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ACOUSTIC VOICE ANALYSIS IN PATIENTS WITH HYPOTHYROIDISM: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Introduction: Hypothyroidism is known to affect phonatory function due to mucopolysaccharide deposition, vocal fold oedema, and altered neuromuscular control. Although voice changes are clinically recognized, objective acoustic evaluation and follow-up after thyroid hormone replacement remain underreported. **Objective:** To evaluate acoustic voice alterations in newly diagnosed hypothyroid patients and to assess improvement following 3 months of levothyroxine therapy using PRAAT software. **Methods:** A prospective observational case series of 30 newly diagnosed female patients with primary hypothyroidism underwent acoustic voice analysis using PRAAT software which included fundamental frequency (F0), jitter (%), shimmer (%), Harmonic to noise ratio (HNR), maximum phonation time (MPT) & Voice handicap index-30 , recorded at baseline and after 3 months of thyroid hormone replacement. Statistical analysis was performed using paired t-test with significance set at $p<0.05$. **Results:** All acoustic parameters showed improvement after 3 months. Mean F0 increased from 173.2 ± 6.2 Hz to 192.4 ± 7.5 Hz ($p<0.001$). Jitter decreased from 0.325 ± 0.012 % to 0.125 ± 0.125 % ($p<0.001$), shimmer decreased from 3.067 ± 0.78 % to 2.145 ± 0.98 % ($p<0.001$), HNR improved from 22.74 ± 2.62 dB to 26.32 ± 3.14 dB ($p<0.001$). MPT increased from 8.7 ± 0.32 seconds to 9.2 ± 0.45 seconds ($p<0.001$). VHI-30 scores improved from 50 ± 2 to 55 ± 1 ($p<0.001$). **Conclusion:** Hypothyroidism significantly alters acoustic voice parameters, which demonstrate measurable improvement following hormone replacement therapy. Objective acoustic assessment may serve as a useful adjunct in monitoring treatment response.

KEYWORDS

Hypothyroidism; Voice; Voice Disorders; Speech Acoustics; Phonation; Thyroid Hormones.

INTRODUCTION:

Voice production depends on the intricate coordination of respiratory, pronator & resonator systems. Hormonal regulation plays a crucial role in maintaining normal voice quality and phonatory stability. Among the various endocrine factors influencing vocal function, sex hormones and thyroid hormones have been shown to exert a direct effect on laryngeal tissues [1]. Disorders of the thyroid gland, along with abnormalities of the parathyroid glands, represent some of the most frequently encountered endocrine conditions associated with voice disturbances [2]. Hypothyroidism, characterized by insufficient production of thyroid hormones due to reduced thyroid gland activity, is the most prevalent thyroid dysfunction [3]. Endocrine imbalance in hypothyroidism contributes to metabolic slowdown and tissue changes, often leading to mucosal and soft tissue alterations that may affect phonation [4]. Compared to hyperthyroidism, the clinical manifestations of hypothyroidism are often subtle and insidious & alterations in voice quality are among its commonly reported symptoms [5].

Importantly, thyroid hormone receptors have been identified within laryngeal tissues, suggesting a direct hormonal influence on vocal fold structure and function [6]. Even mild thyroid hormone deficiency can therefore impact voice production. Patients with hypothyroidism frequently present with a lowered pitch, vocal roughness, reduced vocal range, and early vocal fatigue, reflecting changes in vibratory characteristics of the vocal folds [7]. This case series aims to evaluate baseline acoustic changes in newly diagnosed hypothyroid patients and to assess the degree of improvement after 3 months of levothyroxine therapy.

MATERIALS AND METHODS:

This prospective observational case series was conducted in the department of Otorhinolaryngology at a tertiary care centre which involved 30 female patients.

