Anti-Choking Suction Devices for Foreign Body Airway Obstruction in Children. Would Parents and Kindergarten Teachers be Able to Use Them Without Training?

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Abstract

There is limited scientific evidence on the brand-new suction anti-choking devices as alternative or complementary tools for the treatment of foreign body airway obstruction (FBAO). However, they are already available in some public places. With the hypothesis that laypersons would not use them properly we have carried out the present simulation study. A randomized crossover trial study in a simulated FBAO scenario was conducted. Forty-two parents and eight kindergarten staff without knowledge about anti-choking devices voluntarily participated. Participants had to solve a simulated FBAO situation in three randomized scenarios: 1) Following the current choking international guidelines, 2) Using the LifeVac® device, and 3) Using DeCHOKER® device, according to the instructions provided by manufacturers. Data from 51 participants (54.9% female) were analyzed. Higher success rate was achieved with the LifeVac® and DeCHOKER® devices in comparison with the standard FBAO protocol (median [IQR]: 100.0% [83.0-100.0], 100.0% [75.0-100.0], and 50% [38.0-75.0] respectively; $p=0.004$). No significant differences were observed between both anti-choking devices ($p=0.796$). The procedure time was significantly shorter with the LifeVac® device ($p<0.001$).

Conclusion: Untrained laypeople, under simulated conditions, are able to properly handle LifeVac® and DeCHOKER® anti-choking devices according to the manufacturer's instructions in less than one minute. However, they have difficulties to perform the current recommended choking protocol. Further studies are needed to confirm whether the new devices could have a role in the FBAO management.

What Is Known

- Anti-choking suction devices has recently emerged for the management of foreign body airway obstruction.
- Foreign body airway obstruction is relatively frequent in children.
- There is insufficient evidence for recommend or not recommend the use of anti-choking suction devices.

What is new

- Laypeople were able to use anti-choking suction devices under simulated condition.
- Participants had difficulties to carry out the recommended choking protocol even being provided with the instructions.

Introduction

Foreign body airway obstruction (FBAO) events are relatively common in children [1], particularly in preschool age because their behaviour predisposes to it [2]. FBAO situations represent a potentially life-

threatening emergency that requires immediate recognition and intervention [3] since victims may quickly progress to unresponsiveness and death [4].

Bystanders often intuitively intervene in case of FBAO. In the case of children, most choking events happen at home or at school, where children spend most of their time [5]. Therefore, parents and/or teachers are more likely to be the first responders in such cases. Interventions required will differ depending on whether it is a mild or severe airway obstruction. Current guidelines recommend encouraging to cough while coughing is effective (mild airway obstruction) and afterwards the combination of back blows and abdominal thrust ("Heimlich maneuver") [6] or chest thrust (in children under one year of age) (severe airway obstruction) [4,7].

However, despite FBAO being an important health problem, the evidence available to support these guidelines is weak [8–12]. This, in addition to the risk associated with abdominal thrusts in children (risk of thoracic, vascular, and gastroesophageal injury) [13], leads to a continuous search for a universally accepted and successful technique for FBAO removal.

Recent treatments proposed for the management of FBAO are anti-choking suction devices. Currently, two such devices are commercially available: LifeVac® [14] and DeCHOKER® [15]. Both are relatively simple and non-powered portable devices. They aim to generate a strong negative pressure in the oral airway that helps to relieve airway obstruction. By manufacturers' own choice, they recommend in the product leaflets and websites to apply them when the standard choking protocol fails.

These anti-choking devices are Class 1 registered by the Food and Drug Administration (FDA) for use in a choking emergency, simple registration for low-risk devices that are exempted from further FDA clearance or formal approval and have not passed through a submission and assessment process [8]. Nevertheless, they are widely available for anyone to use them in locations such as airports, hotels, or shopping centers [16]. A recent systematic review on the anti-choking suction devices showed that, given the limited scientific data and biased trials that have tested the use and effectiveness of these devices, there is insufficient evidence for or against their use [17]. Likewise, based on of the limited scientific literature on these devices, the International Liaison Committee on Resuscitation has revealed the need for further research to take a position supporting or opposing these devices [18].

