

ULTRASOUND CONFIRMATION OF LARYNGEAL MASK AIRWAY PLACEMENT CORRELATES WITH FIBEROPTIC LARYNGOSCOPE FINDINGS

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Abstract

Background: Correct placement of a laryngeal mask airway (LMA) requires confirmation to appreciate the adequacy of laryngeal seal and pulmonary ventilation.

Objectives: The present study was designed to assess the feasibility of ultrasound use for confirmation of correct placement of LMA and its correlation with fiberoptic laryngoscopy as a confirmation tool for LMA position.

Materials and Methods: 31 ASA I and II patients scheduled for same day surgery under general anesthesia underwent standard general anesthetic technique with AuraOnce™ or AuraFlex™ Disposable Laryngeal Mask Airways. The position of the LMA cuff was confirmed by transverse neck ultrasound (USG), and reconfirmed with intra-LMA fiberoptic laryngoscopy (FOL).

Results: The ultrasound grade of LMA position strongly correlated positively with the fiberoptic grade of LMA position ($r=0.92$; $p<0.0001$). This correlation was obtained immediately after LMA placement, as well as just before LMA removal. The Bland-Altman scatter plot showed insignificant differences between the two grading systems with small and good limits of agreement (-0.63 to $+0.57$).

Conclusion: Ultrasound examination can replace fiberoptic examination for confirmation of the correct placement of an LMA. Additionally, non-invasive ultrasound examination can further give insight into the cause of airway/ventilation events that may be interfering with the LMA placement and ventilation.

Introduction

Correct placement of a laryngeal mask airway (LMA) requires confirmation to appreciate the adequacy of laryngeal seal and pulmonary ventilation. This confirmation may help to diagnose the etiology of peri-operative airway and ventilation events associated with LMA placement. These events can be prevented by adjusting a malpositioned LMA under the direct guidance of confirmation tools. Campbell et al¹ concluded that a

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fiberoptic laryngoscope (FOL) acts as one such confirmation tool that assesses the adequacy of LMA position. They stressed that ideal intra-oral positioning of an LMA may be highly desirable wherein direct visualization by fiberoptic laryngoscopy may be a better confirmation tool compared to the blind, standard method. However, FOL may be invasive and requires tedious sterilization of the fiberoptic laryngoscope questioning the regular use of this confirmation tool for LMA placement.

The first reported use of ultrasound for confirmation of correct LMA positioning² opens up a new avenue for the use of ultrasound in airway management by the anesthesiologists. The intra-oral LMA cuff may be distorted to varying degrees depending on the enormity of the epiglottis or pre-epiglottic space. Our hypothesis was that ultrasound will help us visualize and grade this distortion. Henceforth, the present study was designed to assess the feasibility of ultrasound use for confirmation of correct placement of LMA and its correlation with fiberoptic laryngoscopy as a confirmation tool for LMA position.

Materials and Methods

After institutional review board approval with waiver for written informed consent, a prospective clinical case series was conducted in 31 ASA I and II patients at an academic university hospital. Patients were aged 12-65 years, weighing 50-100 kgs, who were scheduled for same day surgery under general anesthesia. A standard general anesthetic technique was used. AuraOnce™ or AuraFlex™ Disposable Laryngeal Mask Airways (Ambu Inc., Glen Burnie, Maryland, United States) were placed with a standard technique, as recommended by the manufacturer.

The following observations were made:

The position of the LMA cuff was confirmed by transverse neck ultrasound (USG) per the grading in Table 1, and reconfirmed with intra-LMA fiberoptic laryngoscopy (FOL) per the grading in Table 2 (licensed use of the table from the Springer Publishers) as devised by Aoyama et al³. The grading was repeated before removal of the LMA at the end of anesthesia so that change in LMA position if any could be recorded. The ultrasound examination was performed with a LOGIC® *i* ultrasound machine (GE Healthcare, Waukesha, Wisconsin, United States). Transverse ultrasound views of the LMA cuff were obtained with progressive transverse tilt of the 8L-RS linear array probe (4-12 MHz) as schematically shown with airway manikin in Fig. 1-3. Ultrasound grading was done in the transverse view obtained as per probe position in Fig. 3 wherein the linear ultrasound array is in complete alignment with the correctly placed intra-oral LMA cuff. Intra-LMA fiberoptic laryngoscopy was performed with an Olympus LF-GP tracheal intubation fiberscope (Olympus America Inc., Center Valley, Pennsylvania, United States).

