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Ultrasound in Emergency Medicine

USING ULTRASONOGRAPHY TO ASSESS THE EFFECTIVENESS OF CRICOID PRESSURE ON ESOPHAGEAL COMPRESSION

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Abstract—Background: Cricoid pressure during intubation has been used for decades as a way to potentially occlude the esophagus to avoid aspiration of gastric contents. However, recent evidence has questioned the effectiveness of this maneuver. **Objective:** This study uses a noninvasive modality, ultrasonography, to determine the anatomic position of the cricoid cartilage and the esophagus and examines the effectiveness of cricoid pressure on esophageal compression. **Methods:** Ultrasound imaging was used to describe the anatomic relationship of the esophagus to the trachea as either being directly behind the trachea, partially behind the trachea, or completely lateral to the trachea. These relationships were described with and without cricoid pressure. Participants were also asked to swallow a carbonated beverage with and without cricoid pressure to help visualize the exact position of the esophagus and to see whether cricoid pressure actually occluded the esophagus and the passage of the liquid. **Results:** Without cricoid pressure, 20% of the esophagi laid directly behind the trachea, 60% partially behind the trachea, and 20% completely lateral to the left of the trachea. When cricoid pressure was applied, the esophagus shifted laterally to the left in 50% of the subjects and remained directly behind the trachea in only 4% of our entire study group. In addition, all of the participants were able to swallow liquid with cricoid pressure applied. **Conclusions:** This study highlights the potential ineffectiveness of cricoid pressure on esophageal compression, calling into question the utility of this maneuver. © 2017 Elsevier Inc. All rights reserved.

Keywords—cricoid pressure; ultrasound; intubation; airway

INTRODUCTION

Cricoid pressure (CP) has been used for decades by physicians as a way to occlude the esophagus to avoid aspiration of gastric contents during endotracheal intubation. Dr. Sellick wrote a landmark article in *The Lancet* in 1961, describing the technique and benefits of this maneuver (1). Since then, it gained widespread acceptance and has been adopted as a standard of care for many years.

However, there is an ongoing debate among practitioners and researchers about the effectiveness of CP. Studies have shown that CP can make ventilating with a bag valve mask and inserting an extraglottic device more difficult, decrease visualization of the glottis, and cause esophageal rupture (2–5). Studies using magnetic resonance imaging (MRI) have shown mixed results. Some studies used MRI to show that the esophagus often does not lay directly behind the cricothyroid ring, instead sitting lateral to it, making CP ineffective at occluding the esophagus (6). Another study by Rice et al. concluded that the positioning of the esophagus is irrelevant, as it is the hypopharynx that rests directly behind the cricothyroid cartilage and CP effectively compresses this area when employed, despite the often lateral location of the esophagus (7). These studies were limited by their small sample size but provided the first evidence that the anatomic relationship between

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the trachea and the esophagus may be different than previously thought.

This study uses ultrasonography to describe the anatomic position between the cricoid cartilage and the esophagus and the effectiveness of CP on esophageal compression. Because ultrasonography is a noninvasive imaging modality, it allowed for the recruitment of a larger number of subjects.

MATERIALS AND METHODS

This study was an experimental design in which healthy adults, 18 years and older, volunteered to have their necks scanned with ultrasonography in order to evaluate the anatomic relationship between the trachea and esophagus, with and without CP. A Zonare ZS3 ultrasound machine (Zonare Medical Systems, Mountain View, CA) was used with a L10-5 linear probe. This study underwent complete review and approval by the Institutional Review Board committee and complied with all human subject requirements.

Basic demographic data including age, sex, and body mass index were recorded for each participant. Next, the baseline anatomic relationship of the esophagus to the trachea was identified in each volunteer and categorized as either being directly behind the trachea, partially behind the trachea, or completely lateral to the trachea (Figure 1). These relationships were described both without and with CP.