Therefore, this study aimed to evaluate, in a simulated child choking scenario, the ability of parents and teachers (people with a high likelihood of involvement in an FBAO event) to perform the recommended actions for the management of FBAO and to compare it with the use of these two anti-choking suction devices quickly and correctly.

Methods

Participants

Forty-two parents (84.3%) and eight kindergarten teachers (15.7%), (n=51; 54.9% female) without prior knowledge about suction devices took part voluntarily in this study. Written informed consent on the understanding that the data obtained would be anonymous and used only for research purposes was obtained from all participants. The study was conducted following the 2013 amended Declaration of Helsinki; the protocol was waived by the local Research Ethics Committee because it did not involve the use of participant's health data, the collection of biological samples, or intervention on participants.

Procedure

We conducted a randomized crossover trial in an in-situ (daycare center) simulated FBAO scenario. Participants (n=51) were asked to act in a simulated choking situation in three different scenarios: 1) performing the recommended protocol [Recommended protocol test]; 2) using LifeVac[®] device [LifeVac test]; and 3) using DeCHOKER[®] device [Dechoker test]. This resulted in 153 FBAO events (Figure 1). The tests' performance order was randomised.

In the "Recommended protocol" test participants were provided with instructions of the protocol for airway obstruction according to the international guidelines [4,7] displayed in a wall poster. Following these instructions, they were to respond initially on a simulated victim (a 21-year-old woman, height 1.53 m, weight 46.5 kg, member of the research team) who played a mild airway obstruction, which subsequently became severe, and finally, the victim simulated unresponsiveness, so that participants had to perform all the steps of the mentioned protocol.

Regarding LifeVac test and Dechoker test, the solving of the FBAO simulation was carried out with a junior manikin (Resusci Junior QCPR[™]; Laerdal) (Figure 1). In both tests, participants were given the anti-choking suction devices (LifeVac[®] or DeCHOKER[®]) with the manufacturer's leaflet instructions. Participants had not been previously trained and did not have the opportunity to handle or test the anti-choking suction devices before the tests.

Neither support nor advices were provided to participants during the tests, assuming that they were alone in the incident scenario. The execution of each of the steps (yes/no and correctly/incorrectly performed) according to the corresponding test was assessed by means of a specific checklist by a researcher. Another team member recorded the time taken to carry out the steps and the overall test time.

Instruments

Two anti-choking suction devices were used in the present study: LifeVac[®] and DeCHOKER[®]. LifeVac[®] LifeVac (Nesconset, New York, USA) consists of a one-way valve and a plunger attached to a standard face mask (with three different sizes depending on the anthropometric profile of the victim: pediatric, child, and adult mask). To remove the foreign body from the airway, the mask is held over the choking victim's nose and mouth, and then, two repeated movements are required: push and pull handle. LifeVac[®] is not recommended for choking victims under 10 kg bodyweight.

DeCHOKER® (Concord, North Carolina, USA) is a single device composed of a mask attached to an oropharyngeal tube that needs to be positioned above the tongue, joined to a large cylinder with a plunger. To generate negative pressure, it is necessary to pull the plunger out with force. DeCHOKER® is also available in three different sizes (toddlers, children, and adults) according to the age of the victim, and it is recommended from one year onwards.

This study used for LifeVac test and Dechoker test the manikin Resusci Junior QCPR™ (Laerdal, Medical AS, Stavanger, Norway) which simulates a 6 year old child. For the LifeVac test the child size mask was used and for the Dechoker test the children device was used (participants did not have to select it, we gave them the right size).

Variables

Age, gender, weight and height of each participant were registered. In addition, they were asked about whether they had received previous training on choking (if yes, when it had happened); about whether they had witnessed a real FBAO situation (and when it had happened) and, whether they had acted or not. Moreover, they were also asked about their subjective perception of whether they feel they would be able to solve a FBAO situation (yes/no).