***Inclusion Criteria*:**

1. Newly diagnosed primary hypothyroidism
2. No prior thyroid hormone therapy
3. Age 18 to 50 years
4. No history of smoking, vocal cord lesions or vocal abuse

***Exclusion Criteria*:**

1. Laryngeal pathology
2. Upper respiratory infection
3. Previous neck surgery

Voice Assessment Protocol:

All patients underwent voice assessment before treatment & after 3 months of levothyroxine therapy

1. Acoustic Analysis (PRAAT Software version 6.4.52): Sustained vowel sounds with a, e, i,o,u was recorded in a soundproof room for 3 consecutive samples using PRAAT voice analysis software [8].

Parameters analysed were

- Fundamental Frequency (F0, Hz)
- Maximum phonation time (MPT)
- Jitter (%)
- Shimmer (%)
- Harmonic-to-Noise Ratio (HNR, dB)

2. Voice Handicap Index-30 (VHI-30): Patients completed the validated VHI-30 [9, 10] questionnaire assessing functional, emotional, and physical domains of their voice

3. *Thyroid Profile*: Serum TSH levels were recorded at baseline and after 3 months.

RESULTS:

All 30 participants included in the study were females, with a mean age of 35.5 years. The mean serum thyroid stimulating hormone (TSH) level at baseline was 19 ± 2.8 mIU/L, which decreased to 12 ± 1.4 mIU/L following 3 months of levothyroxine therapy. Objective voice assessment parameters includes Maximum Phonation Time (MPT), Fundamental Frequency (F0), jitter (%), shimmer (%), Harmonic-to-Noise Ratio (HNR) & Voice Handicap Index-30 (VHI-30) were recorded at baseline and at 3-month follow-up. Comparative analysis of these parameters, as illustrated in Table 1, demonstrating notable improvement after thyroid hormone replacement therapy. The observed changes were statistically significant with P value less than 0.001 indicating measurable enhancement in both acoustic and patient-reported voice outcomes.

Table-1: Acoustic Parameters At Baseline & After 3 Months Of Levothyroxine Therapy

Parameter	Time	(Mean ± SD)	P value
MPT (seconds)	*Baseline*	8.7 ± 0.32	P < 0.001
	3 months	9.2 ± 0.45	

F0 (Hz)	*Baseline*	173.2 ± 6.2	P < 0.001
	3 months	192.4 ± 7.5	
JITTER (%)	*Baseline*	0.325 ± 0.012	P < 0.001
	3 months	0.125 ± 0.125	
SHIMMER (%)	*Baseline*	3.067 ± 0.78	P < 0.001
	3 months	2.145 ± 0.98	
HNR (dB)	*Baseline*	22.74 ± 2.62	P < 0.001
	3 months	26.32 ± 3.14	
VHI-30	*Baseline*	50 ± 2	P < 0.001
	3 months	55 ± 1	

The spectrograph outcome of the patient done using PRAAT software is illustrated in figure-1 where maximum phonation time, pitch & pulses are documented for checking prognosis.

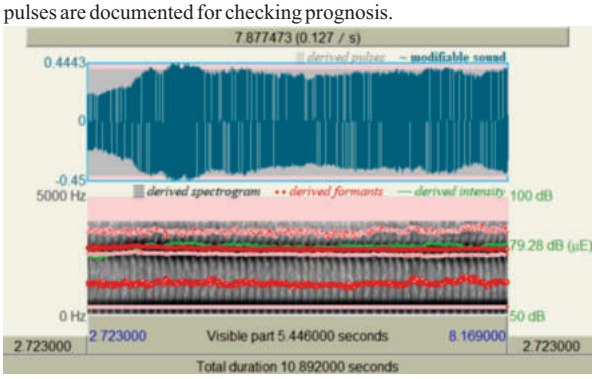

Figure-1: Spectrograph of the patient's voice sample showing MPT, pitch & pulse.

