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● *Original Contribution*

COMPARISON OF THREE METHODS FOR THE CONFIRMATION OF LARYNGEAL MASK AIRWAY PLACEMENT IN FEMALE PATIENTS UNDERGOING GYNECOLOGIC SURGERY

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Abstract—The laryngeal mask airway (LMA) is a supraglottic device that is commonly used to provide lung ventilation during general anesthesia. LMA placement needs to be confirmed to provide adequate lung ventilation. To investigate the feasibility of using ultrasound examination, compared with clinical tests and fiberoptic laryngoscopy, to confirm LMA placement, we performed a clinical study of 64 female patients classified as American Society of Anesthesiologists Physical Status I or II who were scheduled for gynecologic surgery with LMA insertion for airway management. After insertion, placement of the LMA was confirmed by clinical tests, ultrasound examination and fiberoptic laryngoscopy. Of the 64 women, placement was confirmed as acceptable in 89.1% by clinical tests, in 59.4% by fiberoptic laryngoscope assessment and in 67.2% by ultrasound examination. With respect to patients with oropharyngeal leaks classified as high, there were no differences in confirmation of acceptable placement between clinical tests and ultrasound examinations ($p = 0.092$), but the number of patients determined to have acceptable placement by ultrasound examination was greater than that determined by fiberoptic laryngoscopy ($p = 0.034$). Thus, ultrasound examination is a superior technique for confirming the seal on the LMA. (E-mail: Yanminnina@hotmail.com) **© 2015 Published by Elsevier Inc. on behalf of World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Clinical tests, Ultrasound, Fiberoptic laryngoscope, Laryngeal mask airway, Placement.**

INTRODUCTION

The laryngeal mask airway (LMA) is a common supraglottic device that is used to provide lung ventilation during general anesthesia. LMAs were first introduced by Brain (1983), and because of their outstanding advantages, low complication rates (Yu and Beirne 2010) and ease of placement, anesthesiologists regard LMAs as an alternative to the endotracheal tube for positive pressure ventilation (Hohlrieder et al. 2007). The airway is particularly suitable for short operative procedures that do not require muscle relaxant and for longer operations that require controlled ventilation. Importantly, LMA placement requires confirmation to provide adequate lung ventilation and maximize prospective advantages. Previous studies have indicated that clinical tests can be used to determine the placement of the LMA (Keller et al. 1999), but this method is not a visualizable technique; thus, whether the LMA is acceptably positioned remains unknown.

Currently, visualizable techniques including fiberoptic laryngoscopy (FOL) and ultrasound, are available for use in upper airway management. One study found that LMAs that seemed acceptably placed based on clinical tests eventually appeared to be unacceptably placed based on FOL in 43.4% of cases (Chandan et al. 2009). Additionally, a number of publications have indicated that ultrasound (US) is a promising new technique for upper airway confirmation (Kristensen 2011; Sustic 2007; Weaver et al. 2006). The first report of the use of US to confirm the placement of LMAs opened up a new avenue of airway management to anesthesiologists. Ultrasound can quickly and dynamically visualize throat structures including the tongue, epiglottis and esophagus, and these characteristics might result in high sensitivity regarding the positioning of LMAs. Furthermore, US examinations of the placement of LMA offer many attractive advantages compared with clinical tests and fiberoptic scopes (Sustic 2007).

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Ultrasound is widely available, quick, portable, repeatable, relatively inexpensive and tolerable because it can provide real-time dynamic images without interrupting machine ventilation during general anesthesia. In this study, we investigated the feasibility of using US examination in place of clinical tests and FOL assessments for the confirmation of LMA placement in female patients undergoing gynecologic surgery.

METHODS

Patients and anesthesia

After receiving approval from the university hospital ethics board and obtaining written informed consent from all patients, we conducted a prospective clinical case series in 64 patients classified as American Society of Anesthesiologists Physical Status I or II. The exclusion criterion was an anticipated difficult airway. All patients were scheduled for elective gynecology surgery under general anesthesia and were free of comorbidities.