In all three tests, the performance of each step (yes/no) and, if done, the correct execution (yes/no) were recorded (Figure 1). To compare quantitatively the three tests, the variable *estimated success rate* was calculated taking into account whether or not the recommended steps were taken and whether or not they were performed correctly.

The estimated success rate for the "Recommended protocol" test comprised the following dichotomic items: 1) encouraging to cough; 2) giving back blows; 3) giving back blows correctly; 4) giving abdominal thrust; 5) giving abdominal thrust correctly; 6) continue to 5 back blows and 5 abdominal thrusts; 7) continue to 5 back blows and 5 abdominal thrusts correctly; and 8) Starting CPR for victim's unresponsiveness. The estimated success rate for the LifeVac test: 1) inserting the mask into the device, 2) place the mask covering nose and mouth of the victim correctly, 3) fixing the mask to the victim's airway, 4) push in handle, 5) pull handle, and 6) keeping the mask fixed to the victim's airway throughout the procedure. Lastly, the estimated success rate for Dechoker test: 1) place the mask covering nose and mouth of the victim correctly, 2) fixing the mask to the victim's airway, 3) pull the plunger out with force, and 4) keeping the mask fixed to the victim's airway throughout the procedure. Finally, the overall time of the tests and the partial times of each of the phases were recorded (Figure 1).

Statistical Analysis

Data were analysed with SPSS statistical software (IBM corp., v. 25.0 for Mac). Results are expressed as median (interquartile range) and absolute frequencies (relative frequencies) as appropriate. Non-parametric tests were used after checking the normality of variables using the Kolmogorov-Smirnov test. The non-parametric Friedman test for related samples was used for the comparison of the overall time

and estimated success rate between the 3 tests (Recommended protocol test, LifeVac test and Dechoker test) and the Wilcoxon signed-rank test for assessed paired differences. McNemar's test was used to compare categorical variables between LifeVac and Dechoker test. A significance level of $p < 0.02$ (0.05/3) for the paired comparison analyses was considered and a significance level of $p < 0.05$ for the rest.

Results

Anthropometric data and main characteristics of the 51 participants (54.9% female) are shown in Table 1. Nineteen (37.3%) (the eight kindergarten teachers and eleven parents) had received some prior training on how to handle a FBAO event according to recommended protocol. Of all participants, 11 (21.6%) referred to have witnessed a FBAO incident in the past but only 6 had intervened. Before the tests, participants were asked about their self-confidence for solving a FBAO scenario correctly. Twenty-eight (54.9%) answered that they would be able to intervene satisfactorily.

Table 2 shows data related to "Recommended protocol" test (overall sample and disaggregated by previous FBAO-training). Less than a half of the participants (45.1%) encouraged the victim to cough. This percentage was even lower in the case of untrained (31.3%) compared to trained participants (68.4%, $p = 0.010$). Giving back blows was performed by 76.5% of participants, with significant differences between those trained (100%) vs untrained (73.9%) ($p = 0.026$). The same was observed for abdominal thrusts, with a 94.1% of participants performing this step, and significant higher proportion of trained participants (52.6% trained vs 13.8% untrained) who have correctly performed it ($p = 0.004$). Thirty participants (58.8%) stated that they would start CPR when in the last part of the test the victim became unresponsive. Regarding the estimated success rate for the "Recommended protocol" test, overall participants obtained a median score of 50 (75% for those with previous training vs 38% for those without training, $p = 0.003$).

The analysis of each step of the FBAO sequence treatment using LifeVac® and DeCHOKER® anti-choking suction devices is presented in Table 3. Most of the steps were performed correctly by the majority of participants without significant differences between both devices. The poorest performing step was keeping the mask fixed to the victim's airway throughout the procedure, with 43.1% failing to do so with the LifeVac device and 33.3% failing to do so with the DeChoker device.

