

## Research Article

# Perceptual Evaluation and Acoustic Findings in Female Patients with Goiter

Abdul-latif Hamdan<sup>1</sup>, Georges Ziade<sup>1</sup>, Maher M. Kasti<sup>2</sup>, Jad Jabbour<sup>1</sup>, Jihad Nassar<sup>3</sup>, Iyad El-Dahouk<sup>1</sup> and Sami Azar<sup>4\*</sup>

<sup>1</sup>Department of Otolaryngology, American University of Beirut Medical Center – Beirut, Lebanon

<sup>2</sup>Department of Otolaryngology, Head & Neck Surgery, Rafic Hariri University Hospital–Beirut, Lebanon

<sup>3</sup>Department of Otolaryngology – Head & Neck Surgery, Toronto general hospital-Toronto, Canada

<sup>4</sup>Department of Internal Medicine, American University of Beirut Medical Center – Beirut, Lebanon

**\*Corresponding author**

Sami T. Azar, Department of Internal Medicine, Division of Endocrinology, American University of Beirut-Medical Center, Tel: +961-3- 234250; Fax: 011-961-1-365-189; Email: sazar@aub.edu.lb

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**Abstract**

The aim of the study is to describe the vocal characteristics of a group of female patients with goiter. For this purpose, a total of 43 female patients with goiter presenting to the endocrinology clinic and another age-matched group of controls were recruited. Patients underwent acoustic analysis and perceptual evaluation of their voice using the GRABS classification. Zero was considered normal, and 1, 2 and 3 as mild, moderate, severe deviation from normal, respectively. The mean score of each parameter was computed and the distribution of severity of each perceptual parameter was listed. The results of the study showed no significant difference in any of the acoustic variables between patients and controls. There was also no significant difference in the mean score of any of the perceptual evaluation parameters between the two groups except for straining. Goiterous patients had a significantly higher straining score comparing to controls,  $0.48 \pm 0.59$  vs.  $0.13 \pm 0.35$ , with a p value of 0.039. The means of all the perceptual parameters were less than 1 indicating a relatively mild or minimal deviation from normal. Therefore, female patients with goiter seen in a clinical set up have more vocal straining compared to controls, however, the amount of straining is minimal. Acoustic analysis failed to reveal any significant difference compared to controls.

**INTRODUCTION**

Reports on phonatory symptoms in patients with goiter are ubiquitous [1-6]. These include change in voice quality, roughness, breathiness, vocal fatigue, loss of range and inability to project the voice. Most of these symptoms have been reported in patients undergoing surgery or scheduled for thyroidectomy. More so, these vocal symptoms have been described in the context of vocal fold paresis or paralysis as the prevalence of vocal fold paralysis seems to be present in both patients with benign and malignant goiter. When present, the impaired mobility has been attributed to glandular hyperplasia, inflammation of the recurrent laryngeal nerve, and or invasion of the thyroid cartilage and joints. Other symptoms such as difficulty in swallowing have also been attributed to the limited vertical movement of the laryngo-tracheal complex in addition to thyroid hormonal imbalance.

Based on an extensive literature review, the authors of this

manuscript could not identify a study describing the perceptual evaluation and acoustic findings in patients with goiter not scheduled for surgery or seen in an emergency setting. In all the aforementioned studies, the vocal characteristics in patients with goiter have been reported either pre- and post-operatively or in the context of vocal fold paralysis. The purpose of this study is to describe the vocal characteristics of a group of female patients seen in a clinical set up. Both the perceptual evaluation and acoustic findings are reported. The hypothesis is that patients with goiter not presenting to the emergency room or scheduled for surgery have a normal voice with normal acoustic parameters.

**PATIENTS AND METHODS**

A total of 43 consecutive female patients with goiter presenting to the endocrinology clinic were invited to participate in the study after having read the consent form. The study and the consent form were approved by the Institution Review

Board. The diagnosis of goiter was based on clinical and or radiological examination using ultrasound. The study took place at the "Hamdan Voice Unit". Blood levels for thyroid stimulating hormone (TSH) were taken prior to their enrollment in the study. Exclusion criteria included prior history of upper respiratory tract infection prior to presentation, prior history of laryngeal manipulation such as laryngeal surgery or direct laryngoscopy, and or prior history of surgery under general anesthesia. An age-matched group was recruited as controls. Demographic data included age, smoking, allergies and reflux. Laryngopharyngeal reflux disease was asserted using the Reflux symptom Index designed by Belafsky [7], and patients were considered to have allergies using a validated questionnaire [8].

