 54.4 s for LMA Fastrach, 55.8 s for Aura-i, and 58.7 s for Air-Q. There was no significant difference between the successful intubation times of all three SGAs ($P = 0.794$) [Table 2].

It was found that all participants successfully applied for Stage 1S, which is the placement stage of the SGA. There was no significant difference between LMA Fastrach and Aura-i in terms of the time to successful completion of Stage 1S ($P = 0.321$). Both LMA Fastrach and Aura-i were found to be applied significantly faster than Air-Q (13 s, 12.4 s, and 14.4 s respectively, $P = 0.007$ and $P < 0.001$, [Table 2]).

All participants successfully completed Stage 2S with LMA Fastrach and Air-Q in a maximum of two attempts. Despite three attempts for Aura-i, only 30 (83.3%) participants were successfully completed Stage 2S. The rate of successful completion of Stage 2S with LMA Fastrach and Air-Q was significantly higher than Aura-i ($P < 0.001$). The time to successful completion of Stage 2S was 18 s for LMA Fastrach, 17.4 s for Air-Q, and 17.3 s for Aura-i, and there was no significant difference between them ($P = 0.927$) [Table 2]. There was also no significant difference between the three SGAs in the duration of Stage 1S + 2S, which includes successful placement of the SGA and passing the ETT through it ($P = 0.239$) [Table 2].

When the participants were asked which of the SGAs they would prefer, 16 (44.4%) participants stated that they would prefer LMA Fastrach, 8 (22.2%) participants Aura-i, and 12 (33.3%) participants Air-Q. There was a significant difference among the groups ($P = 0.013$). While LMA Fastrach and Air-Q were significantly more preferred than Aura-i, there was no significant difference between LMA Fastrach and Air-Q ($P = 0.014$ for LMA Fastrach vs. Aura-i, $P = 0.004$ for Air-Q vs. Aura-i, and $P = 0.561$ for LMA Fastrach vs. Air-Q). Participants' satisfaction with SGAs, assessed using a five-point Likert scale, yielded median scores of 4.5 (IQR: 4.0–5.0) for Air-Q, 4.0 (IQR: 4.0–5.0) for LMA Fastrach, and 4.0 (IQR: 2.0–5.0) for Aura-i [Figure 3]. A significant difference in satisfaction was observed across all groups ($P = 0.018$).

Discussion

The results of our study comparing three different SGAs suitable for endotracheal intubation showed that 6th-year medical students were more successful in performing endotracheal intubation with SGA using ILMA and Air-Q than with Aura-i.

In Stage 2S, where an ETT was inserted through the supraglottic airway (SGA), Aura-i exhibited more failures compared to ILMA and Air-Q. The reason

Table 1: Successfully intubate rates (Stage 1S + 2S + 3S) with LMA Fastrach, Air-Q, and Aura-i

	LMA Fastrach, *n* (%)	Air-q, *n* (%)	Aura-i, *n* (%)
Attempt 1	34 (94.4)	34 (94.4)	15 (41.7)
Attempt 2	2 (5.6)	2 (5.6)	7 (19.4)
Attempt 3	-	-	8 (22.2)
Total	36 (100)	36 (100)	30 (83.3)

