American Journal of Emergency Medicine xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Determination of the appropriate oropharyngeal airway size in adults: Assessment using ventilation and an endoscopic view

Hyun Joo Kim, MD, Shin Hyung Kim, MD, Ji Young Min, MD, Wyun Kon Park, MD *

Department of Anesthesiology and Pain Medicine, Anesthesia and Pain Research Institute, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea

ARTICLE INFO

Article history:
Received 23 March 2017
Accepted 13 April 2017
Available online xxxx

Keywords:
Airway assessment
Airway management
Difficult airway algorithm
Ventilation modes

ABSTRACT

Introduction: Size 9 and 8 airways for men and women, respectively, have been proposed as most appropriate based on endoscopy. However, a limitation of this guideline is that ventilation was not assessed.
Methods: In this retrospective review of prospectively collected data, 149 patients requiring tracheal intubation for general anesthesia were included. The adequacy for manual and pressure-controlled mechanical ventilation and views at the distal end of each airway was assessed using a fiber-optic bronchoscope with various airway sizes (7, 8, 9, 10, and 11).
Results: For men, size 9, 10, and 11 airways permitted clear manual and adequate mechanical ventilation; size 7 and 8 airways caused partially obstructed manual and inadequate mechanical ventilation. On endoscopy, size 7 and 8 airways caused complete obstruction by the tongue; size 10 and 11 airways either touched or passed beyond the tip of the epiglottis. For women, the size 7 airway caused partially obstructed manual and inadequate mechanical ventilation; size 9 and 10 airways provided clear manual and adequate mechanical ventilation. The size 8 airway permitted clear manual ventilation, though mechanical ventilation was inadequate in one patient. On endoscopy, the size 7 airway caused complete obstruction in >50% of women; size 9, 10, and 11 airways either touched or passed beyond the tip of the epiglottis.
Conclusions: With respect to adequate ventilation in conjunction with an acceptable endoscopic view, size 9 and size 8 oropharyngeal airways appear to be the most appropriate sizes for clinical use in men and women, respectively.

1. Introduction

Oropharyngeal airways are frequently employed as important airway adjuncts in emergency care [1] and for short-term airway management during the peri-anesthetic period [2]. The use of an airway is simple, but it is crucial to select the proper size. If the airway is too small, the distal end of airway will be obstructed by the tongue, resulting in inadequate ventilation. If it is oversized, there is a risk of laryngospasm or traumatic injury to the laryngeal structures. Therefore, selection of the appropriate airway size is important.

To select an appropriate airway size, traditionally, external facial measurements have been used based on the distances between the maxillary incisors and the angle of the mandible (IM distance) [3] and between the corner of the mouth and the angle of the mandible (MM distance) [4]. In this regard, our study [5] demonstrated that the airway size selected based on the IM distance, rather than the MM distance, was more appropriate for achieving adequate ventilation and an acceptable fiber-optic view. However, the airway size selected based on the IM distance did not fulfil the requirement for the appropriate size of an airway, as defined as the positioning of the distal end of the airway as close as possible to the tip of the epiglottis without complete obstruction by the tongue while allowing effective mask ventilation. This is because the distal ends of the airways were located beyond the tip of the epiglottis in 25% of patients. However, in a previous study conducted to assess the appropriate sizes of airways based on fiber-optic viewing [6], we found that a size 9 airway for men and a size 8 airway for women was most appropriate and completely fulfilled the requirement for appropriateness regarding the location of the distal end of the airway. However, the limitation of this previous study was that ventilation was not assessed.

Therefore, the purposes of the present study were to investigate the adequacy of ventilation for a size 9 airway in men and a size 8 airway in women and, thereby, provide a simple guideline for choosing an appropriate airway size for men and women without using traditional guidelines for facial measurements.

