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Original contribution

Confirmation of laryngeal mask airway placement by ultrasound examination: a pilot study ☆

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Abstract

Study Objective: We sought to validate ultrasound against other established methods of confirming laryngeal mask airway (LMA) placement.

Design: An observational study.

Setting: A university teaching hospital, operating department.

Patients: Fifty-eight patients undergoing general anesthesia using an LMA Supreme supraglottic airway device.

Interventions: The position of the LMA was assessed by ultrasound in 3 planes: the pharynx, the larynx, and along the cranial-caudal axis in the midline. The leakage test at 20 cm H_2O and fiberoptic examination were also undertaken independently, with the latter being used to detect suboptimal placement (in which case, the LMA was reinserted).

Measurements: We scored the position of the LMA based on the location of the cuff and whether it had inflated correctly in each of the 3 planes. This score was converted to correspond with the leakage test grading system. We tested the strength of the correlation between the scores and the sensitivity and specificity for predicting reinsertion.

Main Results: Seven patients (12.1%) required LMA reinsertion, and ventilation was inadequate in a further 6 (10.3%). Three patients (5.2%) developed laryngospasm and inspiratory stridor after insertion resulting in inadequate ventilation, but none needed reinsertion as optimal placement was confirmed by fiberscope. Spearman coefficient of rank correlation between the leakage test and ultrasound examination was 0.713 ($P< .0001$). The κ test and Bland-Altman analysis showed good agreement between the 2 scoring systems (weighted $\kappa = 0.605$, standard error = 0.086). An ultrasound examination score equating to grade 3 in the leakage test predicted the need for reinsertion with a sensitivity and specificity of 85.7% and 94.1%, respectively.

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Conclusions: Ultrasound examination is a fast, noninvasive and reliable means of detecting LMA misplacement that agrees closely with the leakage test. Ultrasound is as effective as a fiberoptic examination to confirm LMA placement and indicate the need for reinsertion, but does not require ventilation to be interrupted.

1. Introduction

The laryngeal mask airway (LMA) is widely used as an effective and safe airway adjunct in the routine practice of anesthesia. It is easier to insert an LMA than an endotracheal tube, but there is a greater likelihood of misplacement. Anesthesiologists may not always be able to confirm the exact position of an LMA promptly, potentially resulting in inadequate ventilation, the need for reinsertion, and, if ventilation is not possible for some time, hypoxemia. To avoid these complications, it is essential to be able to determine the reason for inadequate ventilation quickly. Although misplacement is the most common cause, there are many others, such as laryngospasm, that cannot be solved by reinserting the LMA. Indeed, in the event that misplacement is not the cause of inadequate ventilation, an unnecessary attempt at reinsertion would further interrupt ventilation, which in turn further exacerbates existing hypoxemia.

Current methods to assess LMA placement include the following: auscultation, the leakage test, insertion of a suction tube into the drainage conduit if an LMA ProSeal (Teleflex Medical, Shanghai, China) is used, the bubble test, and fiberoptic examination. The leakage test is used most often and, under most circumstances, is good enough to judge LMA placement, even in children [1,2]. However, the technique is not completely reliable, meaning that incorrect placement may not immediately be recognized until an adverse event has occurred, especially in some long cases. Fiberoptic examination and grading of placement into one of 5 grades is thought to be the most precise means of judging LMA position [1,3]. Nonetheless, the categorization of LMA placement was established to describe the position of a traditional single-tube LMA, which has a bar in the middle of the conduit to prevent the epiglottis obstructing the tube. Newer LMA devices that have substantially different designs are now available, for example, the double-lumen airways that have entered routine clinical practice in many countries. Furthermore, although the position of an LMA may be easily evaluated with a fiberscope, there is no consensus as to how the categorization should be used to inform the need for reinsertion. In 2009, Timmermann et al [4] suggested using only 2 categories to describe LMA positioning: optimal and suboptimal, with the latter indicating the need for reinsertion, which is arguably a more practical approach. However, fiberoptic examination is an invasive method, requires ventilation to be interrupted, and may result in contamination of the airway by secretions. Anesthesiologists need an effective and reliable method to confirm LMA placement definitively without interrupting ventilation.

Ultrasound is a fast, noninvasive, and reliable means of assessing and managing the airway [5-7]. Many studies have improved the use of ultrasound to predict difficult intubation [8,9], to guide cricothyroidotomy [10,11], and to confirm the position of an endotracheal tube [12,13]. There have been some attempts to assess LMA placement with ultrasound, but there is still a lack of standardization of this technique [5,14]. This pilot study was intended to evaluate the feasibility of using ultrasound to judge the placement of an LMA.

2. Materials and methods

Conduct of the study was approved by the Human Research Committee of the Peking Union Medical College Hospital. After giving informed consent, we enrolled 58 patients undergoing elective surgery in which the LMA Supreme (Teleflex Medical) was used as the airway adjunct. Exclusion criteria included evidence suggesting difficult airway, history of airway stenosis, airway mass, hyperthyroidism, goiter, carotid stenosis, bowel obstruction, gastroesophageal reflux, aspiration, and history of neck surgery. All patients recruited were judged to be American Society of Anesthesiologists physical status I or II, and underwent general anesthesia in the supine position.

The LMA Supreme was deflated before insertion, and the cuff was coated with lidocaine gel. Anesthesia was induced intravenously with fentanyl 2 μg/kg and a target-controlled infusion of propofol set to 6 μg/mL plasma concentration. When the effect site concentration reached 4 μg/mL and the modified observer's assessment alert/sedation score was lower than 1, one clinician inserted an LMA Supreme with a standard one-handed rotation maneuver, with the patient's head in the neutral position. The LMA was inflated with 20 mL air for size 3 and 30 mL for size 4. The target concentration of propofol was decreased to 3.0 to 3.5 μg/mL for maintenance. A neuromuscular blocker was not administered. Patients were mechanically ventilated with volume-controlled ventilation, with 8-mL/kg tidal volume and a frequency of 10 to 12 breaths/min. An attempt was made to insert a suction tube through the drain conduit after LMA placement.

2.1. Evaluation of LMA placement

Three different anesthesiologists (none of them were anesthesia provider) assessed the placement of the LMA in 3 different ways: one independently evaluated whether air leakage