Am J Otolaryngol xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Am J Otolaryngol

journal homepage: www.elsevier.com/locate/amjoto

Anatomic factors affecting the use of ultrasound to predict vocal fold motion: A pilot study☆

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ARTICLE INFO

Keywords:
Ultrasonography
Vocal cords
Neck
Paralysis
Larynx

ABSTRACT

Purpose: Ultrasonography is a well-established modality for visualization of head and neck anatomy. Using ultrasound to detect vocal fold mobility has been described before, but no study has evaluated factors affecting the exam reliability. The aim of the study is to determine anatomic factors influencing the reliability of ultrasound to detect vocal fold motion.

Methods and materials

Patients underwent ultrasound evaluation and flexible laryngoscopy to assess vocal fold motion from August 2015 to March 2016. Length, accuracy, and clarity of ultrasound examination were assessed, compared to flexible laryngoscopy. For patients with prior neck CT scan imaging, laryngeal anatomy was independently assessed by a blinded neuroradiologist.

Results: A total of 23 patients, 21 with bilateral vocal fold motion and two with unilateral paralysis, were enrolled. Vocal folds were visible in 19 patients (82%). Eight patients (42%) had good/excellent view and 11 patients (58%) had fair/difficult view. The ultrasound correctly detected absent movement of the vocal fold in the two patients with unilateral paralysis. A total of 19 patients had CT scans, and a linear correlation ($r^2 = 0.65$) was noted between the anterior thyroid cartilage angle measured on CT and the grade of view on ultrasound.

Conclusion: Ultrasound was able to detect vocal fold motion in 82% of randomly screened patients. Ease of detection of vocal fold motion correlated with the anterior thyroid angle. Further studies are warranted to investigate the reproducibility of our results and how this might impact use of ultrasound for detection of vocal fold motion in the operative setting.

1. Introduction

Ultrasonography is an effective means of assessing soft tissue anatomy of the neck [1–3]. It has the advantage of being an inexpensive, radiation-free, rapid, highly sensitive, and specific imaging tool for the soft tissue anatomy of the neck that can be performed in an office setting as an adjunct to routine clinical examination [4,5]. -With the use of high frequency transducers, which have a limited depth of penetration but excellent magnified resolution of soft tissue anatomy, ultrasonography is ideal for delineating the complex anatomy in the neck [6]. In addition, ultrasonography possesses the advantage of assessing blood flow and dynamic function, such as vocal fold motion, otherwise not possible with MRI and CT. The quality of the exam is operator dependent, but the technique can be mastered quickly. Ultrasonography has diverse applications including evaluation of neck anatomy (lymph nodes, thyroid gland, parathyroid glands, salivary glands), assessment of vascular flow, as a guidance tool (needle-guided aspiration and Botox injection), and for assessment of motion, including vocal fold motion [7–11].

Some studies recommend ultrasound as a supplement to flexible laryngoscopy for detection of vocal fold movement and paresis and for vocal fold treatments [12,13]. It can serve as a confirmatory imaging modality to increase diagnostic accuracy of vocal fold pathology (Fig. 1). In addition, several studies have suggested that it can be an alternative to a flexible laryngoscopy [14,15]. Every test has its limitations. Therefore, it is important to determine the reliability of

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https://doi.org/10.1016/j.amjoto.2018.04.005
Received 8 February 2018

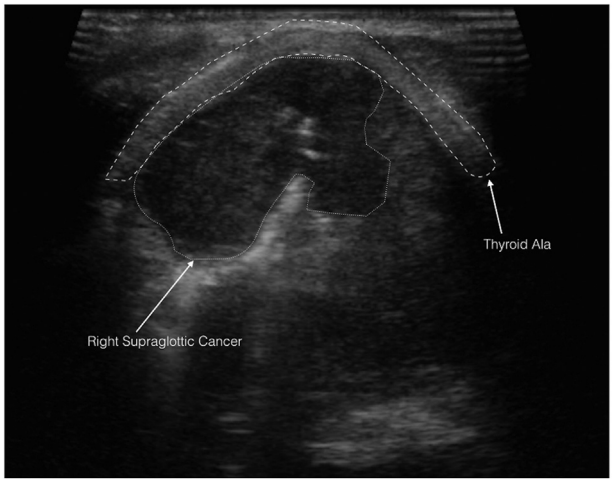

Fig. 1. Transverse ultrasound of a midline neck showing a right supraglottic cancer. Beneath the thyroid lamina (dashed line), a large hypoechoic right supraglottic lesion is seen filling the false vocal fold and extending across midline (dotted line).

ultrasound for detection of vocal fold mobility, and evaluate what anatomic factors may impact this reliability. Our study sought to grade the laryngeal view with ultrasound and determine anatomic factors that may affect the ability to assess dynamic function of the larynx with ultrasound.

