

# The Diagnosis of Vocal Cord Movement Impairment Using Ultrasonography: A Comparison of Transthyroid and Suprathyroid Views

Masood Mohseni,<sup>1</sup> Mahzad Alimian,<sup>1,\*</sup> Behrouz Zaman,<sup>1</sup> Seyed Hamid Reza Faiz,<sup>1</sup> Sara Ahmadi,<sup>1</sup> and Zahra Sadat Koleini<sup>1</sup>

<sup>1</sup>Department of Anesthesiology, Iran University of Medical Sciences, Tehran, Iran

\*Corresponding author: Mahzad Alimian, MD, Department of Anesthesiology, Iran University of Medical Sciences, Tehran, Iran. Tel: +98-2164352326, E-mail: mahzadalimian@gmail.com

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## Abstract

**Background:** Iatrogenic recurrent laryngeal nerve (RLN) injury is an uncommon but serious iatrogenic complication, especially after head and neck surgeries, and some thoracic procedures. Laryngoscopy can be an invasive and uncomfortable procedure; therefore, the use of ultrasonography (US) as a noninvasive method of screening patients for impaired vocal cord mobility is desirable. This study was conducted to compare the visibility of vocal cords in 2 suggested US views: suprathyroid and transthyroid approaches.

**Methods:** In this clinical trial, 144 patients of either sex, who were candidates for elective suchlike surgery, were enrolled. The participants underwent vocal cord US through transthyroid and suprathyroid windows in a transverse plane with and without water bath. The visibility of vocal cords in either view was graded from 1 (invisible) to 5 (clearly visible). Direct laryngoscopy was performed after surgeries, with anticipated risk of vocal cord dysfunction, in patients with suspicious or invisible vocal cords in US.

**Results:** Symmetric movement of vocal cords was visible in 88.8% of the participants. The visibility of vocal cords in transthyroid view was better than the suprathyroid approach. The quality of sonographic views was better in females and in younger age groups. The application of water bath did not improve the overall visibility of vocal cords during US.

**Conclusions:** Transthyroid US seem to be a valuable screening modality for anticipated vocal cord dysfunction. Application of this method, particularly in nonelderly women, conveys more favorable results. Future improvements in the ultrasound machines in the hands of well-trained clinicians will improve its diagnostic accuracy.

**Keywords:** Vocal Cord, Airway, Ultrasonography, Transthyroid, Suprathyroid

## 1. Background

Iatrogenic recurrent laryngeal nerve (RLN) injury is an uncommon but serious iatrogenic complication, especially after head and neck surgeries and some thoracic procedures (1, 2). The incidence of unilateral and temporary RLN injury in thyroid surgery is 1.4% to 5.1% and permanent injury is encountered in 0.4% to 0.9% of patients (3). Unilateral damage can be responsible for hoarseness. Bilateral damage causes dyspnea, stridor, and even complete obstruction of the airway (3-6). Therefore, examination of the vocal cord (VC) movement after such surgeries is crucial.

Direct laryngoscopy (DL) is now the preferred diagnostic modality to evaluate the movement of VC postoperatively. However, DL during light anesthesia could be painful and complications such as tissue damage, laryngospasm, vomiting, and aspiration are not uncommon. Thus, a noninvasive diagnostic modality for VC dysfunction is required. Earlier studies have suggested several im-

plications for ultrasonography in airway assessment (7, 8). Nevertheless, few data are available on the efficacy of ultrasonography in evaluating VC impairments (2, 4, 7).

Few available earlier studies have suggested transthyroid, suprathyroid, and parasagittal sonographic approaches to the larynx; of them, transthyroid view is most commonly recommended (7, 9). This view can be affected by the patient's age and sex due to the calcification of the thyroid cartilage (9). This study was conducted to compare the visibility of vocal cords into 2 suggested sonographic views: suprathyroid and transthyroid approaches.

## 2. Methods

### 2.1. Study Population

In this cross-sectional study, 144 patients of either sex aged 8 to 18 years, who were candidates for elective suchlike but had laryngeal surgery, were enrolled. The type of anesthesia was variable according to the requirements

including neuroaxial, regional, or general anesthesia. Patients with limited head extension, short neck, and those with known laryngeal morbidity including hoarseness, dysphonia, or history of laryngeal surgery were excluded. Informed consent was obtained from all participants before inclusion. Approval from the local ethics committee was obtained. The study was registered as IRCT number 2016060628311N1.

## 2.2. Study Design

All patients underwent vocal cord sonography through transthyroid and suprathyroid windows in a transverse plane with and without water bath. We performed direct laryngoscopy immediately after extubation following thyroidectomy, parathyroidectomy, carotid endarterectomy, and anterior approach of cervical spine fixation, and left-sided thoracic procedures. Direct laryngoscopy was also performed in patients with suspicious VC movement impairment shown in sonography.

Patients who underwent general anesthesia received propofol 150 - 150  $\mu\text{g}/\text{kg}/\text{min}$  and remifentanyl 0.02  $\mu\text{g}/\text{kg}/\text{min}$  to maintain anesthesia. Infusion of propofol was discontinued about 10 minutes before the end of the surgery, while infusion of remifentanyl was continued till the end. Laryngoscopy was performed using Macintosh blade Size 3 or 4 after reversal of muscle relaxation.

