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ScienceDirect

Journal of the Chinese Medical Association 77 (2014) 422–425

www.jcma-online.com

Original Article

Optimal size selection of the classic laryngeal mask airway by tongue width-based method in male adults

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Received November 14, 2012; accepted January 29, 2014

Abstract

Background: Proper size selection is crucial to the effective use of a laryngeal mask airway (LMA). The current choice of LMA size is based on body weight; in addition, the sex-based selection has also been suggested. However, the relationship between body weight, sex, and the dimension of hypopharynx where the LMA is positioned are inconsistent. Here we examined a tongue width-based method to determine the optimal size for the classic LMA (cLMA).

Methods: The enrolled patients had two different cLMA size selections, determined by both weight-based formula and tongue width-based method. Twenty-one male patients were studied. For the tongue width-based method, we made four rulers of different widths that corresponded to the four different cLMAs (Nos. 2.5, 3, 4, and 5) The patient was asked to open his mouth and protrude his tongue; the optimal size of cLMA was determined by the corresponding ruler which had the same tongue width of the patient. Two insertions with different-size cLMAs were randomly performed in every patient. Five parameters — frequency of insertion attempts, the presence of cuff in the mouth, end-tidal CO_2 shown on monitor, oropharyngeal leak pressure, and fiberoptic score — were measured following each cLMA insertion.

Results: For all of the five measured parameters, the tongue width-based method was better than weight-based formula in determining optimal cLMA size selection.

Conclusion: The tongue width-based method is a convenient and efficacious alternative for selecting an optimal cLMA size in male adults.

Keywords: adult; laryngeal mask airway; size

1. Introduction

The laryngeal mask airway (LMA) is a useful device for airway management during anesthesia. Selection of an appropriate size is important for using an LMA. There are several factors to be considered when selecting an appropriate size of LMA, including maintaining an airtight seal during positive pressure ventilation, no excessive pressure on the pharynx, ability to fit around the hypopharynx, and not too large to insert. According to a previous study regarding the optimal LMA size selection, the sex-related formula (size 4 for females and size 5 for males) was more preferable[1] than the manufacturer weight-based recommendations (size 3 for 30–50 kg; size 4 for 50–70 kg; and size 5 for >70 kg). However, these methods cannot always be correct because the relationship between sex, weight, and upper airway geometry appear inconsistent. No method has yet been found to easily measure the potential pharyngeal volume that closely correlates with appropriate LMA size. In the following crossover design study, we compared a tongue width-based method with the manufacturer's weight-based formula for proper size selection of the classic LMA (cLMA) by ease of insertion, oropharyngeal leak pressure (OLP), and anatomic positions.

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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http://dx.doi.org/10.1016/j.jcma.2014.05.009

2. Methods

Ethical approval for this study was provided by the Institutional Review Board of Tri-Service General Hospital (TSGHIRB) and National Defense Medical Center, Taipei, Taiwan. Informed consent was obtained from each patient enrolled in the study. Exclusion criteria from the trial were age younger than 18 years, a known or predicted difficult airway, mouth opening smaller than 2.5 cm, or risk of aspiration. In this crossover design study, participants with American Society of Anesthesiologists classification I–II were selected preoperatively. The enrolled patients had two different cLMA size selections, which were determined by both weight-based formula (size 3, 30–50 kg; size 4, 50–70 kg; size 5, >70 kg) and a tongue width-based method. The tongue width-based method was performed as follows. First, we made four rulers with different widths corresponding to the four different cLMAs (Nos. 2.5, 3, 4, and 5; Table 1, Fig. 1). Each ruler's width was determined by the widest width of each cLMA in which the cuff was minimally inflated. The patient was asked to open his mouth and protrude his tongue in a relaxed manner. The size of the cLMA was determined by the corresponding ruler which had the same width as that of the tongue (Fig. 2).

After preoxygenation, anesthesia was induced with intravenous propofol 2 mg/kg, supplemented with fentanyl 1 g/kg. The insertion order of the two different-size cLMAs (weight-based and tongue width-based) was randomized by tossing a coin. All insertions were performed by a single experienced cLMA user using the technique suggested by manufacturer instructions. After insertion, the cuff was inflated with air to an intracuff pressure of 60 cm H_2O.[2] A maximum of three attempts were permitted prior to insertion, and failure in all three attempts was considered as insertion failure. Following successful insertion, the mouth was then opened to check if the cuff was visible. The OLP was measured by closing the expiratory valve of the circle system at a fixed gas flow of 3 L/minute and noting the airway pressure at which the manometer dial reached stability. The position of the cLMA was assessed by a fiberoptic scope that was passed through the laryngeal mask airway to a position just proximal to the mask aperture bars, and the view was scored as follows: 4 = only vocal cords visible; 3 = vocal cords and posterior part of epiglottis visible; 2 = vocal cords and anterior epiglottis visible; and 1 = vocal cords not seen.[3] After the assessments, the first cLMA was removed and a second cLMA was inserted subsequently. The patient was ventilated with oxygen by facemask for 5 minutes between the two insertions, and additional intravenous propofol 1 mg/kg was given. The assessments following the second cLMA insertion were the same as those following the first cLMA insertion. The optimal size of cLMA was chosen for the proceeded operation. The patients were anesthetized with sevoflurane and maintained spontaneous breathing during the operation.