Table 1
Grading score of ultrasound (USG) confirmation of laryngeal mask airway position

Grading Score of USG:	
Grade 1	Tent view of the LMA cuff
Grade 2	Slight Indentation of the LMA cuff
Grade 3	Gross Indentation of the LMA cuff
Grade 4	No Tent view of LMA cuff
Grade 5	Ventilation not adequate

Table 2
Grading score of fiberoptic laryngoscope (FOL) confirmation of laryngeal mask airway position

(under license from the Springer Publishers)

Score of FOL as devised by Aoyama et al ³	
Grade 1	Glottis completely visible while the epiglottis was not identified
Grade 2	Glottis slightly obscured by the tip of the epiglottis
Grade 3	More than half of the glottis obscured by the epiglottis
Grade 4	Glottis completely obscured by the epiglottis (complete downfolding)
Grade 5	Ventilation not adequate

Fig. 1

Progressive transverse tilt of ultrasound probe as schematically obtained with airway manikin-I



Fig. 2

Progressive transverse tilt of ultrasound probe as schematically obtained with airway manikin-II

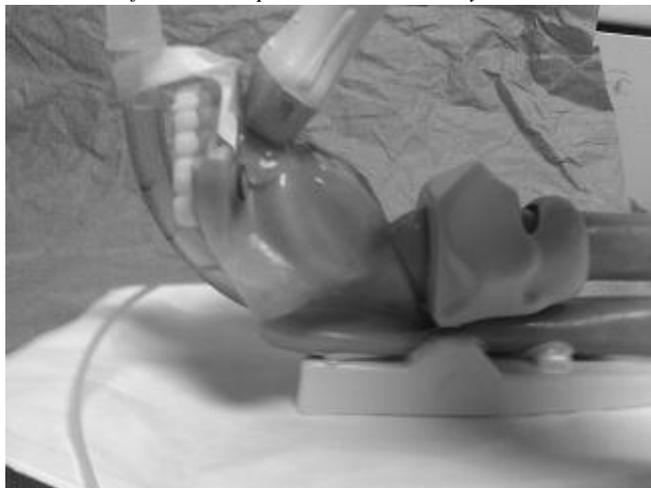
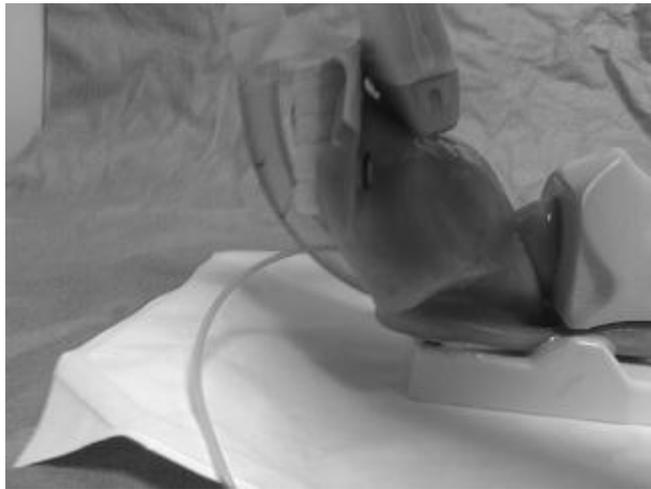


Fig. 3

Progressive transverse tilt of ultrasound probe as schematically obtained with airway manikin-III



A Spearman's rank correlation test was used to examine the strength and direction of correlation between the USG and FOL procedures, as ordered data. "Limits of agreement" with Bland-Altman Plot was used to further compare the two methods (USG and FOL grading). Intraoperative airway and ventilation events were recorded along with the frequency of the intraoperative LMA manipulations to maintain adequate ventilation.

Results

The ultrasound grade of LMA position strongly correlated positively with the fiberoptic grade of LMA position ($r = 0.92$; $p < 0.0001$). This correlation was obtained immediately after LMA placement, as well as just before LMA removal. In one patient, the incidental diagnosis of an asymptomatic epiglottic growth was made with ultrasound that was reconfirmed with the fiberoptic laryngoscope; the epiglottic growth was a cause of failure of LMA placement on the first attempt and interfered with adequate ventilation. No airway or ventilation events occurred in any other patient. Although we had a relatively small number of patients, there was a significant effect correlation ($r = 0.92$; $p < 0.0001$) between ultrasound and fiberoptic grades (Fig. 4). Additionally, the Bland-Altman scatter plot (Fig. 5) of the differences between the USG and FOL grading showed insignificant bias or difference between the two grades (near-zero mean: -0.03) with small limits of agreement (-0.63 to $+0.57$) and 90% of the plotted difference in grades were zero and scattered on x-axis [$y(\text{Grades' Difference})=0$].

