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Transcutaneous ultrasound for evaluation of vocal fold movement in patients with thyroid disease

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ABSTRACT

Background: Preoperative evaluation of recurrent laryngeal nerve function is important in the context of thyroid surgery. Transcutaneous ultrasound may be useful to visualize vocal fold movement when evaluating thyroid disease.
Methods: A 7–18 MHz linear array transducer was placed transversely on the midline of the thyroid cartilage at the anterior neck of patients with thyroid disease. The gray-scale technique was used, with the scan setting for the thyroid gland.
Results: Between August 2008 and March 2010, 705 patients, including 672 patients with normal vocal fold movement and 33 patients with vocal fold paralysis were enrolled. They included 159 male and 546 female patients. Their ages ranged from 10 to 88 years. Vocal fold movement could be seen by ultrasound in 614 (87%) patients, including 589 (88%) patients with normal vocal fold movement and 25 (76%) patients with vocal fold paralysis ($p = 0.06$). The mean age of patients with visible and invisible vocal fold movement was 46.6 and 57.9 years old, respectively ($p = 0.001$). Ultrasound was able to see vocal fold movement in 533 (98%) female patients but only in 81 (51%) male patients ($p = 0.001$). Among the patients with vocal fold paralysis, ultrasound revealed palsied vocal folds in 17 of 18 (94%) female patients but in only 8 of 15 (53%) male patients ($p = 0.01$).
Conclusion: Transcutaneous ultrasound represents an alternative tool to evaluate vocal fold movement for more than 85% of patients with thyroid disease, including more than 90% of female patients and about half of male patients.

1. Introduction

Vocal fold movement, including abduction and adduction, is controlled by the recurrent laryngeal nerve. The recurrent laryngeal nerve is located in the tracheoesophageal groove from the subclavian artery in the right side and the aortic arch in the left side and then enters the larynx at the cricothyroid junction. Therefore, abnormal lesions that are near the tracheoesophageal groove and cricothyroid junction have the potential to damage the nerve, causing impaired vocal fold movement and clinical hoarseness. Neoplasms of thyroid gland origin, especially thyroid cancer, and thyroid surgery are the most common neoplastic and iatrogenic causes of vocal fold paralysis, respectively [1,2].

Because management of the recurrent laryngeal nerve during the operation for thyroid disease is dependent on its function, pre-operative evaluation of the nerve function by checking bilateral vocal fold movement is generally recommended [3]. A mirror or fiberoptic laryngoscope is the most common and simple technique for direct check of vocal fold movement, but some surgeons do not routinely evaluate recurrent laryngeal nerve function before thyroid surgery due to a lack of familiarity with these techniques [4,5]. Because the majority of the thyroid nodules is subjected to ultrasound examination for differential diagnosis and for

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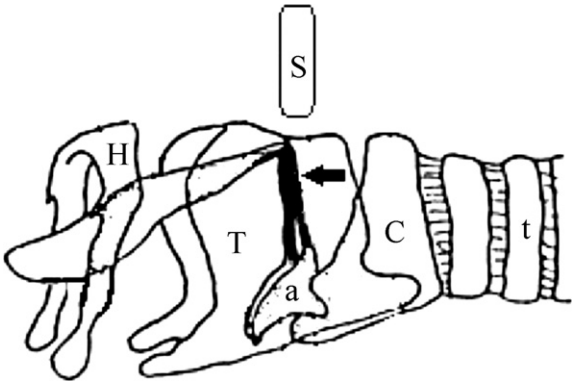

Fig. 1. The sagittal view of the larynx. The true vocal fold is located at the middle between the upper thyroid notch and the lower margin of the thyroid cartilage. The scanner is placed on the thyroid cartilage transversely. True vocal folds (arrow). Thyroid cartilage (T), arytenoids cartilage (a), cricoid cartilage (C), hyoid bone (H), trachea ring (t), scanner (S).

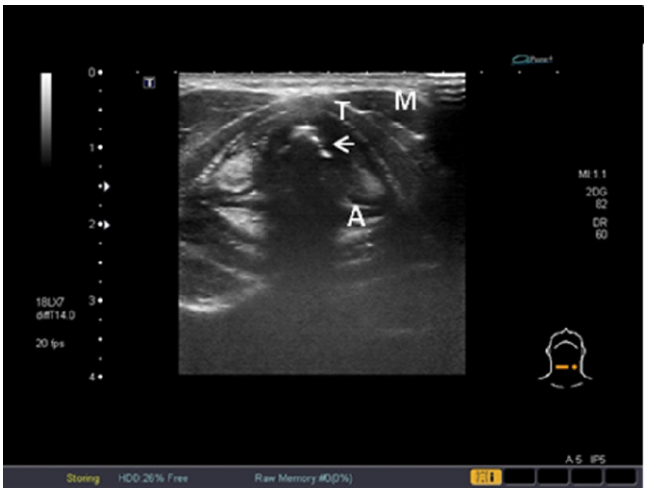

Fig. 2. Ultrasound anatomy of the larynx. The axial view of the larynx at the level of the true vocal folds (arrow). Thyroid cartilage (T), arytenoids cartilage (A), strap muscles (M).

ultrasound-guidance fine-needle aspiration, transcutaneous ultrasound may be an alternative non-invasive method to evaluate recurrent laryngeal nerve function via detection of vocal fold movement at the same time. Reviewing previously published literature, there are few studies on the application of ultrasound in preoperative evaluation of vocal fold movement, especially in adult patients with thyroid nodules [6].