All of the observations after cLMA insertion were performed by another anesthesiologist who was unaware of the cLMA that had been selected. Five parameters were recorded: the frequency of one attempt at insertion, the frequency of cuff presence in the mouth, the frequency of end-tidal CO_2 shown on monitor, OLP, and fiberoptic score (FOS).

Sample size for this crossover study was determined to detect a 20% difference in the success rates of first-attempt intubation for type I error of 0.05 and a power of 0.8. The calculation of the sample size was based on data from a previous similar study.[4] Statistical comparisons between the two methods were performed using paired Student t test for the continuous data, McNemar test for the categorical data, and Wilcoxon matched-pairs signed-rank test for the ordinal data. A p value <0.05 was considered statistically significant.

Table 1
The width of rulers corresponding to each size of the classic laryngeal mask airway.

LMA size and ruler no.	2.5	3	4	5
Width (cm)	4.2	5.0	5.7	6.5

LMA = laryngeal mask airway.

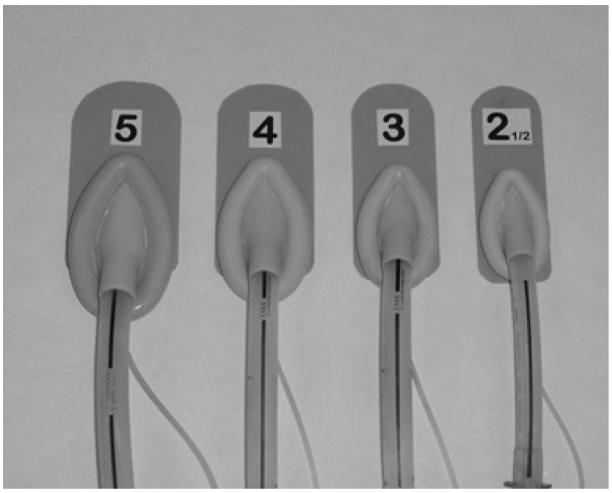

Fig. 1. The four rulers and the corresponding classic laryngeal mask airways with minimal cuff inflation.

Fig. 2. A Number 4 ruler fits the tongue of a patient with mouth open and tongue protruded.

3. Results

Twenty-one male patients were enrolled in this study. The mean ± standard deviation of age (years old), body weight (kg), and body height (cm) were 33.2 ± 12.4, 78.7 ± 9.0, and 174.8 ± 8.2, respectively. All of the cLMA sizes selected by weight-based formula were larger than that by tongue width-based method. Of the 21 studied patients, cLMA size in 12 patients was Number 5 by weight and Number 4 by tongue width, Number 5 by weight and Number 3 by tongue width in seven patients, and Number 4 by weight and Number 3 by tongue width in two patients. Each patient's body weight and the different cLMA size selected by the two methods are shown in Table 2. The frequency of one attempt at insertion, presence of cuff in mouth, and end-tidal CO_2 shown on monitor (weight-based formula vs. tongue width-based method) were 71% versus 90%, 24% versus 5%, and 81% versus 95%, respectively (Table 3). The OLP and FOS (weight-based formula versus tongue width-based method) were 17.90 ± 3.85 cmH_2O versus 15.14 ± 3.15 cmH_2O and 2.23 ± 0.83 versus 3.38 ± 0.74, respectively (Table 4). All of the five observed parameters between the two methods were significantly different.

