



## ORIGINAL RESEARCH PAPER

## Radiodiagnosis

### A COMPARATIVE STUDY OF ULTRASOUND AND FLEXIBLE FIBEROPTIC LARYNGOSCOPE FOR VOCAL CORD ASSESSMENT.

**KEY WORDS:** Flexible fiberoptic laryngoscopy, ultrasound, vocal cords

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#### ABSTRACT

**INTRODUCTION:** Flexible fiberoptic laryngoscopy (FFL) is currently the gold standard technique used for examining the vocal cords. It is associated with minor discomfort and can be challenging in young children. Ultrasound being a non-invasive technique, has been studied as an alternative, inexpensive, rapid and painless method which can be done for evaluation of vocal cords. In this study we compared the assessment of vocal cords using ultrasound and flexible fiberoptic laryngoscopy.

**MATERIALS AND METHODS:** Vocal cords of 200 patients were assessed, first with fiberoptic laryngoscopy and then with ultrasound. Parameters including vocal cord position, movement during phonation, length of vocal cords and presence of any abnormality were compared and statistically analysed with those with fiberoptic laryngoscopy.

**RESULT:** Position of vocal cords was correctly assessed with ultrasound as normal in 99.42% and abnormal in 0.5% patients. Ultrasound rightly assessed mobility of right and left vocal cords as normal in 99.42% and 98.84% and abnormal in 0.58% and 1.1% respectively. Vocal cord polyps were successfully identified in all patients while vocal nodules in 3.49% and 4.07% of patients in the right and left vocal cord respectively and failed to detect vocal cord nodules in 0.58% of patients. Mean duration ( $60.9 \pm 7.31$  sec, vs  $45.8 \pm 13.28$  sec;  $p < 0.0001$ ), median time taken (60 sec vs 50 sec) and time range of procedures (10-90 secs vs 60-120 secs) were shorter in the ultrasound arm respectively.

**CONCLUSION:** Ultrasound is a well tolerated technique for assessment of vocal cord mobility, presence of polyps and nodules, though thyroid cartilage calcification may impair visualization in some. It is a fast alternative with added feature of assessing extra laryngeal structures.

#### INTRODUCTION

Laryngeal function can be assessed by a wide variety of techniques that are divided into clinical assessment and investigations. In addition to a complete medical history and physical examination, the physician may examine the vocal cords internally. Currently, indirect laryngoscopy, flexible fibre optic laryngoscopy and videostroboscopy are the standard techniques used to evaluate the vocal cords. Flexible fiberoptic laryngoscopy (FFL) remains the gold standard to examine vocal folds. It provides an easy and well tolerated modality for examining the nasopharynx and laryngotracheal areas and provides clear viewing with permanent recording facility. It is however associated with minor discomfort and can be challenging in young children.

Ultrasound is a non-invasive technique and has in recent years been studied as an alternative, inexpensive, rapid and painless method for evaluation of vocal chords. It also allows generation of images that may be stored for medical record and re-evaluation at a later interval. In this study we planned to compare the assessment of vocal chords using ultrasound and flexible fiberoptic laryngoscopy. In this study we compared the assessment of vocal cords using ultrasound and flexible fiberoptic laryngoscope.

#### MATERIALS AND METHODS

Institutional ethics approval was taken before starting the study with informed consent taken from each patient. A total of 200 patients were enrolled in the study. The patients were assessed by fiberoptic laryngoscope initially, followed by ultrasound evaluation of the vocal cords. The vocal cords were assessed sonographically using Philips ultrasound scanner (Model No: HD11XE) high frequency (7.5MHz) linear transducer. The patients were examined in supine position with the neck in neutral position. Transverse sonograms using thyroid cartilage as an acoustic window were performed. The position of the vocal cords during quiet breathing and movement during phonation were assessed and tabulated. The findings on fiberoptic laryngoscopy and ultrasonography were then compared and statistically analysed. In

addition, the thyroid cartilage as well as length of the vocal cords was assessed by ultrasound. The length of the vocal cords was measured from the level of anterior commissure to the arytenoid cartilage. Presence of polyps or nodules was also noted.