In order to confirm the exact location of the esophagus, participants were asked to swallow a carbonated beverage. The bubbles in the liquid are seen easily under

ultrasonography and allowed the investigators to clearly visualize the esophagus in relation to the trachea. The ultrasound probe was placed midline, to the right of midline, and to the left of midline in an attempt to visualize the esophagus in each participant. If the esophagus was not seen in any of these three views, it was deemed to be directly behind the trachea. Air from within the trachea obscures any structures located directly behind it from being seen when ultrasonography is employed.

CP was applied with approximately 10 Newtons of force to the cricoid ring by the ultrasonographer. This force was standardized for each patient by having the ultrasonographer practice with a Newton force meter before each case, a technique that has been used in past studies to help calibrate the same amount of force applied between all participants.

Images were interpreted in real time by an emergency medicine (EM) resident and by an EM attending physician. All of the images were recorded and then underwent an independent and blinded review by an ultrasound fellowship-trained emergency physician. This reviewer determined the anatomic relationship of the neck structures for each subject and then crosschecked them with the initial interpretations made by the resident and attending physician. There was 100% concordance with the initial and secondary interpretations.

RESULTS

Of the 50 participants in this study, 25 were female and 25 male. The mean age was 36 years old and the mean body

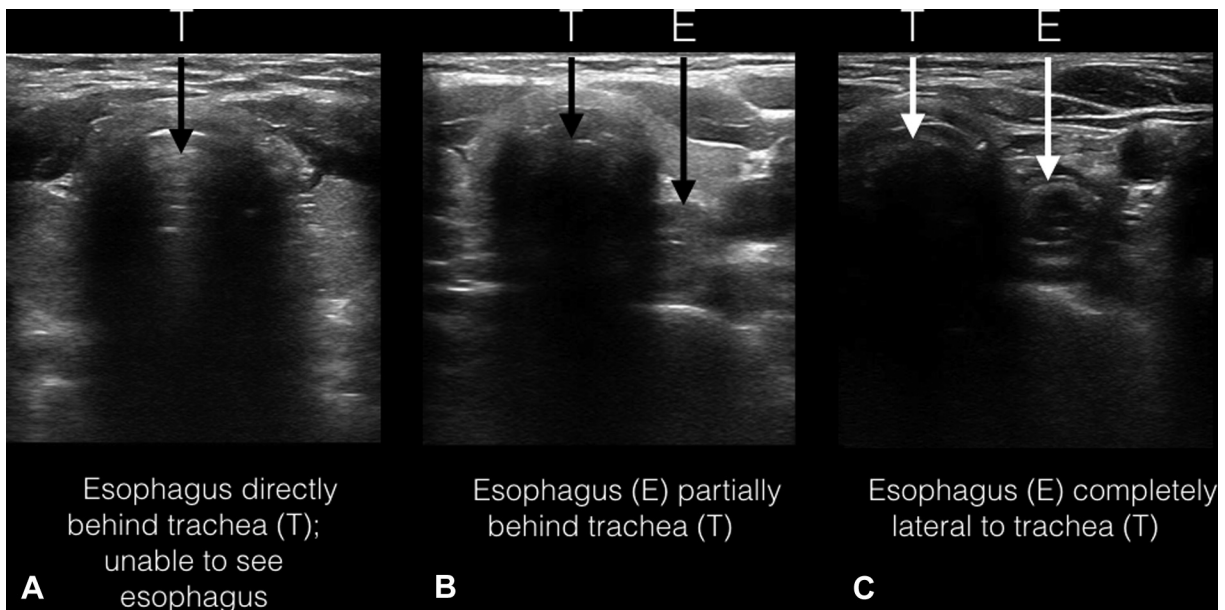


Figure 1. Ultrasound images showing the anatomic relationship of the esophagus to the trachea as being either: (A) directly behind the trachea, (B) partially behind the trachea, or (C) completely lateral to the trachea.

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