The only variable with significant differences between LifeVac and Dechoker was the time spent performing the test where participants spent a median of 9 sec less to place the LifeVac® ($p < 0.001$) (Table 4). The estimated success rate was similar with both devices.

In terms of estimated success rate (Figure 2), a significantly higher rate was obtained with the two devices compared to the recommended protocol ($p < 0.001$). No significant differences were found between LifeVac® and DeCHOKER®.

Finally, significant differences were found when comparing the overall procedure time spent on each of the tests ($p < 0.001$) (Table 4). Participants spent significantly more time with the recommended protocol

and the DeCHOKER® device than with the LifeVac® device ($p < 0.001$). However, no differences in time were found between the DeCHOKER® and the recommended protocol.

Discussion

Our study is the first that aimed to assess, in a simulated scenario, the handling of new anti-choking devices (LifeVac® and DeCHOKER®) and to compare them with the recommended choking protocol by laypeople at risk of witnessing an FBAO: parents and kindergarten teachers. We observed that most participants achieved a higher success rate in managing FBAO using both anti-choking devices than with the currently recommended protocol. However, they often failed fitting and keeping the mask to the victim's airway. When devices were compared with each other, participants needed less time when using the LifeVac®, although in both cases, the mean total time was slightly shorter than one minute.

The main goal of the FBAO treatment is the removal of the obstruction as early as possible without injury to the victim, which means that bystanders are the target population to solve it [19,20]. Controversy about FBAO management is rooted on the limited evidence supporting these interventions, which are mainly based on case series and experts' opinion, and on the potential harms associated with these techniques [13]. This leads to a continuous search for a safe and effective alternative.

Previously published information and evidence on the new anti-choking devices are extremely limited and inconclusive. The recent systematic review by Dunne et al. [17] includes only five studies about the LifeVac® device, two of them on manikins [21, 22], one on a cadaver [23] and the others were case series [24,25] which report a high success rate for FBAO removal, in most cases in the first few attempts. However, these references are seriously biased (industrial involvement, measurement of outcomes, selection, and information bias, with hardly any information on the methodology used, imprecise results...) [17].

Up to now, only two new articles have been published since the above-mentioned review. In one study, the DeCHOKER® device was evaluated in 27 real choking victims, 26 of whom were successfully removed the obstruction with the device [26]. The other study, a manikin randomized crossover trial conducted with medical students, compared abdominal thrust, LifeVac®, and DeCHOKER® device and found a higher estimated success rate for FBAO removal with the LifeVac® device [19]. For these reasons, the need for further studies on this issue has been suggested [16,17].

The estimated success rate, calculated by taking into account the correct performance of all steps in each sequence, showed significantly better results for the anti-choking devices (without significant differences between them). In other words, participants found it easier to use the brand-new LifeVac® and DeCHOKER® devices as they did so with fewer errors than following the recommended protocol.

However, it has to be noted that, although instructions were provided for all three situations, we observed that participants followed the instructions more carefully in the case of the anti-choking devices perhaps because they were completely new tools to them. On the other hand, in the case of the recommended

standard protocol, they often acted instinctively or according to their prior knowledge without strictly paying attention and following the displayed instructions. This may explain why there were more errors while performing the recommended protocol sequence. In fact, only 5.9% of the participants performed all steps correctly compared to 51% with LifeVac® and 56.9% with DeCHOKER® devices.

One of the main problems blamed on these devices is that they can distract rescuers and cause a delay in the recommended techniques (such as back blows and abdominal thrust) [8,16,17,19]. However, in our study, participants spent less than one minute to apply the LifeVac® and DeCHOKER® devices to solve the FBAO simulation. Although our study did not assess the effective FBAO successful removal, the results agree with those of the study by Patterson et al. [19] who showed a higher number of successful FBAO removal in a shorter time with the LifeVac® device (82% in the first minute compared to 44% cases using DeCHOKER® and 67% using abdominal thrusts). Nevertheless, the three situations are not entirely comparable as the devices are theoretically recommended when the choking protocol fails [14,15].