#### STATISTICAL ANALYSIS

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean  $\pm$  SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used. Quantitative variables were compared using Unpaired t-test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups. Qualitative variables were correlated using Chi-Square test /Fisher's exact test. Diagnostic test was used to find out the Sensitivity, Specificity, PPV and NPV of Ultrasonographic findings taking Flexible fiberoptic laryngoscopy findings as gold standard. Inter rater kappa agreement was used to find out strength of agreement between two methods. A p value of  $< 0.05$  was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.



**Fig.1 Transverse sonogram at the level of the thyroid cartilage showing normal anatomy of the true vocal cords. ^Strap muscles, Thin white arrow- Thyroid cartilage, Thick white arrows- Arytenoid cartilage, \*- True vocal cord**

## RESULT AND ANALYSIS

Of the total 200 patients enrolled in the study, 104 patients were males. The age distribution was as follows; 5.5% (11) were in the 11-20 age group, 22%(44) were in the 21-30 age group, 29% (58) were between the 31-40 age group, the rest (19.5%) were in the 41-50 age group

### Assessment of vocal cords using ultrasound and.

On ultrasound, the vocal cord could not be assessed in 28 patients (28/200, 14%) due to thyroid cartilage calcification. All 200 patients could be assessed with laryngoscopy (Tables 1 and 2).

**Table-1. Vocal cord findings on ultrasound**

Parameter	Finding	Frequency	Percent
Position of right vocal cord	Normal	171	85.50
	Abnormal	1	0.50
Position of left vocal cord	Normal	171	85.50
	Abnormal	1	0.50
Mobility of right vocal cord	Normal	171	85.50
	Abnormal	1	0.50
Mobility of left vocal cord	Normal	170	85.00
	Abnormal	2	1.00
Right vocal polyp	Absent	171	85.50
	Present	1	0.50
Left vocal polyp	Absent	169	84.50
	Present	3	1.50
Right vocal nodule	Absent	165	82.50
	Present	7	3.50
Left vocal nodule	Absent	165	82.50
	Present	7	3.50
Impression	Normal study	156	78.00
	Vocal cord paralysis	3	1.50
	Vocal cord polyp	3	1.50
	Vocal cord nodule	10	5.00
Total		172	86

**Table 2. Vocal cord findings on flexible fiber-optic laryngoscopy**

PARAMETER	FINDING	FREQUENCY	PERCENT
Position of right vocal cord	Normal	199	99.50
	Abnormal	1	0.50
Position of left vocal cord	Normal	199	99.50
	Abnormal	1	0.50
Mobility of right vocal cord	Normal	199	99.50
	Abnormal	1	0.50
Mobility of left vocal cord	Normal	198	99.00
	Abnormal	2	1.00
Right vocal cord polyp	Present	198	99.00
	Absent	2	1.00
Left vocal cord polyp	Present	197	98.50
	Absent	3	1.50
Right vocal cord nodule	Present	193	96.50
	Absent	7	3.50
Left vocal cord nodule	Present	192	96.00
	Absent	8	4.00
Impression	Normal study	183	91.50%
	Vocal cord paralysis	3	1.50%
	Vocal cord polyp	4	2.00%
	Vocal cord nodule	10	5.00%
TOTAL		200	100

### 1) Comparison of ultrasound and flexible fiberoptic laryngoscopy in assessing position of bilateral vocal cord (excluding patients with thyroid cartilage calcification).

We were able to correctly assess the position of both vocal cords as normal in 99.42% of patients using ultrasound in comparison with the gold standard flexible fiberoptic laryngoscopy. 0.5% of patients who had abnormal position of both vocal cords on flexible fiberoptic laryngoscopy were correctly identified by ultrasound also.

### 2) Comparison of ultrasound and flexible fiberoptic

### laryngoscopy in assessing mobility of bilateral vocal cords (excluding patients with thyroid cartilage calcification).