The authors made sure that the prevalence of allergies, reflux and smoking was similar in both groups, diseased and controls, in view of their confounding effect.

In patients with goiter, the disease duration, presence or absence of compressive symptoms, presence of thyroid nodules and thyroid stimulating hormonal level were also reported. The size of the thyroid gland was only available in 25 patients out of 43 due to incomplete ultrasound reports for the remaining 18 ones.

Patients underwent acoustic analysis using the VISI-PITCH IV by Kay Pentax (New Jersey). Patients were seated in a quiet room with a microphone placed 10 cm away from the mouth. Patients were asked to sustain the vowel /a/ at a comfortable pitch and loudness. The following acoustic parameters were examined: Fundamental Frequency, Shimmer, Relative Average perturbation, Noise to Harmonic ratio, Voice turbulence Index. Patients were then asked to take a deep breath and phonate for as long as they can and the maximum phonation time was recorded. Then they were asked to count to 10 and the habitual pitch was measured. Later on the recording of the patients were evaluated blindly by the first author and one of the co-author to rate perceptually the overall grading of the voice (G), roughness (R), Asthenia (A), breathiness (B), and straining (S). The GRABS classification was used. Zero was considered normal, 1 as mild deviation from normal, 2 as moderate deviation from normal and 3 as severe deviation from normal [9]. The mean score of each parameter was computed and the distribution of severity of each perceptual parameter was listed.

Frequencies and means ( $\pm$  standard deviation) were used to describe categorical and continuous variables, respectively. At the bivariate level, cases and controls were compared using the *independent t-test* to evaluate differences in the mean scores of each acoustic variable in Table 2. Perceptual evaluation (GRABS) was analyzed as a categorical data using Pearson's chi-square test, and when expected cell's count was less than 5 *Fisher's exact test* was reported instead. All analyses were conducted using the Statistical Package for the Social Sciences software (SPSS, version 17). A two-tailed p-value of less than 0.05 was considered statistically significant.

## RESULTS

### Demographic data

A total of 43 patients with goiter were enrolled in this study.

The mean age was  $45.88 \pm 12.45$  years. The average disease duration was  $3.63 \pm 4.60$  years. Almost 11.6% had reflux, 14.0% had allergies and 23.3% were smokers. The prevalence of smoking, allergies and reflux were comparable to controls. Seventy four percent had nodules and 69.8% were euthyroid based on their last TSH. The mean size of the thyroid gland in 25 subjects out of the 43 was  $30.23 \pm 19.32$  cm<sup>3</sup>. In the remaining patients the size of the gland was incompletely reported by ultrasound (Table 1).

### Acoustic analysis

There was no significant difference in any of the acoustic variables between patients and controls (Table 2).

### Perceptual evaluation

There was no significant difference in the mean score of any of the perceptual evaluation parameters between patients with goiter and controls except for straining. Patients with goiter had a significantly higher score compared to controls,  $0.48 \pm 0.59$  vs.  $0.13 \pm 0.35$ , with a p value of 0.039 (Table 3). It is worth noting that the means of all scores in the goiter group were higher compared to controls, but were less than 1 ( $<1$ ), indicating mild deviation from normal. Looking at the distribution of the severity of these parameters in both groups we see that in the goiter group, 11.9% had moderate grade and roughness, 7.1% moderate breathiness and 4.8% moderate straining compared to 0.0% in controls (Table 4).

**Table 1:** Demographic Data.

	Patients (n=43)	Controls (n=15)	p-value
Age in years (mean $\pm$ SD)	45.88 $\pm$ 12.45	38.33 $\pm$ 12.45	0.059
Reflux			
No	38 (88.4%)	13 (86.7%)	0.861
Yes	5 (11.6%)	2 (13.3%)	
Allergies			
Absent	37 (86.0%)	13 (86.7%)	0.952
Present	6 (14.0%)	2 (13.3%)	
Smoking			
No	33 (76.7%)	12 (80.0%)	0.795
Yes	10 (23.3%)	3 (20.0%)	
Disease duration in years (mean $\pm$ SD)	3.63 $\pm$ 4.60	N/A	N/A
Compressive signs			
Absent	24 (55.8%)	N/A	N/A
Present	7 (16.3%)		
Missing	12 (27.9%)		
Nodules			
Absent	11 (25.6%)	N/A	N/A
Present	32 (74.4%)		
TSH <sup>†</sup>			
Hyper-thyroid	3 (7.0%)	N/A	N/A
Eu-thyroid	30 (69.8%)		
Hypo-thyroid	5 (11.6%)		
Missing	5 (11.6%)		

