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Speech impairment in primary hypothyroidism

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ABSTRACT. ***Objective:*** **Thyroid hormone deficiency may affect human speech and voice. The aim of this study was to evaluate speech variables in patients with hypothyroidism.** ***Design:*** **A case control study.** ***Patients:*** **One hundred and twenty patients, 106 women and 14 men with symptoms and signs of thyroid failure; the diagnosis was confirmed by serum T_4<4.5 μg/dl and serum TSH>10 mU/l. Eighty-eight normal subjects, 78 women and 10 men, age-, sex-, and smoking status-matched, served as controls.** ***Measurements:*** **All symptoms and signs of hypothyroidism were recorded. Serum T_4, T_3, and TSH concentrations were measured. Speech parameters were analyzed by the Visipitch III system model 3900 and multidimensional voice program software and compared to a group of normal subjects with no thyroid disease.** ***Results:*** **Mean age was 35.9±11.4 yr. Dryness in larynx and pharynx, dyspnea, and sensation of lump in the throat were reported by 53.49 and 43% of patients, respectively. Fundamental frequency, voice turbulence index, and soft phonation index were significantly different from control values. There was positive correlation between TSH concentration and variation in fundamental frequency and prevalence of voice disorders (37.2±31.2** ***vs*** **23.9±25.8 mU/l,** ***p*****<0.003).** ***Conclusion:*** **Frequent speech disturbances occur in patients with primary hypothyroidism.**

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INTRODUCTION

Speech is the most significant mechanism of communication for exchanging thoughts among mankind. Speech disorders may appear following neurologic, psychologic, anatomic, and endocrine disorders or inappropriate lifestyle (1). The evaluation of objective voice parameters maybe performed by the Multi Dimensional Voice Program (MDVP), which is a computer-based software that can calculate as many as 33 acoustic parameters from a voice sample (2). Dysarthria is known as one of the leading symptoms of hypothyroidism (3). Myxedema, the deposition of proteoglycans (4) may cause many symptoms and signs in various parts of the body; hoarseness is one of these findings which have a gradual onset, it is progressive and results in a low raspy voice that fatigues easily (5). Although the effect of thyroid hormones on the human voice and speech has already been described, these reports are generally limited to empiric observation and subjective findings (3, 6). The objective of this study was to determine speech ability in patients with primary hypothyroidism.

MATERIALS AND METHODS

Subjects

All new patients with primary hypothyroidism who visited endocrine clinics of Shahid Beheshti University of Medical Sciences between 2004 and 2006 entered this study. None had history of thyroid ablation by radioiodine or surgery. The including criteria were serum T_4<4.5 μg/dl and serum TSH>10 mU/l. Those with history of cerebrovascular accident, brain tumor, and surgery of the thyroid, larynx, neck, and orofacial, recent upper respiratory tract infection, thyroid ablation, consumption of thyroid medications, and drugs affecting speech were excluded. Women were evaluated between 2 menstrual bleedings. Among 138 patients with primary hypothyroidism, 120 fulfilled the inclusion criteria. Eighty-eight normal subjects (78 women and 10 men), matched for sex, age, and smoking served as control group.

Procedure

First, for each patient, a questionnaire was completed to obtain general data, including personal or family history of hearing and ear, nose and throat, and speech disorders. Next, an experienced endocrinologist examined patients and reviewed thyroid function tests. Finally, each patient underwent qualitative measurement and evaluation of speech and voice parameters by an experienced speech-language pathologist.

Tests and measures

Serum T_4 and T_3 concentrations were measured by radioimmunoassay and serum TSH by immunoradiometric assay using kits from Kavoshyar Co., Tehran, Iran. The intra- and inter-assay coefficients of variation were <6 and <9.5% for all tests.

Sensory signs and symptoms in the vocal tract, comprehensive-auditory signs of voice and speech, and the measurement of maximum phonation time and voice parameters such as fundamental frequency (Fo), intensity variation, jitter, shimmer were analyzed by the Visipitch III system model 3900 and MDVP software version 5150 prepared by KAY-Pentax corporation, New Jersey, USA; patient's speech was evaluated from the point of view of pronunciation problems and speech fluency by observing, interviewing, and applying the phonetic test; all data obtained were rechecked and documented.