## 2.3. Method of Sonography

Patients were placed in a sniffing position, with a pillow placed under the occiput to achieve optimal head extension and neck flexion. Ultrasonography was performed by 1 certain anesthetist in all patients using an ultrasound machine (Sonosite S-Nerve, USA) and high-frequency linear transducer (6 - 13MHz). The operator was able to detect VC movement by asking the patients to phonate. The probe was placed transversely on the thyroid cartilage at the level of isthmus for the transthyroid approach and above the thyroid cartilage for suprathyroid window. The probe was tilted in a cephalic-caudal direction to achieve the optimal view. Vocal cords could be visualized as an isosceles triangle with the shadow of trachea at the center. False VCs appear as hyperechoic shadows parallel to and above the true VCs. Normal vocal cord movement was defined as symmetric adduction and abduction during respiration and phonation. False VCs remain relatively motionless during phonation. Vocal cord paresis or palsy was considered when asymmetrical or no movement was noted during phonation.

A hand made water bath was used to improve the quality of sonographic views. To do so, a sterile surgical glove was filled with water to form nearly 1 cm thickness.

Sonography following surgeries at the neck region was performed using sterile ultrasound gel (Aqua sonic, Parker Company, USA) to avoid surgical site contamination. The visibility of VC in sonography was graded from 1 (invisible) to 5 (clearly visible).

## 2.4. Statistical Analysis

Wilcoxon signed rank test was used to compare the quality of sonographic views. For intergroup comparisons, Mann-Whitney U test was used and descriptive statistics were provided. The relationship between quality of sonography findings and age was analyzed using Spearman's rank correlation coefficient. P values less than 0.05 were considered statistically significant. The Statistical Package for Social Science (SPSS) for windows, Version 19 (Chicago, IL, USA) was used for data analysis.

## 3. Results

Symmetric movement of vocal cords was visible in 98.6% of the participants. General anesthesia was applied for 58 patients (40.2%); of them, 10 had surgeries with anticipated risk of RLN injury. One patient with revision thyroid surgery experienced unilateral vocal cord paralysis. The US view in this patient was suggestive of injury, which was confirmed by direct laryngoscopy.

The visibility of vocal cords in transthyroid view was better than the suprathyroid approach in both sexes and all age groups (Table 1). Females revealed better views than males in both suprathyroid and transthyroid approaches (Median, 5 (4, 5) vs. 4 (3, 5); P value < 0.05). The quality of US findings was negatively correlated with aging. For transthyroid view, the correlation coefficient was -0.25 (P = 0.006) and it was -0.299 (P = 0.001) for suprathyroid view.

**Table 1.** The Quality of Two Ultrasound Views Respecting Demographic Variables<sup>a</sup>

Variables	Suprathyroid View	Transthyroid View	P Value
Age > 60, y (n = 34)	3 (2, 4)	4 (3, 5)	0.006
Age < 60, y (n = 119)	4 (3, 5)	5 (4, 5)	0.11
Male sex (n = 94)	4 (3, 5)	4 (3.5, 5)	0.001
Female sex (n = 59)	5 (3, 5)	5 (3, 5)	0.73
Total (n = 144)	4 (3, 5)	5 (3.5, 5)	0.004
With water bath	4 (4, 5)	4 (3, 5)	0.29

<sup>a</sup>Data are presented as median (25, 75 percentile).

The scores of US findings in patients older than 60 years were significantly less than younger participants (Table 1). However, even in this subgroup of patients, the transthyroid view yielded better results than the transthyroid approach. The application of water bath did not improve the overall visibility of vocal cords during US ( $P > 0.05$ ).

#### 4. Discussion

Findings of this study suggest that the visibility of VCs in transthyroid approach is higher than suprathyroid view. The quality of examinations in females was better than males and decreased by age.

The application of US for airway management has been increased over the years; prediction of difficult airway, estimation of proper size of endotracheal tube, emergency cricothyroidotomy, guidance for double-lumen tube insertion, and percutaneous dilatational tracheostomy are some examples (7). US was suggested in the 1990s as an easy, fast, and safe modality for evaluation of VC movement (10). Since then, advances in the equipment and technique of US have resulted in more favorable results (8, 11). The positive predictive value of US in detecting postoperative VC dysfunction was reported to be 62% to 100% in earlier studies (12). However, its diagnostic accuracy is both equipment and operator dependent and could also be influenced by the selected window for laryngeal sonography.

Earlier studies have suggested sagittal, parasagittal, and transverse (transthyroid or suprathyroid) views for airway sonography (7, 9). Of them, transthyroid approach is the most popular and recommended method. However, calcification of the thyroid cartilage reduces the visibility of VCs in the elderly (13). In a 60-year-old male, up to 40% of cartilages at the level of VC have been calcified (14, 15). In females, calcification is less the case (2). Thus, it is expected that the quality of sonographic views through transthyroid window be less in males than in females, especially in the later decades of life. Earlier reports support this hypothesis (8, 14, 16), and concurrently suggest transthyroid US as an ideal screening modality for postoperative VC dysfunction (4). Our findings revealed that suprathyroid window may not replace transthyroid approach even in the elderly males. In nearly 90% of our patients, the symmetrical movement of VCs was visible, which is satisfactorily sufficient for a diagnostic screening modality. To not missing the involved patients, further laryngoscopy is recommended in invisible or suspicious cases.

Administration of water bath technique could be a privilege over gel application in US. The application of water bath in sonography of distal extremities resulted in good skin contact and more patient comfort (17). In airway

assessment, it has been suggested that the movement of VC can be better visualized with the use of a water bath between the probe and skin (7). In our experience, the hand-made water bath improved the probe contact in the interface and resulted in more clear views, but the overall visibility of VCs were not significantly improved.

In conclusion, transthyroid US of vocal cords seem to be a valuable screening method after anticipated RLN injury. In the case of suspicious or invisible vocal cords, direct laryngoscopy is recommended. Future improvements with the equipment in the hands of well-trained clinicians will result in more favorable results.

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