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Two methods for teaching basic upper airway sonography☆,☆☆

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Abstract

Study Objective: The purpose of this study was to evaluate and compare hands-on gel phantom versus instructional video teaching methods to improve anesthesia residents and staff members' ability to correctly identify airway structures using ultrasound on a human volunteer.

Design: Randomized, controlled trial.

Setting: Simulation laboratory.

Study Subjects: Fifty-four anesthesiology resident and staff members (27 anesthesiologists and 27 anesthesiology residents) at the University of Wisconsin–Madison.

Interventions: Study subjects were randomized into one of three groups: control (standard medical knowledge), video training, or gel phantom training. After providing study instructions and training (if relevant), study subjects were asked to perform sonoanatomy identification of the thyroid cartilage, cricoid cartilage, cricothyroid membrane, and the tracheal rings in both the transverse and longitudinal views. Study subjects then returned 14 to 24 days following initial assessment for evaluation of skills retention. They were again instructed to identify the same airway structures as during the initial assessment with scoring performed by the same assessor.

Main Results: All group characteristics were similar at baseline and follow-up. Both training tools produced a learning effect at baseline and follow-up compared to standard anesthesia training. No differences in overall airway structure identification success between groups receiving video versus gel airway phantom training were observed.

Conclusions: Use of either a low cost, airway gel phantom training model for hands-on training or a simple instructional teaching video can be used in a single training session to improve staff anesthesiologist and anesthesia resident knowledge and skills for ultrasound identification of upper airway anatomy.

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1. Introduction

Correct identification of airway structures, such as the cricothyroid membrane and tracheal cartilage structures, is important for performing multiple invasive airway procedures, including transtracheal injection of local anesthetics, oxygenation and jet ventilation, retrograde intubation, cricothyrotomy, and percutaneous tracheostomy. In recent studies, however, anesthesiologists were found to correctly identify the cricothyroid membrane only 30% of the time or less when using traditional palpation techniques [1,2].

The use of ultrasound guidance in anesthesia is becoming commonplace and proving to be superior for guiding invasive procedures, such as central venous catheter placement and peripheral nerve blockade [3,4]. Similarly, ultrasound methods for visualizing upper airway anatomy are being developed [5,6], and preliminary reports on ultrasound-assisted techniques suggest they may improve the accuracy of and decrease the time required for cricothyroid membrane identification [7]. Other reports suggest ultrasound guidance may be useful as a pre-procedure exam tool to facilitate trans-tracheal access if the need arises [8]. Thus, methods to teach basic sonography for upper airway assessment are likely to become necessary.

To this end, we created two training tools for teaching sonographic upper airway assessment. The first was a short training video that featured real-time ultrasound-airway assessment on a human volunteer. The second used a previously described [9] low-cost, gel phantom upper airway model combined with one-on-one hands-on training. The purpose of this study was to assess the efficacy of these teaching tools when used during a single training session to improve anesthesia trainee and faculty anesthesiologist ability to correctly identify upper airway sonoanatomy on a human volunteer at a large university teaching center. Our objectives were (1) to improve upper airway anatomy identification using sonography, (2) determine if there was a difference in performance between groups receiving teaching techniques versus standard medical knowledge, and (3) assess short-term knowledge retention should a difference be noted on initial assessment. We hypothesized that subjects receiving either investigational teaching method would demonstrate improved performance compared to our control group of standard medical knowledge.

2. Materials and methods

Following IRB approval, all anesthesiology faculty and anesthesia trainees in the Department of Anesthesiology at the University of Wisconsin–Madison were invited to participate in the study. Subjects who agreed to participate and provided written informed consent were randomized using a random number generator (www.randomizer.com) into one of three study groups: (1) hands-on gel phantom teaching, (2) instructional video teaching or (3) no training beyond regular anesthesia residency training or clinical practice experience (control group). Randomization was determined prior to participation recruitment and subjects were assigned on a rolling basis following confirmed participation. Randomization groups were concealed to subjects during recruitment phase and no crossover between randomization groups following commitment to the study occurred. Exclusion criteria included age <18 years, non–English-speaking, unwillingness to sign a study consent form, and financial interest or relationship with an ultrasound manufacturer. All anesthesia resident trainees at the University of Wisconsin– Madison complete a 4-week rotation in regional anesthesia, during which ultrasound-guided peripheral nerve blockade procedures are taught and practiced; however, no specific instruction on upper airway sonography is provided. In addition, departmental faculty do not currently perform upper airway sonography as a routine part of their clinical practice.

2.1. Teaching tools

The gel phantom upper airway model used in this study was constructed using the technique previously described by Schroeder et al [9]. In brief, a porcine laryngotracheal complex, containing an inflated oblong balloon, was fixed in a plastic container, and cured in a red dyed, psyillum-gelatin mixture at a surface-to-unit depth intended to simulate human conditions. Chlorhexidine gluconate 2% solution (Scrub Care, CareFusion Inc, Leawood, KS) was added to the mixture to retard microbial growth and extend the model life [10]. Ultrasound images of the model demonstrated similarity to images obtained on a human model.

The instructional teaching video used in this study was created by the study team using Microsoft PowerPoint (Microsoft Corp, Redmond, WA) and a digital camera. The video reviewed background information on upper airway anatomy of the neck and demonstrated transverse and sagittal imaging techniques for sonographic identification of the thyroid and cricoid cartilages, cricothyroid membrane, and proximal tracheal rings [5].The video was approximately 9 1/2 minutes long and showed real-time footage of these techniques performed on a human model and static ultrasound images highlighting the basic upper airway structures listed above.

2.2. Training methods

All study subjects were trained individually in the absence of any other study subjects. Using the gel phantom model and a semi-structured teaching script, subjects assigned to the hands-on gel phantom teaching group were taught sonographic upper airway assessment in both sagittal and transverse imaging planes by one of the study investigators (CB), and given time for hands-on practice in identifying the basic upper airway structures listed previously. The semi-structured teaching script included the same background information on