<sup>†</sup>Hyper-thyroid ( $<0.27$ ); Eu-thyroid ( $\leq 0.27 - 4.20$ ); Hypo-thyroid ( $>4.20$ )  
\* uIU/mL

**Table 2:** Mean and standard deviation of acoustic symptoms among patients and controls.

	Patients (mean±SD)	Controls (mean±SD)	P-value
Fundamental frequency (Hz)	190.39±33.22	198.40±35.49	0.433
Habitual pitch (Hz)	178.96±28.61	187.20±34.65	0.367
Jitter (RAP) in %	0.99±0.84	0.91±0.58	0.758
Shimmer (%)	3.64±2.20	3.73±2.11	0.890
Noise to harmonic ratio	0.13±0.03	0.13±0.02	0.681
Voice turbulence index	0.04±0.02	0.04±0.01	0.812
Maximum phonation time (seconds)	14.32±7.27	15.09±7.06	0.722

\*significant results ( $p\text{-value}<0.05$ )

**Table 3:** Mean and standard deviation of perceptual evaluation (GRABS classification) among patients and controls.

	Patients (n=42) (mean±SD)	Controls (n=15) (mean±SD)	P-value
Grade	0.71±0.67	0.53±0.52	0.425
Roughness	0.69±0.68	0.47±0.52	0.309
Asthenia	0.36±0.58	0.27±0.59	0.474
Breathiness	0.40±0.63	0.20±0.41	0.292
Strain	0.48±0.59	0.13±0.35	0.039*

\*significant results ( $p\text{-value}<0.05$ )

**Table 4:** Perceptual evaluation (GRABS classification) among patients and controls.

	Patients (n=42) N (%)	Controls (n=15) N (%)	P-value
Grade			
Normal	17 (40.5%)	7 (46.7%)	0.375
Mild	20 (47.6%)	8 (53.3%)	
Moderate	5 (11.9%)	0 (0%)	
Roughness			
Normal	18 (42.9%)	8 (53.3%)	0.358
Mild	19 (45.2%)	7 (46.7%)	
Moderate	5 (11.9%)	0 (0%)	
Asthenia			
Normal	29 (69.0%)	12 (80.0%)	0.588
Mild	11 (26.2%)	2 (13.3%)	
Moderate	2 (4.8%)	1 (6.7%)	
Breathiness			
Normal	28 (66.7%)	12 (80.0%)	0.467
Mild	11 (26.2%)	3 (20.0%)	
Moderate	3 (7.1%)	0 (0%)	
Strain			
Normal	24 (57.1%)	13 (86.7%)	0.114
Mild	16 (38.1%)	2 (13.3%)	
Moderate	2 (4.8%)	0 (0%)	

\*significant results ( $p\text{-value}<0.05$ )

## DISCUSSION

There are many reports in the literature on the vocal symptoms and laryngeal findings in patients with goiter presenting either to the emergency room with airway symptoms or for surgical intervention. The frequently reported complaints

are hoarseness, swallowing disorders, sore throat, globus sensation, and respiratory discomfort and cough [8,10-12]. The pre-operative vocal changes were invariably attributed to the enlarged neck mass, presence of systemic diseases or influential factors with confounding effect such as reflux, allergies and smoking, and last but not least impaired mobility of the vocal folds. The reported prevalence of vocal fold paralysis among patients with benign goiter pre-operatively is up to 0.7%, with higher prevalence in patients with retro-sternal goiter [1]. In malignant diseases of the thyroid gland the percentage is higher and patients may present with bilateral recurrent laryngeal paralysis [3]. Post-thyroidectomy, the phonatory symptoms have been attributed to injury to the recurrent laryngeal nerve and or the superior laryngeal nerve. Other etiologies include the effect of endotracheal intubation, scar contracture limiting the vertical movement of the laryngotracheal complex, and last of all not-related diseases with confounding effect such as allergies and laryngopharyngeal reflux [1,13]. In a study by Fiorentino et al, swallowing and voice disorders persisting for 3 months after surgery were due to laryngopharyngitis [14].