2. Materials and methods

2.1. Study approval and enrollment

The University of North Carolina Institutional Review Board approved this prospective pilot study. After an informed consent process, patients were enrolled in this single institution prospective study from August 2015 to March 2016. Patients were considered for enrollment if they had a larynx and were scheduled to undergo flexible laryngoscopy as part of their routine clinical examination. Patients with prior external laryngeal trauma or external laryngeal surgery were excluded from enrollment.

2.2. Ultrasound assessment and grading

Patient was positioned in the upright seated position with mild neck extension, and then underwent an ultrasound examination of the anterior midline neck, performed by the senior surgeon (T.H), with a 7.5–10 MHz linear array transducer held in the transverse position. A novel grading system was established as part of this pilot study by the senior author (T.H) as a potential grading system that can be emulated by other studies and ultrasound operators. The operator's subjective ability to assess vocal fold motion was assessed on a scale (1-no view, 2-poor view, 3-fair view, 4-good view, 5-excellent view) and length of the examination was collected. If no vocal fold anatomy could be reliably seen, the exam was scored as a 1 (Fig. 2). When the anatomy was not clear, but soft tissue motion could be seen intermittently with phonation in limited fashion, a score of 2 was given. When the view was limited, but consistent motion could be appreciated, a grade of 3 was given (Fig. 3). When the view of the arytenoid and/or vocal fold was discernible and the motion was consistently maintained, a score of 4 was given (Fig. 4). When the arytenoid complex, vocalis muscle, and mucosa/air interface were clearly seen and motion easily assessed, a grade of 5 was given (Fig. 5).

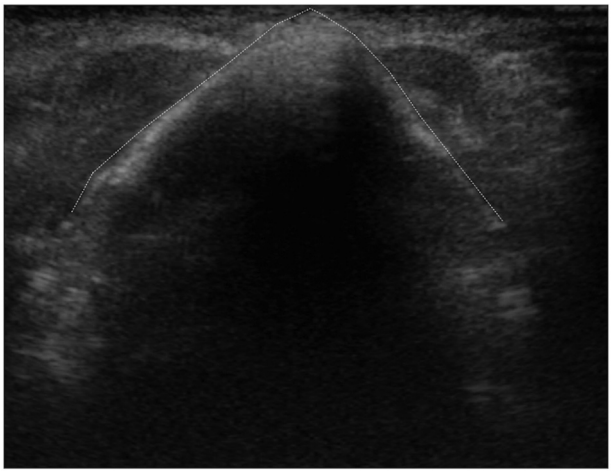

Fig. 2. Grade 1 view of the vocal folds. Beneath the thyroid ala (dotted line), there is no visible endolaryngeal anatomy.

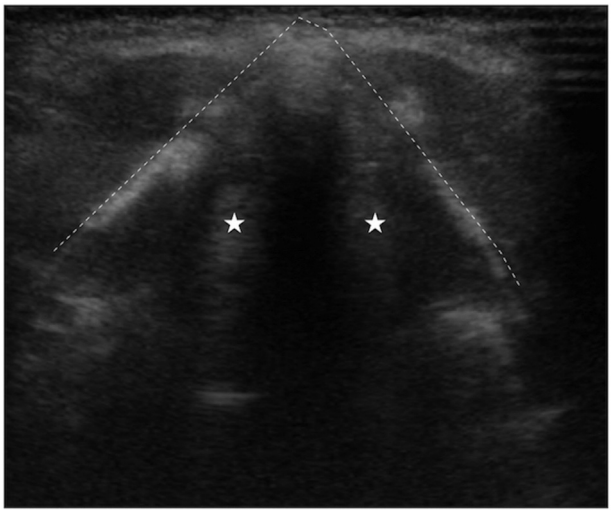

Fig. 3. Grade 3 view of the vocal folds. Beneath the thyroid ala (dashed line), the hyperechoic signals (stars) represent the ill-defined vocal folds in adduction.

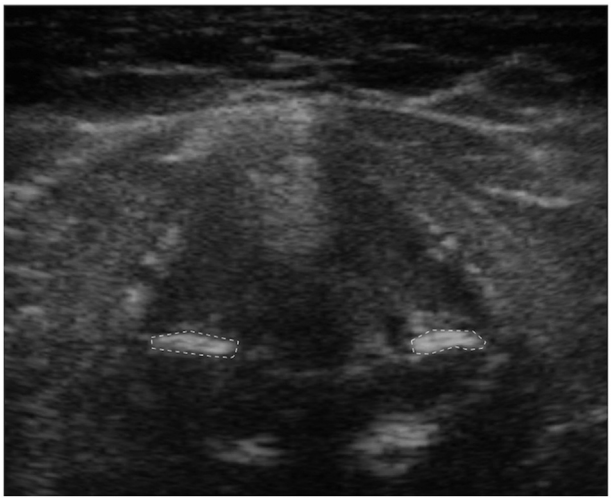

Fig. 4. Grade 4 view is depicted in this midline laryngeal view, the bilateral arytenoids (dashed lines) can easily be seen moving throughout the exam.