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The Correlation between Voice Handicap Index and Specific Acoustic Measures in Patients with Muscle Tension Dysphonia

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Background: With regard to the multidimensional concept of the voice, different assessments are needed to diagnose and treat voice disorders. Additionally, it is important to know how various aspects of voice are compared and related to each other.
Objectives: The purpose of this study was to examine the correlation between the Voice Handicap Index (VHI) score and the acoustic measures in different types of Muscle Tension Dysphonia (MTD).
Patients and Methods: Eighteen females including 12 with primary MTD (group 1) and 6 with secondary MTD (group 2) participated in this cross-sectional study. All subjects completed VHI and were provided voice samples including three trials of the sustained vowel /a/ at a comfortable loudness level as well as a connected speech sample. Acoustic measures were performed with Praat software and included fundamental frequency, jitter %, shimmer % and intensity.
Results: Certain correlations were found between fundamental frequency in vowel and total VHI, physical, functional and emotional domains of VHI in group 1 (r = 0.636, 0.649, 0.613 and 0.592 respectively). There was good correlation between speaking fundamental frequency and total VHI and its subscales - except the physical subscale - were also correlated. In group 2, the correlations between jitter and total VHI as well as the emotional domain of VHI was very good (r = 0.829, and 0.812 respectively). Furthermore, we found very good correlation between the intensity of speech and functional domain (r = 0.812).
Conclusions: VHI and acoustic parameters likely measure different aspects of voice and thus are not interchangeable. However, the correlation between VHI and some laboratory measurements increases in dysphonia of the same nature, origin and same sexuality.

Keywords: Acoustic; Muscle Tension Dysphonia, Voice

1. Background

All of clinicians believe that voice assessment should be multidimensional. A voice clinical assessment usually includes objective and subjective voice measurements including video-laryngostroboscopy, aerodynamic measures, perceptual assessments and analyses of acoustic features. The assessments demonstrate possible mass and tension of the vocal folds, as well as their biomechanical properties (1). Such data provide information about vocal folds pathology and its effects on the structure and function of phonatory mechanism, therefore all of them indicate clinician perception about voice.

Considering the multidimensional features of quality of life, many questionnaires have been developed to assess various dimensions of health and level of disability a person experiences (2, 3). Jacobson et al. offered Voice Handicap Index (VHI) that measures the patient's perception of disability due to voice disorder (4). VHI questionnaire asks dysphonic patient to rate the effect of their disorder on different aspects of their life. If the source of voice production is not normal structurally and functionally, then the patients' responses would relate to the acoustic measures. Considering that multidimensional voice assessments are necessary for the diagnosis and treatment of voice disorders, it would be important to know how they relate to each other. Previous studies examined the association between VHI scores and acoustic measures (5-8). Hsiung et al. and Wheeler et al. did not report any relation between overall VHI score

Implication for health policy/practice/research/medical education:
The results of this study recommend that quality of life measurement instruments such as Voice Handicap Index (VHI) be applied in the clinical process of voice disorders.

and acoustic measures; however, correlations between some subscales of VHI and some voice parameters were discovered previously (5, 6). Woisard et al. discovered fair correlation between minimal frequency and total VHI and its subscales, except the emotional subscale, as well as between the frequency range and the physical subscale (7). Schindler et al. divided the patients into four groups: functional dysphonia, unilateral vocal fold paralysis, structural dysphonia and nodules. They found good correlation between jitter and functional VHI domain in vocal fold paralysis, and physical VHI domain and jitter, shimmer and Noise to Harmonics ratio (NHR) in vocal fold nodules (8). Different results in such investigations indicate that acoustic measures were not predictive of total VHI and its subscales.

The previous investigations did not emphasize on the relationship between acoustic measures and voice handicap among patients with Muscle Tension Dysphonia (MTD). In fact, dysphonic patients in the previous investigations were not homogenous in terms of etiology. Moreover, the authors could not analyze the acoustic parameters in females or males separately.

2. Objectives

In this study, we sought to assess the correlations between patients' voice handicap measured by VHI score and disability (indicated by acoustic parameters in patients with MTD). Also, the correlation between VHI score and acoustic features in different types of MTD including with and without organic lesions was evaluated.