Analysis of the mobility of both vocal cords on ultrasound and flexible fiberoptic laryngoscopy show that ultrasound was able to rightly assess the mobility of right and left vocal cords as normal in 99.42% and 98.84% respectively. 0.58% and 1.1% of patients who had abnormal mobility of the right and left vocal cord respectively on flexible fiberoptic laryngoscopy was correctly picked up on ultrasound also.

### 3) Comparison of ultrasound and flexible fiberoptic laryngoscopy in assessing polyps in bilateral vocal cords (excluding patients with thyroid cartilage calcification).

Analysis shows that ultrasound rightly diagnosed the absence of vocal cord polyps in 99.42% and 98.26% of patients in right and left vocal cords respectively. Vocal cord polyps were successfully picked up on ultrasound in all patients who had the same which included 0.58% and 1.74% in the right and left side respectively.

### 4) Comparison of ultrasound and flexible fiberoptic laryngoscopy in assessing nodules in bilateral vocal cords (excluding patients with thyroid cartilage calcification).

Analysis shows that using ultrasound, vocal nodules was rightly picked up in 3.49% and 4.07% of patients in the right and left vocal cord respectively. Ultrasound failed to pick up vocal cord nodules in 0.58% of patients which was picked on flexible fiberoptic laryngoscopy.

### 5) Time Comparison Between Ultrasound And Flexible Fibre-Optic Laryngoscopy

On comparing the time required to perform flexible fiber-optic laryngoscopy and ultrasound for the assessment of the vocal cords, it was observed that, mean duration (60.9 ± 7.31sec, vs 45.8 ± 13.28sec; p<0.0001), median time taken (60 sec vs 50 sec) and time range of procedures (10-90 secs vs 60-120 secs) were shorter in ultrasound arm respectively.

## DISCUSSION

The wide variety of available techniques to assess laryngeal function can generally be divided into clinical and investigational categories.[1,2,3] A practical technique fundamentally should be safe, non-invasive, well tolerated and reliable and results should be reproducible, accurate and recordable for future reference.

Flexible fiber-optic laryngoscopy provides an easy handled, well tolerated modality for examining the nasopharynx and laryngotracheal areas with permanent recording facility. Compared to rigid laryngoscopes, fiber-optic laryngoscopes are easy to handle with minimal discomfort to the patient. Minor discomfort related to use of topical anesthetic in the nose or pharynx and rare complications like tachycardia, tachypnea, oxygen desaturation, epistaxis, vasovagal events, laryngospasm and aspiration events can however occur.

With the aim of resolving some of these problems, ultrasound for the evaluation of vocal cords has been studied in the past. Qiao Hu et al in their study showed promising results using ultrasound in evaluating the vocal cords in those less than 18 years but with rates of visualization decreasing with increasing age and more so in males.[4] The limiting factor in ultrasound assessment is thyroid cartilage calcification that obscures visualization of the true vocal cords.[5] All 55 patients in our study between 11-30 years had non calcified thyroid cartilage, providing a good acoustic window for the assessment of the true vocal cords. 44.8% of patients between 51-60 years, 40% of patients between 61-70 years and 75% of patients >70 years showed calcified thyroid cartilage, suggesting increased calcification with increasing age, more so in males. Ooi et al too concluded that ultrasound would be an alternative for the evaluation of vocal-cord movement in over 90% of women and about 50% of men.[6] This in turn could be taken advantage of in evaluation of thyroid dysfunction, a condition more commonly affecting females where ultrasound of the neck for the evaluation of the thyroid gland may be combined with adjunctive preoperative ultrasound of vocal cord mobility prior to

thyroidectomy instead of flexible fiber optic laryngoscopy.