4. Discussion

The results of this study demonstrated that the tongue width-based method could be an alternative for selecting an optimal size cLMA in male adults. An optimal size of LMA is critical for clinical anesthesia. The laryngeal mask is designed to fit the hypopharyngeal space. Too large or too small is not safe and effective. A too-large laryngeal mask may produce a greater risk of the cuff being positioned in the oral cavity, which may cause a sore throat[5] or damage to the lingual nerve.[6] Insertion of a too-small laryngeal mask will result in a leak and possibly an increased risk of glottis impaction. Overinflation of the cuff rarely solves the problem and instead causes loss of seal because the overexpanded cuff may change its shape, possibly the distorted laryngeal mask may be displaced from the laryngeal inlet. The cuff volume or cuff pressure should be adjusted to the minimum, particularly if a larger LMA is used. One serious complication associated with the use of an inappropriately sized LMA is neuroparalysis. There have been several reports of temporary or long-term paralysis of the lingual, hypoglossal, or recurrent laryngeal nerves.[7–10] In addition, transient tongue cyanosis after LMA insertion has also been reported.[11]

Several investigators have reported methods for selecting an appropriately sized LMA.[1,4,12–14] Clinically, neither the manufacturer nor the inventor is always correct. Therefore, the safest and most efficacious method should be sought, and the instructions or guidelines should be amended if necessary. Based on current information, it appears that selection of the LMA size is suggested to be based primarily on sex (size 5 for males and size 4 for females). Previously, the manufacturer's instruction manual for the device indicated that size selection should be based on weight,[15] but the latest manual[16] concedes that size selection based on weight is a rough estimate and acknowledges the sex-based selection method. However, it seems unreasonable to argue which single factor should be

Table 2
The body weight of each patient and the classic laryngeal mask airway sizes selected by weight-based and tongue width-based methods.

Patient	Body weight (kg)	Weight-based LMA size	Tongue width-based LMA size
1	71	5[a]	3
2	90	5[a]	4
3	74	5	3[a]
4	73	5	4
5	65	4[a]	3
6	72	5	4[a]
7	82	5	4[a]
8	71	5	3[a]
9	82	5[a]	3
10	97	5[a]	4
11	71	5[a]	3
12	85	5	3[a]
13	90	5[a]	4
14	80	5[a]	4
15	82	5	4[a]
16	62	4	3[a]
17	74	5[a]	4
18	77	5[a]	4
19	80	5	3[a]
20	85	5	4[a]
21	90	5	4[a]

LMA = laryngeal mask airway.
[a] The first inserted LMA.

Table 3
Comparison of weight- and tongue width-based size selection of the classic laryngeal mask airway.

One attempt at insertion			
		Tongue width-based*	
		Yes	No
Weight-based	Yes	15	0
	No	4	2
*$p = 0.008$ vs. weight-based.			
Cuff in mouth			
		Tongue width-based*	
		Yes	No
Weight-based	Yes	1	4
	No	0	16
*$p < 0.001$ vs. weight-based.			
End-tidal CO_2 shown on monitor			
		Tongue width-based*	
		Yes	No
Weight-based	Yes	17	0
	No	3	1
*$p = 0.002$ vs. weight-based.			

Table 4
Comparison of weight- and tongue width-based size selection of the classic laryngeal mask airway.

	Weight-based	Tongue width-based	p
No. of patients	21	21	
OLP (cmH_2O)	17.90 ± 3.85	15.14 ± 3.15	<0.001
FOS	2.23 ± 0.83	3.38 ± 0.74	<0.001

Data are presented as mean ± SD.
FOS = fiberoptic score; OLP = oropharyngeal leak pressure.

used exclusively for size selection, as there is no consistent relationship between sex, weight, height, body mass index, and the size or shape of the hypopharynx where the LMA is placed.

By the results of this study, we found that the tongue width-based method was better than the weight-based formula in selecting optimal size for cLMA. We found that, compared to weight-based-selected cLMA, OLP was lower when using tongue width-based-selected cLMA. Actually, the presence of some air leakage is not as crucial for those patients using LMA with spontaneous breathing. It has been reported that a smaller LMA may be more appropriate in spontaneously breathing patients, in whom leak pressures are less critical to effective functioning of the LMA.[17] However, if positive pressure ventilation is needed during anesthesia, a larger LMA should be chosen.

Currently, there are many different types of LMA, such as proseal LMA, intubating LMA, i-gel, several kinds of disposable LMA, etc. The widths of those LMAs with the same number are different. Accordingly, further studies are warranted to examine the suitability of the tongue width-based method introduced here for all other types of LMA.

There are some limitations to this study. First, all the participants were male; however, this may decrease the bias of sex influence. Second, we did not recruit patients with low body weight and a large tongue, in whom a larger LMA should be chosen by the tongue-based method. Third, the number of participants was small. However, significant difference was presented between the two selection methods. Fourth, there was no postoperative sequelae measurement. The third and fourth limitations are the result of the crossover design of this study.

In conclusion, the tongue width-based method is an easy and efficacious alternative for selecting optimal size for cLMA in male adults.

Acknowledgments

This work was supported by grant number TSGH-C100-105 from Tri-Service General Hospital, Taipei, Taiwan.

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