Fig. 4

Scatter diagram of ultrasound grade versus fiberoptic grade of LMA position

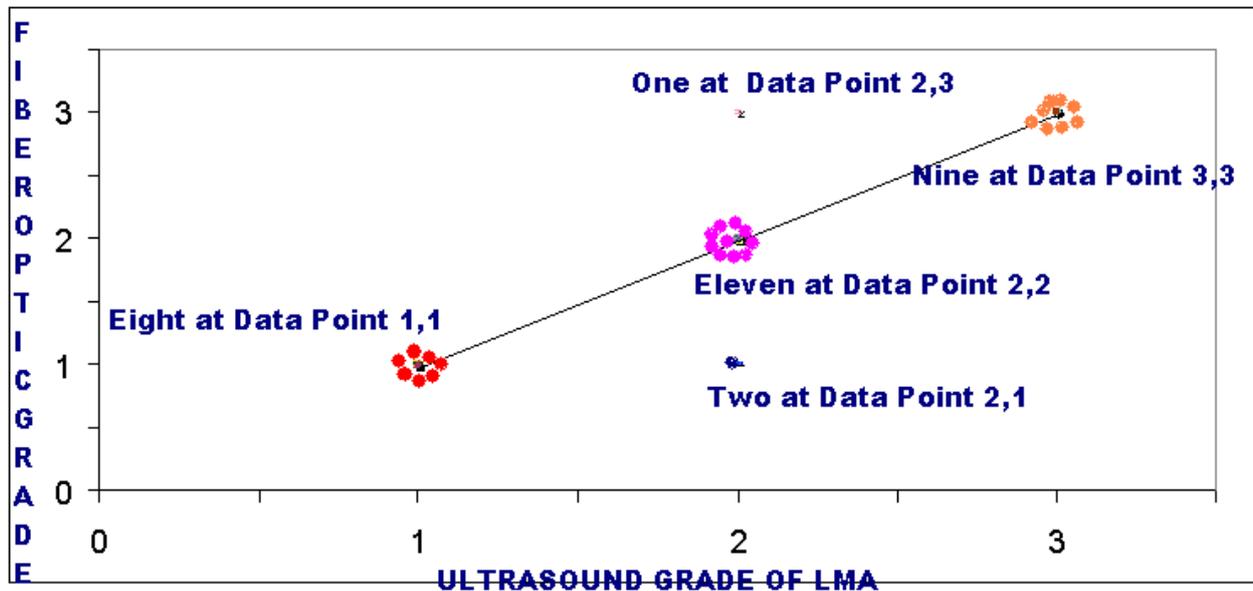
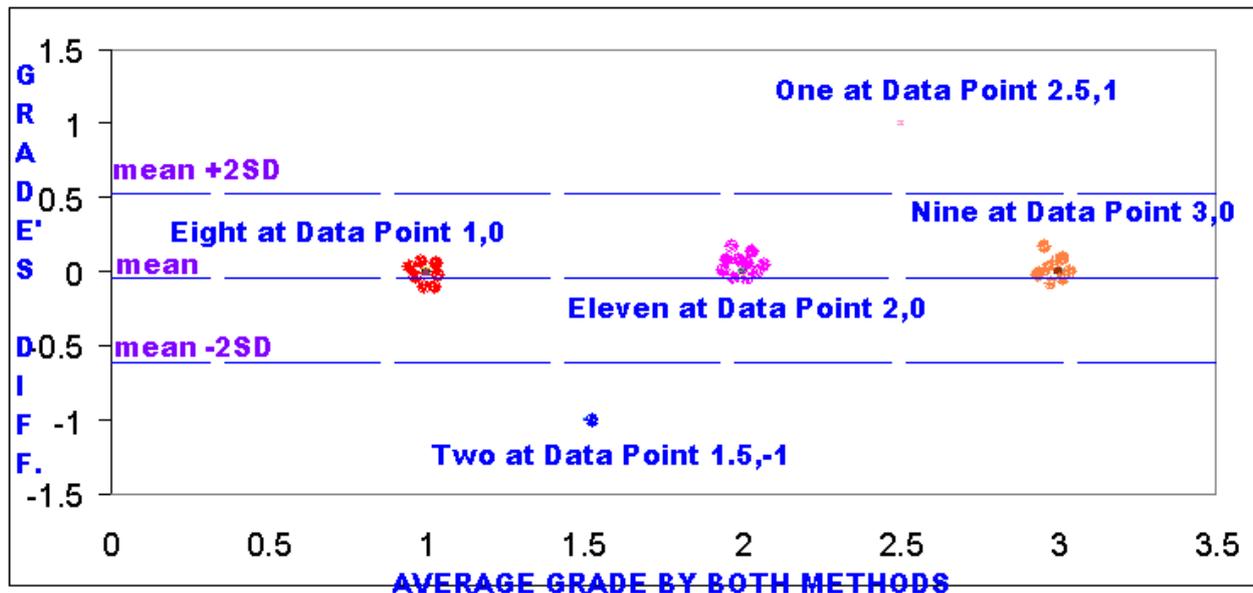


