Clinical Usefulness of Ultrasonography-Guided Laryngeal Electromyography

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Summary: Objectives/Hypothesis. To investigate the proper approach and technical method of ultrasonography-guided laryngeal electromyography (US-guided LEMG).

Study Design. This is a prospective study.

Methods. Twenty patients who underwent US-guided LEMG were enrolled. US-guided LEMG was cooperatively performed by one otolaryngologist, one neurologist, and one radiologist. The location of the needle electrode was confirmed with US after electrode insertion into the laryngeal intrinsic muscle. The US transducer was applied on the neck by a transverse/midline and transverse/oblique approach to identify the cricothyroid (CT), thyroarytenoid (TA) muscles, and the location of the needle electrode.

Results. CT muscles were easily identified on US in all 20 patients. TA muscles were identified in 17 patients (85%). The transverse/oblique approach was helpful to detect TA muscle in case of calcified thyroid cartilage or anatomic variation.

Conclusions. US-guided LEMG, which enables the exact insertion of the needle electrode, improves the reliability of examination and is helpful in early detection and to prevent complications.

Key Words: Ultrasonography–Laryngeal electromyography.

INTRODUCTION

Laryngeal electromyography (LEMG) has become recently used to detect the neuromuscular disorders of larynx. LEMG uses needle electrodes to capture electric signals from intralaryngeal muscles. It is useful in diagnosing neuromuscular problems of the larynx, predicting progress of these problems, and in choosing a therapeutic method in some cases.[1–3] However, LEMG has not been widely used clinically for various reasons. The main reason is the technical difficulties of the approach. Insertion of a needle into a small intralaryngeal muscle requires a lot of experience because it is impossible to confirm with the naked eye that the needle electrode is located exactly in the targeted muscle.[4] Moreover, even if the needle electrode has been located exactly, it can be displaced by the patient's movement, phonation, or deglutition during the LEMG process. It can also be hard to locate the laryngeal muscles in cases of short or obese necks or anatomic variations caused by neck surgery or radiation.

A possible solution is ultrasonography (US) guidance. The radiation-free, noninvasive approach has become widely used in head and neck applications. Also, US might be used to evaluate the structure and movement of the vocal folds in real time.[3,5,6] The use of US to locate laryngeal structures in LEMG would overcome the technical difficulties of LEMG and improve the technique's accuracy.[7,8] The aim of this study was to investigate clinical usefulness of US-guided LEMG.

METHODS

Subjects

From September 2013 to December 2014, adult patients (aged >18 years) referred to the voice clinic for evaluation of vocal complaints were enrolled. All patients completed detailed history taking, physical examinations with stroboscope, and voice analysis (multidimensional voice profile) with *CSL* (KayPENTAX, Tokyo, Japan). Any patient with vocal fold pathologies such as nodules, polyp, cyst, and laryngitis was excluded. Patients who provided informed consent were included. Twenty patients were finally included. The study was approved by the Institutional Review Board, Ewha Womans University Hospital, Seoul, Korea.

Techniques

US-guided LEMG was cooperatively performed by one otolaryngologist, one neurologist, and one radiologist. LEMG was recorded under US guidance from the cricothyroid (CT) and thyroarytenoid (TA) muscles. US evaluations were performed with a 10-MHz linear transducer (iU22 xMATRIX; Philips, Netherland). Electromyography (EMG) was performed with a Neuroscreen EMG machine (Toennies, Wurzburg, Germany) using 24-gauge needle electrodes. A pillow was put under the shoulders of the patient while in a supine position to slightly extend the neck. Subcutaneous anesthesia was done with the use of 2% xylocaine. Before the insertion of needle electrodes, US examination was conducted on the anatomies of the thyroid cartilage, cricoid cartilage, CT membrane, and true vocal folds (TVF) by the radiologist (J.H. Yoo). The needle electrode was inserted by the otolaryngologist (H.S. Park) after the US transducer was removed. LEMG was performed on the CT and TA muscles on the opposite side of the lesion first and on the lesion later. Interpretation of LEMG was done by the neurologist (H.J. Park).

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Identification of CT muscles. The otolaryngologist inserted the needle electrode approximately 0.5 cm from the midline at the level of the inferior border of the cricoid cartilage and angled 30–45° superiorly and laterally. The position of the electrode was verified by asking the patient to phonate "[i]" from low to high notes and by observing the concomitant sharp increase motor unit activity. The radiologist located the ultrasonic transducer transversely at the level of the cricoid cartilage to identify the needle electrode. The hypoechoic CT muscle can be easily observed (transverse/midline approach) at the level of the cricoid cartilage. After identifying the location of the CT muscle, the radiologist observed the muscle while turning the probe 15–20° in parallel with the muscle (right part clockwise and left part counterclockwise; transverse/oblique approach; Figure 1). On US, the needle electrode was observed with a hyperechoic line or dot (Figure 2). The operator could identify the location of the needle electrode while moving it.