When devices were compared with each other, both had similar success rates. Of the entire procedure, the most difficult step for the participants was the one related to fitting and keeping the mask to the victim's airway. This is a remarkable fact because although participants spent less time in the process with the LifeVac® device, they had more difficulties with the mask seal. In this line, the successful removal of a FBAO using devices depends on the generation of a strong negative pressure associated with an effective mask seal [19]. Previous studies using facemask also reported difficulty of use, especially for novices and above all with one-hand technique [27,28]. In this sense, further studies are needed to corroborate our preliminary results.

Regarding the management of a FBAO simulation acting according to recommended protocol, we have found that most participants (94.1%) gave abdominal thrusts and many also gave the back blows (76.5%). However, when it came to performing these steps correctly, we found that more participants who had received prior training did significantly better. As mentioned, the estimated success rate of executing the steps was lower than with the anti-choking devices. And, in turn, participants with prior training achieved a significantly higher rate. Although no previous studies on evaluating the effect of training on the choking recommended protocol have been found, our results might be related to other studies where different methods of training in BLS content, such as AED [29], and adult [30,31] and pediatric [32] CPR, improved performance outcomes.

Based on our results, we consider that the anti-choking devices are easy to use but a short training would be needed to reduce errors and take advantage of the devices' function. Further evidence on the efficacy of these devices is needed in order to be able to recommend their use as previously reported [17,18]. In agreement, the 2021 European Resuscitation Council Guidelines of Basic Life Support [33] maintain the prior recommendations for the management of a FBAO and insist that alternative techniques lack sufficient evidence for their introduction into the guidelines at this moment.

Limitations

Our study is not free of limitations. First, we conducted a simulation manikin study that involves two weaknesses: the manikin doesn't exactly reflect the characteristics of a real victim and participants might have different attitudes compared to a real FBAO scenario. Moreover, the manikin was a standard CPR model, not a specific one for FBAO. Although there are manikins for FBAO situations, they were not created for the evaluation of anti-choking devices effectiveness. Thus, no manikins exist that would allow reliable evaluation of the effectiveness of these devices. On the other hand, for the recommended protocol test we used a real person to simulate the FBAO instead of a manikin due to the particular characteristics of the manikin did not allow the technique to be executed correctly. Our sample was small and specific: parents and teachers in a kindergarten, which makes it necessary to interpret the results with caution and not to extrapolate them to the general population.

In addition, the success rate variable, calculated to compare quantitatively the three situations, has the limitation that in each test was calculated based on a different number of items (recommended protocol 8 items, LifeVac® 6 items, and DeCHOKER® 4 items).

Conclusions

Untrained laypeople, under simulated conditions and according to the manufacturer's instructions, are able to handle LifeVac® and DeCHOKER® anti-choking devices in less than one minute. However, they have difficulties in applying the current recommended choking protocol. Further studies are needed to confirm whether the new devices could have a role in the FBAO management.

Abbreviations

FBAO: Foreign body airway obstruction

FDA: Food and Drug Administration

Declarations

Compliance with Ethical Standards

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Conflicts of interest/Competing interests: The authors declare that they have no conflict of interest.

Availability of data and material: The authors confirm that the main data supporting the findings of this study are available within the article. Additional data of this study are available from the corresponding author (CA-G) on request.

Code availability: N/A

Authors' contributions: AR-N conceived the idea. All authors designed the methodology. RB-F contacted with the kindergarten. AC-F, CA-G & ER-R collected the data. AC-F & CA-G performed the statistical analysis. AC-F wrote the first draft. CA-G carried out the first revision of the manuscript. All the authors reviewed the following versions of the manuscript and approved the final article.

Ethics approval: the protocol was waived by the local Research Ethics Committee because it did not involve the use of participant's health data, the collection of biological samples, or intervention on participants.