Fig. 5

Bland-Altman scatter plot for the differences in the ultrasound grade and fiberoptic grades of LMA position



Discussion

There has been a new push for utility of the ultrasound in upper airway management⁴⁻¹². The present study was designed to evaluate a possible use of the ultrasound for LMA placement. The working hypothesis was that when the LMA is correctly placed, the cuff of the LMA maintains its ‘reverse hanging drop’ contour inside the laryngopharynx¹³. However, as the cranial half of the LMA cuff lies in the glossoepiglottic fold, this contour of

the cuff may be hard pressed upon by the weight of the large epiglottis or large amount of fat in the pre-epiglottic space. This distortion in the LMA cuff may be varied depending on the enormity of the epiglottis or pre-epiglottic space. Hence we hypothesized that ultrasound will help visualize the cranial half of the LMA cuff and we graded the ultrasound views according to the distortion incurred on the cuff by the epiglottis/pre-epiglottic space. The ultrasound views ranged from 'tent' view similar to the igloo tent as the normal contour with minimal interference from the epiglottis/pre-epiglottic space, to the 'no tent' view with complete obscuration from the epiglottis/pre-epiglottic space. We were able to correlate these ultrasound views with the intra-LMA fiberoptic laryngoscope views because whether the epiglottis was large or the pre-epiglottic space had a large amount of fat, the final result was the varying degrees of obstruction of the laryngeal inlet and hence varying degrees of potential interference of adequate ventilation with the LMA. Because positive pressure ventilation or spontaneous ventilatory efforts may reversibly and rhythmically move the epiglottis cranio-caudally with each breath giving the anesthesiologist a false sense of security regarding the adequacy of ventilation, the knowledge about varying degrees of obstruction of the laryngeal inlet can help the anesthesia care provider to be cautious and alarmed about the potential airway obstruction during surgery or when the LMA is removed after the surgery. As ultrasound non-invasively provides both reassuring views of LMA placement as well as alarming views of possible laryngeal inlet obstruction, the anesthesiologists have an additional tool of patient safety when providing anesthesia with an LMA.

When visualizing the structures and LMA with the ultrasound, the operator can sometimes confuse the ultrasound image of the indentation of the LMA with the ultrasound image of the epiglottis; however this confusing imaging can be easily overcome by deflating the cuff of the LMA. On deflation of the cuff, the ultrasound image of the LMA will disappear while the ultrasound image of the epiglottis will persist.

The limitations to the study are: (a) extremely small number of subjects though the correlation was significant; (b) the non-blinding of the fiberoptic grading and ultrasound grading between the observers who graded the views though this was unavoidable due to logistic reasons; (c) logistical non-availability of the stored (printed or electronic) ultrasound images to demonstrate the applied USG grading in the presented study and (d) the seemingly apparent inadequacy to add more information by the fiberoptic grading (and/or additional ultrasound grading) over the clinical assessment (by visual inspection, capnography and quality of airway seal) for adequacy of LMA placement and ventilation. However, the non-invasiveness of ultrasound provides the opportunity for examining the patient's anatomical airway and its interaction with LMA-in-situ so that etio-pathogenesis of the airway and ventilation parameter changes secondary to the LMA placement can be understood, and individually corrected per se with adjustments of the LMA position under the direct and real-time visualization with ultrasound without the need for the tedious fiberoptic guidance.

Conclusion

Ultrasound examination can replace fiberoptic examination for confirmation of the correct placement of an LMA. Ultrasound examination is non-invasive, less tedious and can be done repeatedly without any interruption in ventilation because each fiberoptic examination involves insignificant but minimal interruption of the ventilation during the time period of examination. Finally, ultrasound examination can further give insight into the cause of airway/ventilation events that may be interfering with the LMA placement and ventilation.

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