Identification of TA muscles. The operator inserted the needle electrode approximately 0.5 cm lateral from the midline to the investigated side at the level of the superior border of the cricoid cartilage. After piercing the CT membrane, the needle was angled superiorly 30–45°. The location of the needle was validated by asking the patient to phonate a high-pitched "[i]" sound, causing a simultaneous sharp and sustained increase in motor unit activity. The operator identified the location of the needle electrode using US. When moving the transducer up and down at a transverse position at the level of thyroid cartilage, the operator could observe hyperechoic false vocal folds and hypoechoic TVF, which formed a triangle (transverse/midline approach). The hyperechoic arytenoid cartilage was observed around the posterior part of the TA muscle. It was important for patients to breathe comfortably because it was difficult to observe the muscle in the process of phonation. After observing the muscle in the midline, the operator positioned the transducer on the target region parallel with the curvature of thyroid cartilage, which increased the contact area between the transducer and the skin, making a clearer view (transverse/oblique approach; Figure 3). The operator identified the location of the needle electrode by moving it (Figure 4).

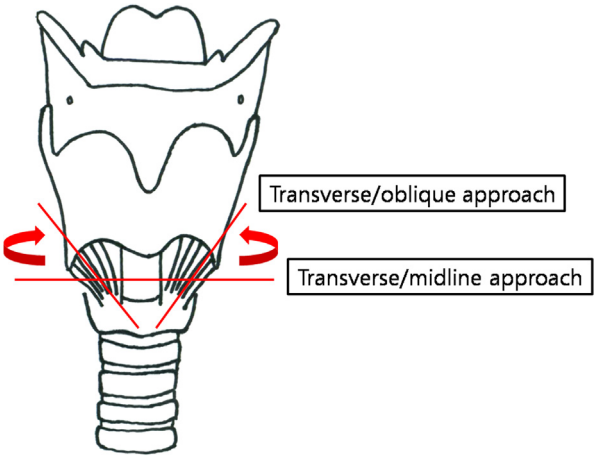

FIGURE 1. Ultrasonographic techniques to identify the cricothyroid muscle. The operator located the ultrasonic transducer transversely at the level of the cricoid cartilage to identify the needle electrode (transverse/midline approach). After identifying the location of the CT muscle, the operator observed the muscle while turning the probe 15–20° in parallel with the muscle (right part: clockwise; left part: counterclockwise; transverse/oblique approach).

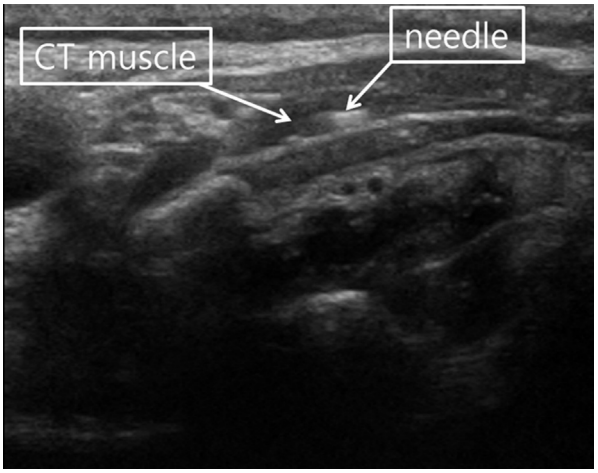

FIGURE 2. Ultrasonographic finding of laryngeal EMG. A hyperechoic monopolar needle electrode is inserted into right cricothyroid muscle.

RESULTS

Patient characteristics

The study group included 12 men and 8 women with a mean age of 50.7 years (range, 28–73 years). On average, it took patients 39 weeks (range, 7–192 weeks) to get LEMG after first displaying symptoms of voice discomfort. On stroboscopic examination, eight patients (40%) showed vocal fold paramedian fixation. Decline in vocal fold movement was evident in 10 patients (50%). In one patient (5%), incomplete glottal closure and false vocal fold squeezing, which suggested muscle tension dysphonia, were found. In another patient (5%), no problem was detected. Nine patients (45%) presented a normal LEMG pattern. In five patients (25%), LEMG of the CT muscle revealed diminished motor unit recruitment and the presence of some spontaneous activity as fibrillation potentials. In four patients (20%), LEMG of the TA muscle showed decreased motor

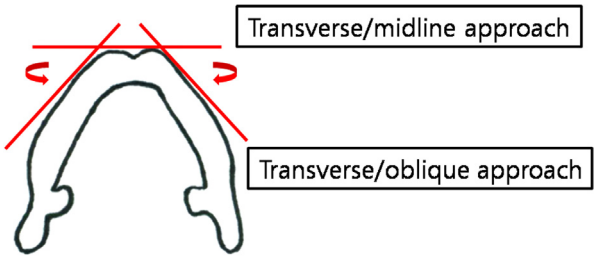

FIGURE 3. Ultrasonographic-mediated identification of the thyroarytenoid muscle. When moving the probe up and down at a transverse position at the level of thyroid cartilage, the operator could observe thyroarytenoid muscle (transverse/midline approach). After observing the muscle in the midline, the operator positioned the probe on the target region in parallel with the curvature of thyroid cartilage.