Consent to participate: Written informed consent to participate was obtained from all participants.

Consent for publication: Written informed consent to publish the data was obtained from all participants.

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Tables

Table 1. Characteristics of the participants.

Age _{in years}		40.0 (36.0 – 43.0)
Weight _{in kg}		70.0 (58.0 – 80.0)
Height _{in m}		1.7 (1.63 – 1.76)
Gender	Male	23 (45.1)
	Female	28 (54.9)
Training FBAO	Yes	19 (37.3)
	No	32 (62.7)
Years since training		5.0 (2.0 – 8.0)
Witnessed FBAO	Yes	11 (21.6)
	No	40 (78.4)
Years since witnessed FBAO		10.0 (8.0 – 17.5)
Intervened FBAO	Yes	6 (54.5)
	No	5 (45.5)
Feel to be able to solve the FBAO	Yes	28 (54.9)
	No	23 (45.1)

FBAO: Foreign Body Airway Obstruction

Continuous variables [median (interquartile range)]

Categorical variables [absolute frequency (relative frequency)]

Table 2. Descriptive analysis of the performance of the steps recommended for the treatment of the adult victim with FBAO.

		Overall (n=51)		Trained (n=19)	Untrained training (n=32)	χ^2 p- value
Encouraging to cough		Yes	23 (45.1)	13 (68.4)	10 (31.3)	6.653
		No	28 (54.9)	6 (31.6)	22 (68.6)	0.010
Giving 5 back blows		Yes	39 (76.5)	16 (84.2)	23 (71.9)	1.008
		No	12 (23.5)	3 (15.8)	9 (28.1)	0.315
Giving back blows correctly (n=39)		Yes	33 (84.6)	16 (100.0)	17 (73.9)	4.933
		No	6 (15.4)	0	6 (26.1)	0.026
Giving back blows with an incorrect number (n=6)			6 (11.8)	0	6 (18.8)	1.800
						0.180
Giving 5 abdominal thrusts		Yes	48 (94.1)	19 (100)	29 (90.6)	1.893
		No	3 (5.9)	0	3 (9.4)	0.169
Giving abdominal thrusts correctly (n=48)		Yes	14 (29.2)	10 (52.6)	4 (13.8)	8.381
		No	34 (70.8)	9 (47.4)	25 (86.2)	0.004
Giving abdominal thrusts with an incorrect number			20 (39.2)	6 (31.6)	14 (43.8)	1.218
						0.270
Performance of the abdominal thrust (n=48)	Standing behind the victim and putting both arms round the upper part of the abdomen	Yes	47 (97.9)	19 (100)	28 (87.5)	2.577
		No	1 (2.1)	0	4 (12.5)	0.108
	Leaning the victim forwards; clenching one hand and place it between the umbilicus and the ribcage	Yes	25 (52.1)	13 (68.4)	12 (37.5)	4.561
		No	23 (47.9)	6 (31.6)	20 (62.5)	0.033
	Grasping both hands and pulling sharply inwards and upwards	Yes	45 (93.8)	18 (94.7)	27 (84.4)	1.233
						0.267