Statistical analysis

Data are expressed as mean±SD; SPSS 11.5 software package (SPSS inc., Chicago, IL) was used for analysis. The normality of

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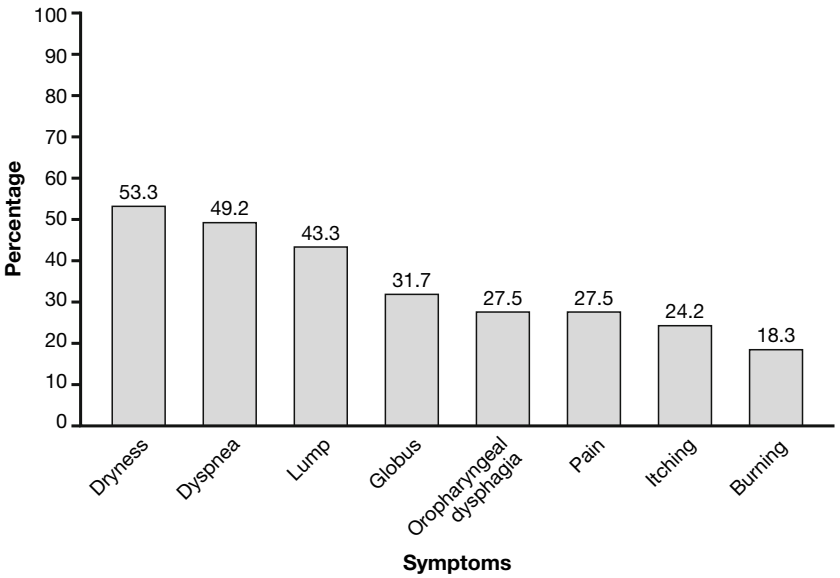

Fig. 1 - *Distribution of pharyngolaryngeal symptoms reported by patients.*

variables was tested using the one sample Kolmogorov-Smirnov test. Differences between mean values for quantitative variables were evaluated using Student's t-test, Chi square, and Mann-Whitney tests were used for analysis of nominal and ordinal variables. The correlation between variables was examined by Spearman's correlation of coefficient. All *p* values obtained from two-tailed tests, and values <0.05 were considered significant.

RESULTS

Mean age was 35.9±11.4 and 34.3±9.8 with a range of 7-55 and 7-54 yr for patients and control subjects, respectively. There were 106 (88%) females and 14 (12%) males in case and 78 (89%) women and 10 (11%) men in control group. Figure 1 shows the distribution of symptoms reported by patients. Dryness in larynx and pharynx, dyspnea, sensation of lump in the throat and globus were more prevalent, followed by oropharyngeal dysphagia, vague pain, itching, and burn in the larynx. In no subject in the control group symptoms such as dyspnea, lump, and oropharyngeal dysphagia was seen, but dryness (%3.4), globus and burning (%1.1), pain and itching (%2.3) were seen. In males, serum TSH concentration was increased in those with oropharyngeal dysphagia (64.7±24.4 *vs* 24.3±17.3 mU/l, $p<0.028$). In men, serum T_4 was decreased in those with burning sensation in the throat (0.28±0.30 *vs* 5.3±2.8 µg/dl, $p<0.028$). In women, serum TSH was increased in those with strain (husky) voice (38.9±31.9 *vs* 28.1±29.3 mU/l, $p<0.019$).

Mean±SD of 13 voice parameters in hypothyroid patients compared to values given by normal subjects with no thyroid disease are seen in Table 1. Fo, minimum Fo, voice

Table 1 - *Mean and SD of voice parameters in patient with primary hypothyroidism and those provided by normal subjects with no thyroid disease.*

Parameters	Females		*p*	Males		*p*
	Control	Hypothyroid		Control	Hypothyroid	
F_0Average (Hz)	237±25	201.0±33	<0.001	139.5±21.7	118.0±19	<0.001
STD F_0 (Hz)	2.4±2.3	8.5±14.0	<0.001	1.6±0.4	2.0±2.3	<0.507
F_0Max (Hz)	249±24.2	234.4±53	<0.001	146.2±22.6	149.3±100	<0.908
F_0Min (Hz)	228.4±26.5	176.5±48	<0.001	137.70±21.4	113.0±20.2	<0.001
Jitter (%)	0.7±0.5	2.0±2.1	<0.001	0.6±0.3	0.07±0.06	<0.470
vF_0 (%)	1.3±2	5.0±8.5	<0.001	1.0±0.6	2.0±2.4	<0.213
vAm	11.2±4.3	18.3±10.1	<0.001	7.4±5.2	13.0±6.2	<0.006
Shimmer (%)	1.3±0.5	7.0±6.0	<0.001	2.6±0.2	4.3±3.0	<0.022
NHR (%)	0.1±0.02	0.2±0.1	<0.001	0.1±0.06	0.2±0.05	<0.002
VTI	0.06±0.01	0.04±0.02	<0.001	0.08±0.04	0.03±0.01	<0.001
SPI	7.8±3.4	35.0±21.0	<0.001	7.4±2.5	32.4±18.5	<0.001
Ftri (%)	0.4±0.1	1.1±2.4	<0.003	0.3±0.2	1.4±2.5	<0.238
Atri (%)	2.2±1.5	6.1±4.4	<0.001	1.9±1.1	4.0±3.0	<0.044