On analysis of patients with non- calcified thyroid cartilage, ultrasound rightly diagnosed the vocal cords as normal in 90.12% (155) of patient. 1.74% (3) of patients who had vocal cord palsy and vocal cord polyps was rightly picked up using ultrasound also. 5.23 % (9) of the patients who had vocal nodules on flexible fiberoptic laryngoscopy was rightly picked up using ultrasound also. However 0.58% (1) patient who had normal vocal cords on flexible fiberoptic laryngoscopy showed a false positive for vocal cord nodules on using ultrasound. On excluding patients with thyroid cartilage calcification, it was seen that those patients with false positives and false negative for abnormal position, mobility, vocal cord polyps or nodules was less than 1%.

When compared with flexible fiberoptic laryngoscopy, the sensitivity of ultrasound in assessing position, mobility and vocal polyps in bilateral vocal cords in our study is 100%. The sensitivity of ultrasound to detect vocal nodules in both vocal cords is between 85-87%. A specificity of 84-86% was obtained in the assessment of position and mobility of vocal cords as well as detecting vocal cord polyps and nodules in bilateral vocal cords. J Amis et al conducted a similar study which showed sensitivity of ultrasound in assessment of vocal fold motion abnormality of 71% and a specificity of 89%. The positive predictive value of the ultrasound assessment of the vocal folds was 83% and the negative predictive value was 80% suggesting ultrasound to be a useful tool to screen for vocal fold motion abnormalities in the adult population. Abnormal findings on vocal fold ultrasound should be confirmed with subsequent laryngoscopy.[7] Ghassan A et al demonstrated a sensitivity of ultrasound of 100% and specificity of 80%.[8] Emad K et al in their assessment of the vocal cords using translaryngeal ultrasound and flexible fiberoptic laryngoscope pre and post thyroid surgery in 250 patients, found a sensitivity, specificity, and accuracy of preoperative TLUSG of 53.8%, 50.5%, and 50.6%, respectively and for postoperative TLUSG of 55.6%, 38.7%, and 39.6%, respectively. [9]

The other variable in our study was the duration for performing each of these procedures, which for flexible fiber optic laryngoscopy and ultrasound was a mean duration of 60.9+/-7.31 seconds and 45.8+/-13.28 seconds respectively.

Being a non- invasive procedure ultrasound was associated with no discomfort during or post procedure unlike flexible fiber optic laryngoscopy. Ultrasound also had no risk of complications. Prior studies have shown that 25% of adults undergoing flexible fiberoptic laryngoscopy for evaluation of vocal cords have reported gagging and 10% have dyspnoea with the procedure.[10] Additionally, ultrasound is relatively inexpensive and could be easily coupled with ultrasound of the neck for the evaluation of the thyroid gland or neck vessels.

Both flexible fiberoptic laryngoscopy and ultrasound could be easily recorded and saved for later evaluation using the permanent recording facility and the skill required for assessing the vocal cords using ultrasound can be easily attained.[8] Ultrasound while viewing the status of the vocal cords, has the added advantage over laryngoscopy of assessing other neck structures including the thyroid glands, cervical lymph node, status of thyroid cartilage and status of neck vessels.

The portable feature of ultrasound adds another advantage over laryngoscopy – that of performing bedside examination of vocal cords of critically ill and uncooperative patients even in wards and ICU's. Vocal cord assessment using flexible fiberoptic laryngoscope requires utmost patient cooperation and is not possible in patients with trismus and uncooperative and disoriented patients. Though we did not assess children below 11 years in our study, being non-invasive, it would not be unfair to suggest that ultrasound may be the preferred choice compared to laryngoscopy. Smaller thyroid cartilage in children with resultant smaller acoustic window may however be the challenge with regards feasibility of ultrasound for the same.

In conclusion, ultrasound is a non-invasive, safe, well tolerated and a relatively innocuous technique with good spatial resolution for the assessment of vocal cord mobility, presence of polyps and nodules, though thyroid cartilage calcification may impair visualization in some. It may serve as a useful adjunct to fiberoptic laryngoscopy by being a fast alternative with added feature of assessing extralaryngeal structures, and ease of performing the procedure, even at patients' bedside.

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