2. Methods

2.1. Study design and recruitment

To assess the adequacy of ventilation in previous work [6], we performed a study (Study I) to assess both ventilation and position for

* Corresponding author.
E-mail addresses: jjollong@gmail.com (H.J. Kim), TESSAR@yuhs.ac (S.H. Kim), EARLKAIN@yuhs.ac (J.Y. Min), wkp7ark@yuhs.ac (W.K. Park).

http://dx.doi.org/10.1016/j.ajem.2017.04.029
0735-6757/

several sizes of airways (men: sizes 7, 8, and 9; women: sizes 8 and 9) chosen based on the results of the previous study. In addition, to assess the adequacy of ventilation for various airway sizes, we analyzed the results of ventilation and position status for various airway sizes used in a previous study [5] in which the airway sizes were chosen based on external facial distances (Study II). We combined all data in these two studies and assessed the appropriateness of various sizes of airways, especially for a size 9 airway for men and a size 8 airway for women, based on both effective ventilation and positioning. Enrollment included 149 patients (66 men and 83 women).

Approval was obtained from the Institutional Review Board of the hospital. The clinical trials were registered before patient enrollment. Written informed consent was obtained from all patients.

2.2. Selection of participants and airway assessments

All patients were aged 20–75 years, with American Society of Anesthesiologists Class I–II physical status and had scheduled elective ear, nose or throat surgeries under general anesthesia. Patients with the following characteristics were excluded: an abnormal airway anatomy in preoperative radiologic studies; cervical spine pathology; a history of difficult intubation, neurologic disease, cardiovascular disease, or dental problems; or a mouth opening smaller than 2 cm. Airway assessments included the modified Mallampati classification [7], thyromental distance and inter-incisor gap, all of which were evaluated before induction of anesthesia.

2.3. Anesthesia

On arrival in the operating room, the patients were laid supine with the head in a neutral position, 3–4 cm above the plane of the table using a ring support. All patients were given 0.2 mg glycopyrrolate intravenously. Standard monitors for electrocardiography, pulse oximetry and non-invasive arterial blood pressure were applied. Anesthesia was induced with 1.5 mg/kg propofol, 1.0 μg/kg remifentanil and 0.5 mg/kg atracurium. The patients' lungs were manually ventilated with oxygen at 4–6 L/min and 4–5% sevoflurane via a face mask with the head held in an extended position by pulling the mental symphysis in the anterocephalic direction. Complete muscle relaxation was assessed at the adductor pollicis muscle by supramaximal train-of-four stimulus applied to the ulnar nerve using a peripheral nerve stimulator (Innervator 252; Fisher & Paykel Healthcare, Auckland, New Zealand).

2.4. Data collection in study I

After induction, when anesthesia was considered to be deep enough, the airway was inserted into the mouth with the tip positioned upwards and rotated 180° and was then advanced until the flange of the airway made contact with the upper incisors. The adequacy of manual and mechanical ventilation was assessed after airway insertion. The adequacy of manual ventilation was classified into three grades: clear, partial obstruction or complete obstruction. Partial obstruction was defined by the presence of adventitious sounds (snoring) with insufficient chest wall movement. Complete obstruction was defined by the absence of chest expansion despite the application of positive pressure ventilation. Because we could not deliver the inspired tidal volume and pressure consistently during manual ventilation, we applied mechanical ventilation using the pressure-controlled mode to provide a consistent inspiratory pressure and tidal volume after evaluating the adequacy of manual ventilation. To evaluate the adequacy of mechanical ventilation, the anaesthesiologist held the face mask with both hands. Then, with the head in extension and the mandible in a forward position, we mechanically ventilated the lungs with 100% oxygen using the pressure-controlled mode of the anesthesia machine (Aisys; GE Datex-Ohmeda, Műnich, Germany). The fresh gas flow of oxygen was set to 2 L/min. The peak inspiratory pressure, respiratory rate and inspiration-to-expiration ratio were set to 15 cm H_2O, 15 breaths per min, and 1:2, respectively. Mechanical ventilation was classified as either adequate or inadequate. Inadequate ventilation was defined as when the mean expired tidal volume from the sixth to tenth breaths was <5 mL/kg.