DISCUSSION:

In this study a detailed voice analysis was conducted on 30 patients of hypothyroidism diagnosed newly & after 3 months of levothyroxine therapy. Thyroid hormones exert systemic metabolic influence including effects on laryngeal tissue. Change in voice or hoarseness is one of the cardinal features of hypothyroidism [11].Hypothyroidism causes extracellular matrix expansion and myxedematous infiltration of vocal folds resulting in increased mass and reduced vibratory frequency. After therapy, F0 increased significantly, indicating reversal of vocal fold oedema. Previous literature has similarly demonstrated decreased F0 in hypothyroidism, with improvement following levothyroxine replacement. Jitter and shimmer reflect cycle to cycle instability. Elevated baseline values indicated irregular vocal fold vibration, likely due to mucosal oedema. Post-treatment reduction signifies improved vibratory regularity. HNR improvement suggests reduced glottis noise component, reflecting better phonatory efficiency. Reduced MPT at baseline may reflect incomplete glottis closure and reduced respiratory phonatory coordination. Significant improvement after therapy supports restoration of vocal fold pliability. The marked variation in VHI-30 scores confirms that objective acoustic improvement translated into subjective benefit. Likewise pitch of the voice has a major setback in hypothyroidism patients which can be depicted in the software showing considerable variations as illustrated in figure-2 & glottal cycles with frequency variations of subsequent vowels demonstrating shimmer & jitter is illustrated in figure-3. The deposition of proteoglycans along the vocal cord, leading to excess mass, can hamper the higher vibratory rates which are reflected as reduced high F0. The same can be responsible for increasing the glottal resistance

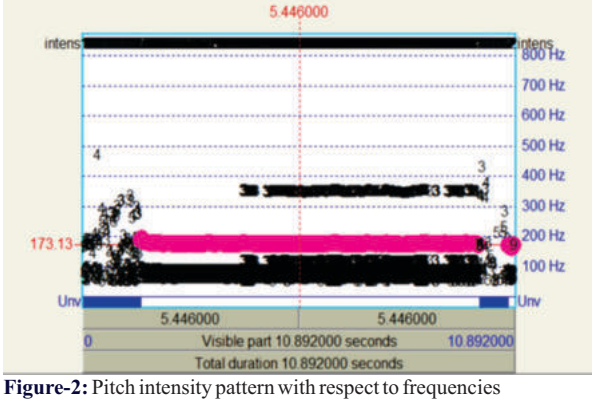

Figure-2: Pitch intensity pattern with respect to frequencies

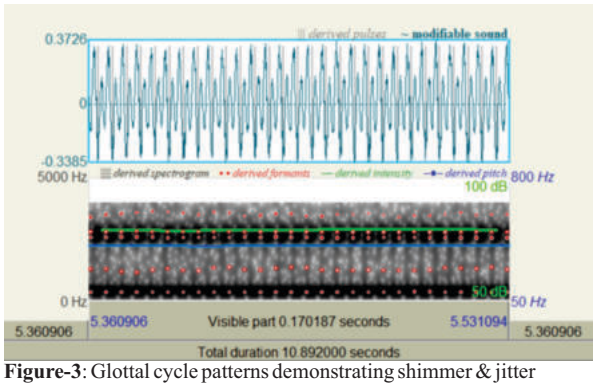

Figure-3: Glottal cycle patterns demonstrating shimmer & jitter

Clinical Application Of This Study:

- Acoustic voice analysis will serve as a non-invasive monitoring tool for early detection of subtle vocal changes in hypothyroidism & may aid in prognosis.
- ENT consultants should always consider thyroid evaluation in unexplained dysphonia.

Limitations of this study:

- All are female participants & sample size is comparatively less.
- Short follow up duration & lack of control group.

Future studies with larger populations and longer follow up should be done

CONCLUSION:

Hypothyroidism significantly alters acoustic voice parameters & patient reported voice handicap index. Measurable improvement usually starts after levothyroxine therapy. Objective acoustic analysis using PRAAT provides a reliable adjunctive tool for monitoring vocal function in hypothyroid patients & aids as a prognostic assessment tool. Voice assessment should be incorporated into the multidisciplinary management of hypothyroidism.

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