	No	3 (6.3)	1 (5.3)	5 (15.6)	
Continue to 5 back blows and 5 abdominal thrusts	Yes	18 (35.3)	9 (47.4)	9 (28.1)	1.933
	No	33 (64.7)	10 (52.6)	23 (71.9)	0.164
Continue to 5 back blows and 5 abdominal thrusts correctly (n=18)	Yes	12 (66.7)	7 (77.8)	5 (55.6)	1.000
	No	6 (33.3)	2 (22.2)	4 (44.4)	0.317
Continue to abdominal thrust only		6 (11.8)	2 (10.5)	4 (12.5)	0.010 0.920
Starting CPR for victim's unresponsiveness	Yes	30 (58.8)	12 (63.2)	18 (56.3)	0.235
	No	21 (41.2)	7 (36.8)	14 (43.8)	0.628
Performed all steps	Yes	8 (15.7)	5 (26.3)	3 (9.4)	2.687 0.108
	No	43 (84.3)	14 (73.7)	29 (90.6)	
Performed all steps correctly	Yes	3 (5.9)	2 (10.5)	1 (3.1)	1.180
	No	48 (94.1)	17 (89.5)	31 (96.9)	0.277
Estimated success rate (in %)		50.0 (38.0 – 75.0)	75.0 (50.0-88.0)	38.0 (25.0-63.0)	0.003 [†]
Time until back blows (in seconds)		13.1 (10.7 – 15.3)	12.4 (10.7-14.2)	14.1 (10.2-15.8)	0.271 [†]
Time until abdominal thrust (in seconds)		25.2 (19.1 – 32.9)	23.5 (16.2-26.4)	27.0 (20.8-34.2)	0.137 [†]
Overall procedure time (in seconds)		48.3 (42.1 – 60.7)	48.6 (43.0-59.6)	47.4 (41.7-62.1)	0.778 [†]
Overall time of participants who completed all steps (n=8) (in seconds)		55.1 (46.9 – 68.7)	60.7 (48.7-73.4)	46.8*	0.143 [†]

FBAO: Foreign Body Airway Obstruction; CPR: cardiopulmonary resuscitation

* n=3 Unable to calculate interquartile range

Continuous variables [median (interquartile range)]

Categorical variables [absolute frequency (relative frequency)]

† Mann-Whitney U test

Table 3. Descriptive analysis of the performance of the treatment of the adult victim with FBAO with LifeVac® and DeCHOKER® device.

	LifeVac®		DeCHOKER®		p-value
Inserting the mask into the device	Yes	46 (90.2)	--		--
	No	5 (9.8)			
Place the mask covering nose and mouth of the victim correctly	Yes	40 (78.4)	Yes	46 (90.2)	0.109 [†]
	No	11 (21.6)	No	5 (9.8)	
Fixing the mask to the victim's airway	Yes	42 (82.4)	Yes	45 (88.2)	0.453 [†]
	No	9 (17.6)	No	6 (11.8)	
Push in handle	Yes	50 (98.0)	--		--
	No	1 (2.0)			
Pull handle (LifeVac®) // Pull the plunger out with force (DeCHOKER®)	Yes	50 (98.0)	Yes	50 (98.0)	1.000 [†]
	No	1 (2.0)	No	1 (2.0)	
Keeping the mask fixed to the victim's airway throughout the procedure	Yes	29 (56.9)	Yes	34 (66.7)	0.405 [†]
	No	22 (43.1)	No	17 (33.3)	
Performed all steps correctly	Yes	26 (51.0)	Yes	29 (56.9)	0.678 [†]
	No	25 (49.0)	No	22 (43.1)	
Estimated Success rate	100 (83.0 – 100.0)		100 (75.0 – 100.0)		0.796*

FBAO: Foreign Body Airway Obstruction

Continuous variables [median (interquartile range)]

Categorical variables [absolute frequency (relative frequency)]

* Wilcoxon test

† McNemar test

Table 4. Comparison of procedure time between recommended protocol, LifeVac[®] and DeCHOKER[®].

	Recommended protocol	LifeVac [®]	DeCHOKER [®]	p- value	RP vs L	RP vs D	L vs D
Time until device fitting on the victim		31.9 (24.8 – 38.2)	39.6 (29.8 – 57.2)	< 0.001*			
Overall time	48.3 (42.1 – 60.7)	39.3 (31.4 – 44.4)	55.6 (38.9 – 71. 0)	< 0.001†	< 0.001*	0.115*	< 0.001*

L: LifeVac[®]; D: DeCHOKER[®]; RP: Recommended protocol

* Wilcoxon test

† Friedman test

Figures

Figure 1

Flow chart of the design of the study.

Figure 2

Comparison of estimated success rate between three tests. Grey dots symbolize outliers.