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Predicting laryngeal edema in intubated patients by portable intensive care unit ultrasound☆,☆☆,★

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Cuff leak test

Abstract

Purpose: The purpose of this study is to determine the diagnostic accuracy of portable ultrasound for detection of laryngeal edema (LE) in intubated patients.

Materials and Methods: We conducted a prospective, observational study from December 2010 to September 2011. We measured air column width differences (ACWD) in planned extubation patients admitted in intensive care unit by ultrasound. The primary outcome was the diagnostic accuracy of ACWD to predict the presence of LE.

Results: A total of 101 patients were enrolled. The prevalence of LE was 16.8%. Baseline characteristics were similar between intubated patients with and without LE. The mean difference of increasing of air column width in patients without LE was higher than in LE group (1.9 vs 1.08 mm, $P <$ .001). The sensitivity and specificity at ACWD higher or equal to 1.6 mm were 0.706 and 0.702, respectively. The positive predictive value and negative predictive value were 0.324 and 0.922, respectively. The area under the receiver operating characteristic curve of laryngeal ultrasound was 0.823 (95% confidence interval, 0.698-0.947) and that of cuff leak test was 0.840 (95% confidence interval, 0.715-0.964).

Conclusion: Portable intensive care unit ultrasound visualizing ACWD between predeflation and postdeflation cuff balloon is a promising objective tool, which aids in prediction of successful extubation regarding LE.

☆ Competing interests: The authors declare that they have no competing interests.

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1. Introduction

Laryngeal edema (LE) in intubated patients is common in intensive care unit (ICU) patients. The prevalence of LE ranges from 3% to 30% [1,2]. This complication leads to reintubation that is associated to increase in hospital mortality rate by 17.4% [1,3] and increase in rate of nosocomial pneumonia and duration of ICU stay [4].

The risk factors of LE in intubated patients have been studied in several trials. These factors included female sex [5], history of difficult intubation, self-extubation, and prolonged intubation periods [6]. However, the study conducted by De Bast et al [7] and Chung et al [8] has reported no specific risk factors to predict LE and/or stridor. As a result of this, more objective methods are required for predicting this complication. One of the standard methods for predicting LE is cuff leak test [7-9]. However, variations of its sensitivity and specificity have been demonstrated in many studies [9,10]. Another method to evaluate LE is bronchoscopy. This technique allows the physician to clearly visualize edematous vocal cords, but it is somewhat an invasive procedure.

Recently, ultrasound is a promising noninvasive method widely used in ICU and allows visualization of vocal cords and larynx. The study by Ding et al [11], using intensive care ultrasound, has shown the new assessment, namely, air column width (ACW) measurement of vocal cords. This study has found that patients without postextubation stridor have significant greater increase of vocal cord ACW (air column width difference [ACWD]) after deflation of endotracheal tube. However, the appropriate cutoff value that applies in clinical practice has not been evaluated. Consequently, we would like to determine the cutoff value and diagnostic accuracy of ultrasound measuring ACWD for detection of the LE in intubated patients with planned extubation in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the area under receiver operating characteristic (ROC) curve.

2. Materials and methods

We conducted a prospective, observational study from December 2010 to September 2011 at the ICU of a university hospital in Bangkok. This study has been approved by the Ethics Committee of Mahidol University, Bangkok, Thailand, and followed the National Helsinki Committee guidelines. The patients or their next of kin gave written informed consent.

2.1. Patients

We enrolled adult patients older than 18 years who were admitted at the intensive care department of Ramathibodi Hospital, Mahidol University. The inclusion criteria were all eligible patients who required intubation and planned for extubation. The decision for extubation was assessed by the attending pulmonary staff or pulmonary fellows. The exclusion criteria were patients with C-spine injury, active lesions on skin at position of ultrasound placement, and oropharyngeal ulcers.

All cases received standard respiratory care. The mechanical ventilators in our ICU were Puritan Bennett 7200 and 840 model. All ventilators were equipped with bacterial filter at position of gas inlet and outlet. We used heated wick humidifier for humidification and set it at appropriate temperature. The cuff pressure in all patients was routinely monitored by critical care nurses every 8 hours and was maintained at 20 mm Hg. Baseline characteristics including age, sex, duration of intubations, causes of respiratory failure, and body mass index (BMI) were recorded.

2.2. Assessment of ACWD

Before starting the measurement of the ACW, all patients were ventilated by the volume assist/control mode with tidal volume of 10 mL/kg, constant flow rate of 50 L/min, positive end-expiratory pressure of 5 cm H_2O, and 40% of oxygen

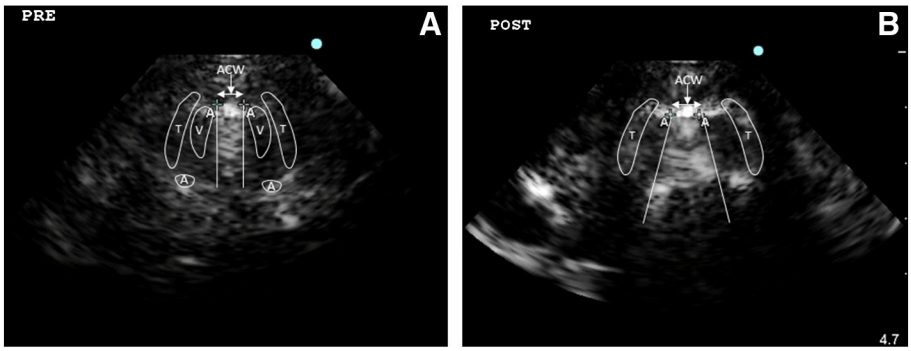

Fig. 1 The imaging from laryngeal ultrasound demonstrates the ACW before (A) and after (B) endotracheal tube cuff deflation. After cuff deflation, the fan-shaped widening ACW obliterates surrounding structure such as vocal cords and arytenoids cartilage by acoustic shadow (T, thyroid cartilage; V, vocal cord; A, arytenoids cartilage).