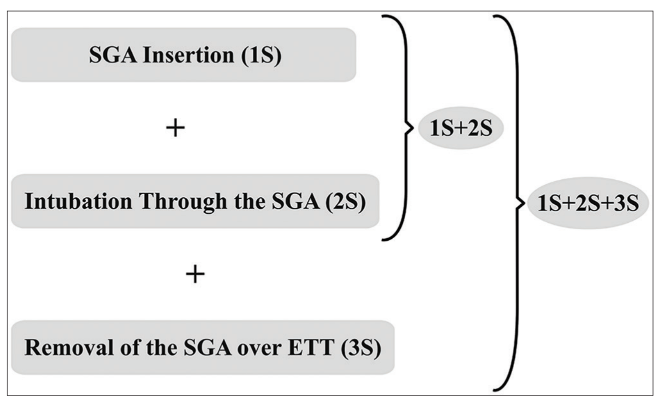

Figure 2: Stage of intubation with supraglottic airway. ETT: Endotracheal tube

Table 2: Successful insertion times of LMA Fastrach, Air-Q, and Aura-i

	Stage 1S (s), median (ıqr)	Stage 2S (s), median (ıqr)	Stage 3S (s), median (ıqr)	Stage 1S + 2S (s), median (ıqr)	Stage 1S + 2S + 3S (s), median (ıqr)
LMA Fastrach	13 (12–14.6)	18 (14.1–21.8)	24.3 (21–29.7)	31.8 (27.7–37.9)	54.4 (51.2–62.4)
Aura-i	12.4 (11–13.6)	17.3* (14.7–20.6)	26.3* (21.9–31.1)	30.2* (27–33.7)	55.8* (48.5–64.9)
Air-Q	14.4 (12.9–16.4)	17.4 (15–19.6)	25.9 (22.6–30.3)	33 (28.7–35.7)	58.7 (52.9–65.1)
LMA Fastrach and Aura-i and Air-Q (*P*)	0.003	0.927	0.195	0.239	0.794
LMA Fastrach vs Aura-i	0.321	0.861	0.141	0.753	0.807
LMA Fastrach vs Air-Q	0.007	0.715	0.405	0.906	0.715
Aura-i vs Air-Q	<0.001	0.865	0.422	0.363	0.865

*Since six people failed the first stage, *n*=30 was calculated. IQR: Interquartile range for more unsuccessful ETT may be the inadequacy in directing ETT to the trachea by Aura-i compared with LMA Fastrach and Air-Q [Figure 4]. LMA Fastrach was designed with an iron body so that it has a rigid structure and a narrow angle to better direct ETT into the trachea. Air-Q has a ramp-shaped protrusion at the tip of the body to guide an ETT into the trachea. Aura-i may not be sufficient to direct an ETT into the trachea. This disadvantage of intubation with the Aura-i can be overcome using a fiberoptic bronchoscope.

Each participant who successfully completed Stage 2S could remove the SGA over the intubation tube. At this point, it can be said that the intubation with SGA will be successful if the ETT is successfully inserted through the SGA.

Artime *et al*.[7] showed that the success of intubation with LMA Fastrach was similar in both fiberoptic bronchoscope-guided insertion and blind intubation techniques. Schiewe *et al*.[8] found similar results for intubation with Aura-i. However, they showed that blind intubation with LMA Fastrach was faster than bronchoscope-guided intubation with Aura-i. Schiewe *et al*.[8] and Anand *et al*.[9] compared the rate of successful blind intubation and the time taken to tracheal intubation with LMA Fastrach and Aura-i and found that LMA Fastrach was more successful and faster than Aura-i. In our study, blind intubation with LMA Fastrach was more successful than with Aura-i; however, the successful intubation times did not differ between LMA Fastrach and Aura-i. The results of our study are consistent with the literature.

In our study, we did not observe any significant differences between LMA Fastrach and Aura-i in the successful placement of SGA in Stage 1S. Similarly, some studies have reported the successful placement of these SGAs.[8,9] According to these results, LMA Fastrach or Aura-i can be used in patients who have planned only SGA without an ETT insertion as in emergency situations.

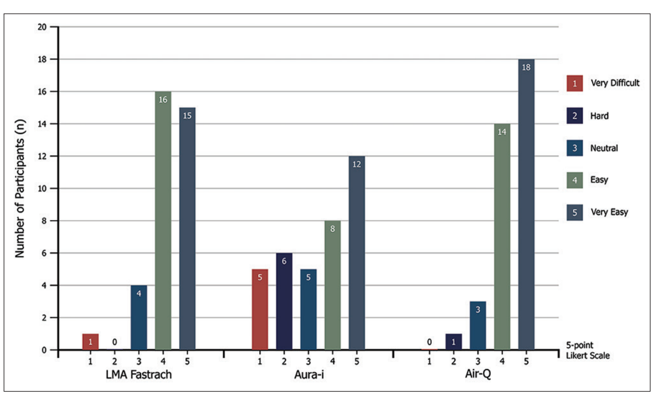

Figure 3: Participants' satisfaction with supraglottic airways with the 5-point Likert scale