3. Patients and Methods

3.1. Participants

Eighteen females who were visited for voice disorders at Amir-Alam hospital participated in the study. All of participants had referred to the hospital from October 2011 to mid-January 2012, and those who presented MTD were enrolled. The diagnosis of MTD was made after thorough history was taken and laryngeal palpation and video-laryngostroboscopy with a rigid endoscope was performed by a mastered speech therapist and a laryngologist. Endoscopic examinations were conducted using a Karl Storz rigid endoscope (KARL STORZ Endoscope, Germany, Hopkkins 11.Autoklav.7210CA.70). Therefore, the initial inclusive criteria included being over the age of 18 years and not having any positive history of neck or chest operations or receiving previous voice therapy. After providing informed written consent for participation, the patients were divided into two groups including patients with primary or secondary MTD. Twelve patients had primary MTD which is dysphonia in the absence of any concurrent organic vocal fold pathology. Primary MTD is associated with excessive, atypical, or abnormal laryngeal movements during phonation, without obvious psychogenic or neurologic etiology (9) (group 1). Also, group 2 was comprised of Six patients with secondary MTD who had dysphonia in the presence of an underlying organic condition (10) (four with polyps and two with nodules).

3.2. Tasks

All of participants completed the Persian VHI questionnaire before a sample of their voice was recorded (11). This tool consists of 30 questions divided into three equal subscales: functional, emotional and physical. Its total score is from 0 to 120 and a higher score indicates a maximum perceived handicap resulting from the voice disorder. A few cases were assisted by a speech therapist due to difficultly with reading or filling the questions (4). Afterward, voice samples were collected in both vowel and speaking tasks. Patients were instructed to produce the vowel /a/ using a comfortable loudness level and a constant pitch at least three seconds in three trials. Voice samples were collected with a microphone (Panasonic RP-VC 151 E-S). The microphone was positioned approximately 10 cm from the mouth and slightly below the chin to reduce airflow effects. All digital recordings were made in an acoustic room. Measures of fundamental frequency (F0), jitter (jitt %), shimmer (shim %) and intensity were analyzed with Praat software program. A mid vowel segment on a sustained /a/ (A minimum one second) was analyzed. For speaking fundamental frequency and intensity, patients were asked to speak about their voice problems or describe the day activities for at least 20 seconds. For every connected speech sample that was recorded, the middle 10 seconds segment of the sample was analyzed using the Praat software program.

3.3. Statistical Analysis

Mann-Whitney U test was used to compare the two groups of patients. Kolmogorov-smirnov test was used to assess the normality of VHI and objective scores distribution. The correlation between acoustic measures and VHI was measured through Spearman's Rank Correlation Test. A significance level of 0.05 for all tests was used. Statistical analyses were performed using SPSS 17.

4. Results

Eighteen females with MTD participated in this study. The mean age was 37.2 ± 10.1 years (range, 18 - 53 years). Participants included 12 patients with primary MTD in group 1 and six patients with secondary MTD in group 2. Mean age was 36.9 ± 11.3 years (range, 18 - 53 years) in group 1 and 38 ± 7.8 years (range, 30 - 50 years) in group 2.

4.1. VHI Results and Acoustic Parameters

The mean score of total VHI had a minimum of 6 and maximum of 86 in group 1 and a minimum of 11 and maximum of 74 in group 2. The score of each of the subscales are summarized in Table 1. Also the data regarding the acoustic parameters are reported in Table 2. The mean of F0 was 236.02 ± 98.12 Hz and 233.14 ± 94.03 Hz in vowel and speech tasks in group 1, respectively. F0 mean was 191.46 ± 38.36 Hz and 208.69 ± 34.94 Hz in vowel and speech tasks in group 2. The mean of intensity in group 1 was higher in the two tasks compared to group 2, respectively. Jitter value in primary MTD (2.25 ± 3.60%) was higher in the two tasks in comparison with secondary MTD (1.25 ± 0.79%), but there was no considerable difference between Jitter values in the two groups of patients.

Table 1. The Means and Standard Deviations (SD) of Voice Handicap Index (VHI) Scores in the two Groups of Patients With Muscle Tension Dysphonia (MTD)

Groups	Minimum	Maximum	Mean	SD
T[a] VHI Group 1[b]	6	86	38.16	28.21
P[a] VHI Group 1	3	30	17.16	7.64
F[a] VHI Group 1	0	35	10.25	12.87
E[a] VHI Group 1	0	38	11.58	11.70
T VHI Group 2	11	74	33.83	21.51
P VHI Group 2[c]	6	31	17.66	8.04
F VHI Group 2	0	22	5.50	8.50
E VHI Group 2	4	21	10.66	6.74