In all the aforementioned studies, subjects with abnormal vocal characteristics were patients either admitted for thyroidectomy or presenting to the emergency room. These subjects invariably have advanced thyroidal disease and thus represent only a selected group of patients with goiter. The purpose of this study is to report the perceptual evaluation and acoustic findings in patients with goiter seen in a clinical setting. To our knowledge no previous study has reported the perceptual evaluation and vocal characteristics of patients with goiter in a non- emergency or surgical set up. The results of our study indicated that patients with goiter strain more compared to controls. This was evident by the significant difference in the mean score of straining on perceptual evaluation between the diseased group and controls ( $p\text{-value}$  0.039). It is also worth noting that despite the fact that there was no significant difference in the frequency of the perceptual parameters between the two groups, their frequencies were higher in patients with goiter specifically in relation to straining, breathiness and asthenia. A large sample size might have revealed a significant difference between patients with goiter and controls. On the other hand, all the acoustic parameters were within normal and did not differ significantly from controls.

The significant difference in the mean straining score in patients with goiter vs. controls, and the fact that 42.9% had mild to moderate straining compared to 13.3% in the control group, can be explained on several basis. One possible explanation is vocal fold impaired mobility, which we can neither refute nor confirm in our subjects due to the lack of a laryngeal examination [1-13,15]. Vocal straining or hyper-functional behavior is among the main vocal characteristics of patients with vocal fold paresis or paralysis. It is believed to be a compensatory behavior to the impaired mobility of the vocal folds and incompetence of the glottis. The paresis and paralysis have been attributed to either stretching of the recurrent laryngeal nerve, compression of the nerve, fibrosis and chronic inflammation around the nerve and last but not least direct invasion of the cricoarytenoid joint and adjacent muscles in patients with malignant goiter disease.

Another explanation for the increase in vocal straining is the possible restricted movement of the laryngeal framework mostly in the cephalo-caudal direction. Patients with goiter might have fixation of the gland to the strap muscles and laryngeal framework. Glandular hyperplasia and possible inflammatory spread might hinder the movement of the laryngotracheal complex. This impaired movement can hypothetically contribute to the increase in vocal straining. This mechanism remains a hypothesis because of lack of radiological or video imaging in our study. On the other hand, laryngotracheal fixation by scarring has been reported as a cause of short-term vocal changes in patients post-thyroidectomy. The temporary malfunction in the strap and extralaryngeal muscles can limit not only the elevation and lowering of the larynx during inspiration and various phonatory tasks but also the contraction and lengthening of the vocalis muscle. The movement of this latter is affected by the attenuated rotation and displacement of the thyroid cartilage during pitch raising sound production [16].

The third explanation for the significant increase in straining is the hypo- or hyper-thyroid state in many patients with goiter. The thyroid hormone is known to have many physiologic effects on the laryngeal growth and function. Second to sex hormones, thyroid hormones have been shown to be crucial not only for the androgen-evoked cell proliferation, but to the proliferation of various laryngeal structures. This conclusion was substantiated by the results of Altman et al in his report on thyroid hormone receptors in the larynx of human males and females [17]. In our study, this explanation remains a far fledged possibility because 70% of our patients were euthyroid.

Our study has three limitations; one is the small sample size, two is the lack of laryngeal examination to assess vocal fold mobility even though this was not the purpose of this investigation, and last but not least is the lack of information on the size of the thyroid glands in many of the subjects enrolled in this study. The authors of this manuscript aimed at answering the following question: Do female patients with goiter not admitted for surgery or emergency room have abnormal perceptual rating of their voice and abnormal acoustic findings? The results of our study clearly indicate that patients with goiter have more vocal straining compared to patients with no goiter. However, the amount of straining is almost normal as the perceptual rating is below one. The remaining perceptual parameters and acoustic findings are normal.

## CONCLUSION

Female patients with goiter seen in a clinical set up have normal vocal characteristics except for vocal straining which is higher compared to controls. Acoustic analysis failed to reveal any significant difference compared to controls.

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