Following the evaluation of mechanical ventilation, the curvilinear distance from the incisors to the tip of the epiglottis was measured with a flexible fiber-optic bronchoscope (Olympus LF-GP, Olympus Optical Co., Tokyo, Japan) after passing the fiberscope through the lumen of the airway (Fig. 1). The fiber-optic views at the distal end of the airway were classified as follows: epiglottis visible (clear or partial obstruction by the tongue), complete obstruction by the tongue, contact with the epiglottis tip or passing beyond the epiglottis tip. The classification of passing beyond the epiglottis tip included impaction in the vallecula, entry of the epiglottis into the lumen of the airway and proximity to the vocal cords. During insertion of each airway and measurement, the face mask was removed, and ventilation was ceased. After measurements were performed, the airway was removed, and mask ventilation resumed until the next different-sized airway was inserted. Three different Guedel airway sizes (Hudson RCI, Teleflex Medical, Research Triangle Park, NC), [size 7 (7 cm, white), 8 (8 cm, green), and 9 (9 cm, yellow)] in men (n = 20) and 2 different sizes (size 7 and 8) in women (n = 16) were examined. During the study, as we found that the fiber-optic views for each airway size in men and women were quite similar to the results of a previous study [6], we did not evaluate further; thus, we only observed 20 and 16 male and female patients, respectively.

2.5. Data collection in study II

The methods have been described previously [5]. Briefly, before induction of anesthesia, two facial distances were measured: the MM distance and the IM distance. After induction, when anesthesia was considered to be sufficient, the two different-sized airways selected according to the measured MM or IM distances were inserted in random order into each patient. The size of the airway was determined by the measured distance rounded down to the nearest whole number. For example, if the measured MM distance was 9.6 cm, a size 9 airway was chosen. Five different Guedel airway sizes (Hudson RCI, Teleflex Medical, Research Triangle Park, NC), namely, 7 (7 cm, white), 8 (8 cm, green), 9 (9 cm, yellow), 10 (10 cm, red) and 11 (11 cm, orange), were chosen based on the MM or IM distance. The adequacy of manual and mechanical ventilation was assessed after airway insertion. The fiber-optic view was examined using a flexible fiber-optic bronchoscope. The procedures to measure manual or mechanical ventilation as well as the assessment of fiber-optic views were the same as in Study I. The classification of adequacy of manual and mechanical

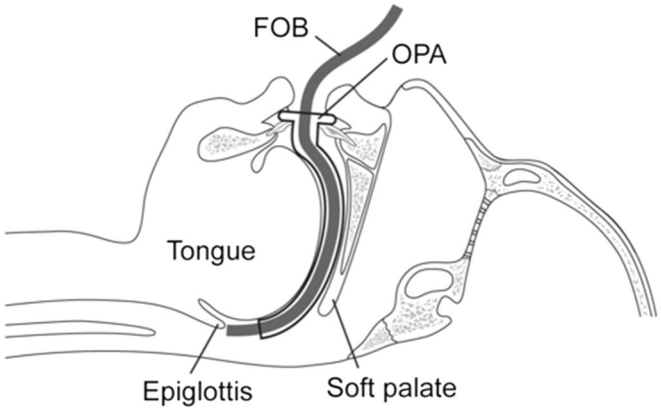

Fig. 1. Schematic representation for assessing the position of the distal oropharyngeal airway using fiber-optic bronchoscopy. FOB: fiber-optic bronchoscope, OPA: oropharyngeal airway.

Please cite this article as: Kim HJ, et al, Determination of the appropriate oropharyngeal airway size in adults: Assessment using ventilation and an endoscopic view, American Journal of Emergency Medicine (2017), http://dx.doi.org/10.1016/j.ajem.2017.04.029