[a] Abbreviations: T, total; P, physical; F, functional; E, emotional
[b] Group 1, patients with primary MTD (n = 12)
[c] Group 2, patients with secondary MTD (n = 6)

Table 2. The Means and Standard Deviations (SD) of Acoustic Parameters in the two Groups of Patients With MTD

Groups	Vowel				speech	
	F0	**Jitt %[a]**	**Shim %[a]**	**Intensity**	**F0[a]**	**Intensity**
Minimum Group 1[b]	136.93	0.16	1.89	43.71	154.29	40.93
Maximum Group 1	442.86	10.36	22.32	72.25	443.53	62.68
Mean Group 1	236.02	2.25	9.47	59.05	233.14	56.15
SD Group 1	98.12	3.60	7.03	7.23	94.03	5.94
Minimum Group 2[c]	118.11	0.46	3.20	48.84	179.78	45.98
Maximum Group2	222.31	1.25	17.52	57.64	267.73	61.41
Mean Group 2	191.46	0.79	10.33	53.18	208.69	54.48
SD Group 2	38.36	0.30	5.22	3.57	34.94	5.20

[a] Abbreviations: Jitt %, jitter; Shim %, shimmer; F0, fundamental frequency
[b] Group 1, patients with primary MTD (n = 12)
[c] Group 2, patients with secondary MTD (n = 6)

4.2. Analysis of VHI and Acoustic Parameters

In the first group (primary MTD), good correlations were found between vowel F0 and total VHI (Figure 1), as well as F0 and physical, functional and emotional domain of VHI (r = 0.636, 0.649, 0.613 and 0.592 respectively). In addition, there was certain correlation between the speaking F0 and total VHI and its subscales, except for the physical subscale. In group 2 (secondary MTD), the correlation between jitter and total VHI and emotional subscale of VHI was very noticeable (r = 0.829, and 0.812 respectively). Furthermore, we found prominent correlation between intensity of speech and the functional subscale (r = 0.812) (Table 3).

Table 3. The "r" Values of Spearman's Rank Correlation Test Showing the Correlation Among the Four Acoustics Measurements and Total VHI Score in the two Groups of Patients With MTD

Groups	Vowel				Speech	
	F0	**Jitt %**[a]	**Shim %**[a]	**Intensity**	**F0**[a]	**Intensity**
T[a] VHI Group 1[b]	0.636[c]	0.200	-0.014	-0.413	0.622[c]	-0.070
P[a] VHI Group 1	0.649[c]	0.260	0.070	-0.544	0.558	-0.182
F[a] VHI Group 1	0.613[c]	0.171	0.132	-0.531	0.635[c]	-0.303
E[a] VHI Group 1	0.592[c]	-0.070	-0.210	-0.217	0.585[c]	0.025
T VHI Group 2[d]	0.257	0.829[c]	-0.143	0.486	0.429	0.543
P VHI Group 2	-0.543	0.314	-0.486	0.086	-0.143	0.029
F VHI Group 2	0.377	0.493	-0.319	0.725	0.464	0.812[c]
E VHI Group 2	0.348	0.812[c]	0.058	0.145	0.406	0.239

[a] Abbreviations: T, total; P, physical; F, functional; E, emotional; Jitt %, jitter; Shim %, shimmer; F0, fundamental frequency
[b] Group 1, patients with primary MTD (n = 12)
[c] $P < 0.05$
[d] Group 2, patients with secondary MTD (n = 6)

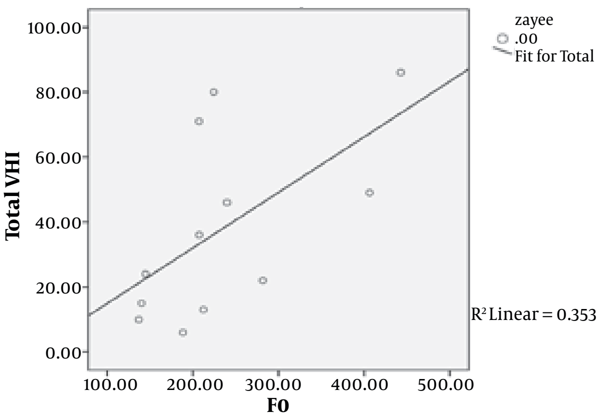

Figure 1. Graphic representation of the Relationship Between Total VHI Scores and Mean Fundamental Frequency in Vowel Task in Primary MTD (Spearman's r = 50.96)

5. Discussion

The correlation between acoustic voice measures and VHI was analyzed in patients with different types of MTD including primary and secondary MTD. In patients with primary MTD, fundamental frequency of vowel correlated with total VHI as well as functional, physical and emotional domains of VHI. Furthermore, the correlation between speaking fundamental frequency and total VHI and its subscales except for the physical subscale was good in primary MTD.