All patients were asked to fast overnight. Standard monitors, including non-invasive arterial blood pressure, pulse oximetry, capnography, continuous electrocardiogram and bispectral index monitors, were used. Preoxygenation was performed via a face mask for 3 min in all, cases and anesthesia was induced with propofol (2 mg/kg, intravenously) and fentanyl (2 μg/kg, intravenously). Anesthesia was maintained by continuous infusion of propofol and remifentanil.

Airway management

A size 4 LMA, as illustrated in Figure 1a and a′, was chosen for the female patients. During the preparation period, the LMA was confirmed to be available and was lubricated with water-soluble paraffin. Once an adequate depth of anesthesia was achieved ($40 <$ bispectral index < 60), the LMA was inserted by an experienced anesthesiologist (>600 successful insertions). The insertion technique and patient positioning were identical to those recommended. After insertion, volume-controlled ventilation with a tidal volume (V_T) of 10 mL/kg, respiratory rate of 12 breaths/min and inspiratory-to-expiratory ratio of 1:2 was initiated. The LMA was fixed by taping the tube over the chin.

The cuff volume was increased in 5-mL increments to a maximum of 20 mL of air via a three-way stopcock attached to the pilot balloon, and a calibrated pressure transducer was attached to the three-way stopcock to measure the intracuff pressure (ICP). ICP_1 and ICP_2 were recorded when the cuff was inflated with 5 and 10 mL of air, respectively. Next, ICP was adjusted and maintained at 60 cm H_2O by withdrawing unnecessary air from within the cuff, and the final cuff volume (ICPV) was recorded. Peak inspiratory pressure (PIP) was taken as the highest pressure during inhalation in volume-controlled ventilation and was recorded from the ventilator pressure gauge.

The oropharyngeal leak pressure (OLP), which is determined from the artificial airway seal, was measured via the following functional test: (i) a stethoscope was placed lateral to the thyroid cartilage of the patient; (ii) the expiratory valve was closed, and the gas flow was fixed at the rate of 3 L/min; and (iii) OLP was defined as the maximum airway pressure value shown in the ventilator pressure gauge without audible gas leak, while the patient underwent transient manual hyperinflation ventilation (approximately 8 s). On the basis of the observed OLP, the patients were divided into an OLP-High group (OLP $\geq$ 20 cm H_2O) and an OLP-Low group (OLP $<$ 20 cm H_2O).

Confirmation of LMA placement

Placement of the LMA was then confirmed by clinical tests, FOL assessment and US examination. The patients were divided into an acceptable group and an unacceptable group after the confirmation. Clinical tests included a chest inspection and auscultation that was performed by placing a stethoscope lateral to the thyroid cartilage. Bilateral symmetric chest movements and no audible gas leakage were used as the index of acceptable placement (C-A); otherwise, the patient was categorized as having unacceptable placement (C-U). All LMAs were assessed by a senior staff doctor with experience in airway management, and the numbers of acceptable placements (C-As) and unacceptable placements (C-Us) were recorded. ICPV, ICP_1, ICP_2 and OLP were also recorded for each patient.

Subsequently, LMA placement was detected with a MyLab70 Xvision (Esaote, Genova, Italy) ultrasound scanner with a LA523 linear array transducer (4–10 MHz). For example, *in vitro* ultrasound images (Fig. 1b′–d′) were obtained when the LMA was placed in a water bath (Fig. 1b–d); the cuff appeared to be hyper-echoic structures, also called the three-line sign. All US examinations were performed by a doctor with experience in US examination of the airway. During examination, the patient was placed in the supine position. Sterile gel was smeared to provide coupling of the ultrasound between the transducer and the skin surface. To determine the position of the tip of the LMA cuff, the linear array transducer was placed transverse to the trachea below the cricoid cartilage at the esophagus–thyroid level approximately one-third of the distance from the medial part (Fig. 2a). The transducer was placed parallel to the midline of the neck to investigate whether the cuff of the LMA was folded in the longitudinal aspects (Fig. 2b). To determine whether the LMA cuff was symmetric and adjacent to the epiglottis, the transducer was