F_0 Average: average fundamental frequency; STD F_0: SD of fundamental frequency; F_0Max: maximum of fundamental frequency; F_0Min: minimum of fundamental frequency; vF_0: fundamental frequency variation; vAm: peak-to-peak amplitude variation; NHR: noise to harmonic ratio; VTI: voice turbulence index; SPI: soft phonation index; Ftri: fundamental frequency tremor intensity index; Atri: amplitude tremor intensity index.

Table 2 - *Distribution of speech disorders in patients with primary hypothyroidism.*

Gender	Speech disorders			
	Stuttering	Misarticulation	Hypernasality	Voice disorders
Male	4 (3.3)*	1 (0.1)	2 (1.6)	12 (10)[a]
Female	9 (7.5)	6 (5.0)	3 (2.5)	85 (71)
All	11 (9.2)	6 (5.0)	4 (3.3)	97 (81)

[a]Numbers in parentheses denote percentage; *p<0.003, compared to female.

turbulence index, soft phonation index, peak to peak amplitude variation, noise to harmonic ratio, and amplitude tremor intensity values in both genders were significantly different from controls. The prevalence of speech impairment in hypothyroid patients is shown in Table 2. Stuttering was more frequent in males than females. There were no speech disorders such as stuttering and hypernasality in the control group but voice disorder in the control group were 10% of males and 10.3% of females and misarticulation were 3.8% of females. Serum TSH was increased in those with voice disorders (37.2±31.2 *vs* 23.9±25.8, p<0.003). There was positive correlation between serum TSH concentration and variation in Fo (vFo) (r=0.563, p<0.036). No correlation was observed between serum TSH concentration and other voice parameters.

DISCUSSION

This study shows frequent speech disturbances in patients with primary hypothyroidism. To the best of our knowledge, this is the first comprehensive evaluation of speech alterations in thyroid failure. The most common speech abnormalities were voice disorders and stuttering which were correlated with serum TSH concentration. Articulation and resonance abnormalities were less prevalent.

In most previous studies, speech disorders have been studied as a cognitive and neurological dysfunction. Studies on the neurological dysfunction of patients with hypothyroidism indicated that patients with congenital hypothyroidism and iodine deficiency disorders suffer from extensive developmental brain impairments including motor and behavioral abnormalities, and hearing and speech impairments (7-10). Voice disorders have been reported to range from 9 to 52% in patients with hypothyroidism (11-13). In the present study, 81% of primary hypothyroid patients suffer from voice alterations; this high rate maybe due to the severity of thyroid failure in our patients, as we have selected those with clinical findings of hypothyroidism, accompanied by hypothyroxinemia.

In the present study, quantitative values of voice parameters have been measured using advanced techniques in patients with hypothyroidism. Most voice parameters in hypothyroids were impaired as compared to reference normal values. Several theories maybe proposed for such alterations. Altman et al. have found that thyroid receptors are present in larynx in both genders (12). The staining for thyroid receptors was positive in perichondrium, fibroconnective tissue, and lamina propria. They implied a role for thyroid hormones within the human larynx, through both α and β thyroid receptors. The precise role of thyroid hormones on the larynx is unknown. The hypothyroid larynges stain largely with colloidal iron which remains within the connective tissue cells; this confirms the existence of hyaluronic acid-containing mucoprotein, corresponding to generalized myxedematous state in hypothyroidism (4).

Possible mechanism accounting for hoarseness in patients with hypothyroidism include myxedematous thickness of the vocal cords, cordal paralysis from goiter, edema of the cricothyroid muscle and edema of the nucleus ambiguous of the vague nerves (14-16).

The limitation of this study is that it is a cross-sectional study of speech alterations before treatment of thyroid failure. Therefore, it could not present the effect of thyroid hormone supplementation and long-term follow-up of each of the abnormalities after such therapy. However, being the first study of its kind, it will open a domain of further detailed interventional studies.

In conclusion, speech impairments occur in the majority of patients with thyroid hypofunction, and voice changes correlate with the level of serum TSH. Further research including evaluation of speech before and after treatment with levothyroxine should be considered.

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