Our findings can be explained with respect to the clinical features of MTD. MTD is a common functional dysphonia in which patients have many vocally hyperactive behaviors (12, 13). Such vocally hyperactive behaviors may result in acoustic and perceptual abnormalities of the voice (14-16). Increasing F0 as an acoustic sign correlates with increased strain, while both are common features that occur in MTD. With regard to the correlation found between F0 and perceived voice-related disability, it seems that F0 is an important perceived acoustical quality of the dysphonic voice. In patients with secondary MTD, jitter value showed a very good correlation with total VHI and of course, the emotional subscale of VHI. Additionally, there was a very good correlation between speech intensity and functional subscale of VHI in patients with secondary lesions of the larynx. It seems that jitter is associated with different aspects of voice-perceived disability in patients with secondary MTD, because lesions in the vocal folds cause irregularity in vocal fold vibration and also increase quality disorders. No significant difference was found between the two groups of patients -neither for the total VHI score and its three subscales nor for the laboratory measures- indicating that the two groups had similar severity of perceived voice-related disability and acoustic deterioration. Correspondingly, severity of the voice disorder does not necessarily result in different correlations between acoustic measures and VHI score.

To date, a few studies have aimed to examine the correlation between VHI and acoustic parameters (5-8); however, none of them considered the gender difference factor. Also, most of them did not consider a homogenous group of dysphonic patients in terms of nature and etiology. Hsiung et al. analyzed 79 patients with dysphonia and found a fairly significant correlation between the functional subscale of VHI and NHR (5). Wheeler et al. analyzed 17 patients and reported a significant correlation between acoustic parameters of both sustained vowel and connected speech and total VHI and subscale scores. Although, shimmer, jitter, and NHR were significantly correlated with most VHI items, but no significant correlation was found between total VHI and acoustic parameters from a sustained vowel. Moreover, speaking fundamental frequency and total VHI were correlated (6). Woisard et al. analyzed 58 patients and reported a fair correlation between the voice minimal frequency and total VHI and its subscales, except for the emotional subscale. Furthermore, they reported a relationship between voice frequency range and the physical subscale (7). On the contrary, voice laboratory data of the present study showed stronger correlation between fundamental frequency and total VHI in both sustained vowel and connected speech.

There is only one study which has categorized the patients with dysphonia according to the underlying etiology (8). This study was performed by Schindler et al. on 115 dysphonic patients for evaluating the correlation between VHI and voice measurements. Patients were divided into four groups including functional dysphonia, unilateral vocal fold paralysis, structural dysphonia and nodules. The authors reported strong correlation between jitter and functional VHI domain in group 2 ($r = 0.61$), and physical VHI domain and jitter, shimmer and NHR in group 4 ($r = 0.58, 0.77, 0.76$ respectively). Therefore, they concluded that different acoustic parameters are associated with different aspects of voice-perceived disability. On the contrary, our study showed a more homogenous correlation between acoustic parameters of specific fundamental frequency and total VHI as well as its subscales. It seems that such results may be related to the more homogeneity of our patients in terms of both the nature of dysphonia and gender.

In conclusion, our findings indicate that acoustic measurements and voice related disability may correlate in patients with dysphonia of the same etiology and same gender; however, there is no doubt that VHI and acoustic parameters likely measure different aspects of the voice and are not interchangeable. It may also suggest that objective laboratory tests now used may measure specific parameters of the voice, but not the global impact of a voice disorder on patients' emotional, functional, and physical perceptions of health. Objective laboratory tests are needed to accurately and reliably characterize the severity of dysphonia, but VHI can be used along with other objective tools to assess the impact of ones' voice characteristics on his/her quality of life. Despite this, further objective and subjective assessments are necessary for a precise clinical judgment. Thus, future studies with larger sample sizes and similar diagnoses are necessary to determine which acoustical parameters significantly correlate with VH scores.

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Authors' Contribution

Mohadese Tarazani, carried out the design, coordinated the study and collected the data; Seyyedeh Maryam Khoddami contributed to the design, drafting and revising the article as well as interpretation and analyses of the data; Zohre Jalayi, participated in data analyses, Saeed Talebian Moghadam and Mohammad Akbari carried out the design and coordinated the study.

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We have no financial interests related to the material in the manuscript.

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