In this study, we reported our experience using transcutaneous ultrasound to visualize the structure of the larynx and the movement of bilateral vocal folds during the evaluation of thyroid disease.

2. Patients and methods

Patients who had been diagnosed with thyroid disease and underwent head and neck ultrasound examination at the Department of Otolaryngology of the National Taiwan University Hospital between August 2008 and March 2010 were enrolled in this study. This study was reviewed and approved by the institutional review board at the National Taiwan University Hospital. The exclusion criteria included the presence of a tracheostomic tube in the neck and a diagnosis of primary untreated laryngeal/hypopharyngeal cancer. Patients with a history of laryngeal trauma were also excluded. All eligible patients underwent direct or indirect laryngoscopy (performed by all otolaryngologists listed in the authorship statement) and neck ultrasound (performed by C.P. Wang) to evaluate bilateral vocal fold movement, without a knowledge of the result of laryngoscopy. An ultrasound machine (Aplio^{TM}XG SSA-790A, Toshiba, Medical Systems Co., Otawara, Japan) with a 7–18 MHz linear array transducer (PLT-1204BX) was used. The scanner was placed transversely on the middle of the thyroid cartilage at the anterior neck to visualize the level of the true vocal folds (Fig. 1). Upon examination, with a pillow behind the head and neck, the patient was in supine position and asked to slightly extend the neck and to maintain even breathing without phonation or swallowing. The gap between the scanner and the surface of the anterior neck was filled with gel, especially when the angle of the thyroid cartilage was sharp. The gray-scale technique with the scan setting for the thyroid gland was applied to evaluate the morphology of the larynx firstly and then the movement of the bilateral vocal folds (Fig. 2). Normal vocal fold movement was defined as bilaterally symmetric abduction and adduction movements of the vocal folds. Palsied vocal fold was defined as limited abduction or adduction movement compared with the other side normal vocal fold.

All statistical analyses were performed using GraphPad prism 3.02 (GraphPad Software, San Diego, CA). Fisher's exact test and Student's *t*-test were used to determine the differences of clinical parameters between groups as appropriate. Corresponding *p*-values ≤ 0.05 were interpreted as statistically significant.

3. Results

A total of 705 patients, including 672 patients with normal vocal fold movement and 33 patients with vocal fold paralysis were enrolled in this study. The clinical data of these patients are shown in Table 1. They included 159 male and 546 female patients. Their ages ranged from 10 to 88 years, with a mean age of 48 years. The age distribution of the female patients with a mean age of 48 years was not significantly different from that of the male patients with a mean age of 49 years ($p = 0.15$). Vocal fold movement could be seen by the ultrasound in 614 (87%) patients, including 589 of 672 (88%) patients with normal vocal fold movement and 25 of 33 (76%) patients with vocal fold paralysis ($p = 0.06$). Vocal fold movement could not be seen by the ultrasound in the other 91 (13%) patients, including 83 of 672 (12%) patients with normal vocal fold movement and 8 of 33 (24%) patients with vocal fold paralysis. The mean age of the patients with visible vocal fold movement by the ultrasound was statistically lower than that of patients with invisible vocal fold movement (46.6 years vs. 57.9 years, respectively, $p = 0.001$). With regard to sex, ultrasound could see vocal fold movement in 533 (98%) of 546 female patients but in only 81 (51%) of 159 male patients ($p = 0.001$). Among the patients with vocal fold paralysis, ultrasound revealed a palsied vocal fold in 17 of 18 female

Table 1
Demographic characteristics of 705 patients including 672 patients with normal vocal fold movement and 33 patients with palsied vocal fold receiving ultrasound examination of vocal fold movement.

Characteristics	Numbers
Age, mean (range)	48 years (10–88)
Sex (M:F)	159:546
Visible vocal fold movement	
All cases	614/705 (87%)
Normal vocal fold movement	589/672 (88%)
Palsied vocal folds	25/33 (76%)
Visible vocal folds by sex in all 705 cases	
Women	533/546 (98%)
Men	81/159 (51%)
Visible vocal folds by sex in 33 palsied cases	
Women	17/18 (94%)
Men	8/15 (53%)