LMA Fastrach, the first developed and widely used SGA device designed for intubation, has been extensively studied.[10-14] Air-Q is another SGA device suitable for intubation and is considered a good alternative to LMA Fastrach. Studies in the literature by Karim and Swanson,[10] Neoh and Choy,[11] and Erlacher *et al*.[12] have shown that intubation with LMA-Fastrach was more successful than intubation with Air-Q. Badawi *et al*.[13] and Seyed Siamdoust *et al*.[14] found no significant differences in intubation success between LMA Fastrach and Air-Q. Similarly, Abdel-Halim *et al*.[15] showed no significant differences in fiberoptic bronchoscope-guided intubation success between LMA Fastrach and Air-Q. Our study also showed no significant differences in intubation success between LMA Fastrach and Air-Q. On the other hand, studies have reported that the device insertion time and intubation time were significantly longer with the Air-Q compared to the LMA Fastrach. In contrast, we found no significant difference in the time to successful intubation between ILMA, Aura-i, and Air-Q.

In the literature, most studies have evaluated the ease of SGA insertion. On the other hand, only a few studies asked participants which SGA they preferred. de Lloyd *et al*.[16] showed that the participants preferred LMA Fastrach more than Aura-i. Similarly, in our study, participants preferred ILMA and Air-Q over Aura-i. Furthermore, there were no differences in participant preference between LMA Fastrach and Air-Q.

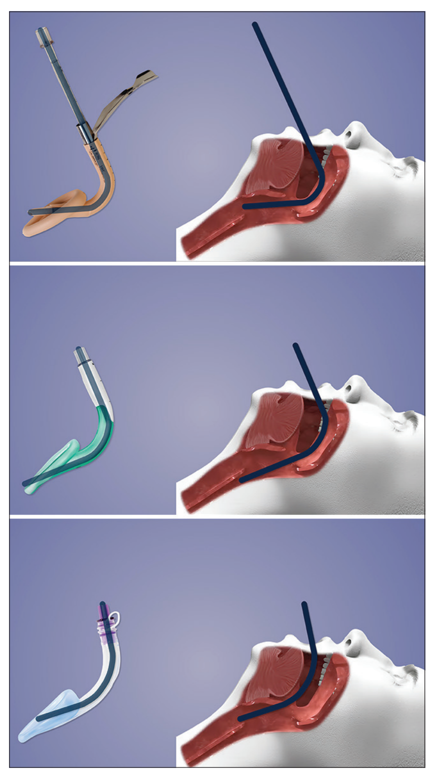

Figure 4: Angle of supraglottic airways

Limitations

Our study was conducted with 6th-year medical students who had no experience with SGA. Different results may be obtained from experienced physicians or health professionals in different groups, such as anesthesiologists, emergency medicine specialists, paramedics, or nurses. The airway anatomy of the manikin is not fully equivalent to that of the adult human, and our results may have been affected by this difference. It should also be noted that SGA insertion into a manikin is quicker than that in a human. Because a standard adult airway manikin was used in our study, the results cannot be generalized to children or patients with difficult airways.

Conclusion

The findings of our study show that novice practitioners can proficiently utilize LMA Fastrach, Air-Q, and Aura-i as SGAs for patient ventilation in airway management. If the aim is endotracheal intubation after SGA insertion, LMA Fastrach and Air-Q should be preferred. While the time required for successful intubation remains comparable across all three devices, the duration for successful SGA insertion is shorter with LMA Fastrach and Aura-i than with Air-Q. Furthermore, novice users, in this case, 6th-year medical students, exhibited a preference for LMA Fastrach and Air-Q over Aura-i.

Authors' contributions

Conceptualization – OS, NC, BB; Data curation – OS, SGK, SSH; Formal analysis – NC,BB; Funding acquisition - OS; Methodology – OS, NC, BB; Project administration – OS, SGK, SSH; Resources – NC, BB; Software – SGK, OS; Supervision –.NC, BB, OS; Validation – OS, SGK; Visualization – SGK; Writing – original draft – OS,NC, BB, SGK,SSH; Writing – review & editing- OS, NC.

Conflicts of interest

None declared.

Ethics approval

The approval of the Ethics Committee for Clinical Studies of Dokuz Eylül University Faculty of Medicine (date: 31.07.2019, file number: 4906-GOA, and decision number: 2019/19-37) was obtained for the study.

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