Multiparameter Voice Assessment for Voice Disorder Patients: A Correlation Analysis Between Objective and Subjective Parameters

Yu Ziwei, Pang Zheng, and Dong Pin, *Shanghai, China*

Summary: Objective. The aim of this study was to establish a multiparameter voice assessment profile using objective multiparameter test and subjective voice quality assessment.

Methods. We assessed 50 patients with voice disorders before and after operation. The assessment incorporates (1) subjective voice quality assessment, (2) patients' self-assessment, and (3) objective acoustic analysis. The subjective voice quality assessment uses GRABS system to evaluates the grade of hoarseness (G), proposed by the Japanese Society for Logopedics and Phoniatrics. Patients' self-assessment is modified based on the Chinese version of voice handicap index (VHI) scale, composed of functional (F), physiological (P), emotional (E) part, and a total score (T). The acoustical analysis evaluate the patients' voice sample by voice analysis software "Dr. Speech". Three parameters, jitter (J), shimmer(S), and normalized noise energy (NNE), were taken in analysis.

Results. We observed high correlations among subentries F, P, and the total score T_{vH} of the VHI scale in patients' subjective assessment. Parameter E does not correlate well with other assessed parameters. The Chinese version of VHI, which incorporate multifactors including age, education, and especially the cultural difference may account for the inconsistent correction in parameter E. In the objective acoustic analysis, high correlation among the three parameters J, S, and NNE is observed.

Conclusion. Systemic assessment combining a subjective voice quality assessment, an objective acoustic analysis, and a self-assessment is helpful in clinical practice in the diagnosis and treatment for voice disorders. The E component in VHI scale assessment may not be a reliable parameter to evaluate treatment outcome.

Key Words: Voice disorder–Subjective voice quality assessment–Self-assessment–Acoustic analysis.

INTRODUCTION

Voice disorder is commonly seen in Otolaryngology patients. Disrupted voice function negatively impact patients' psychology and social life, thereby affecting patients' overall quality of life. In 1997, Jacobson[1] proposed the voice handicap index (VHI) scale, a self-assessment approach, to evaluate the impact of voice disorders on patients' physiological, social, and psychological functions. VHI score is widely used to evaluate patients' quality of life under the condition of voice disorders. It is a self-evaluation of the degree of voice handicap and calculated as the sum of all questions (T) for the following three domains: functional (F), physiological (P), and emotional (E) components to evaluate the impact of voice disorders on patients' physiological function, social self-adaptability, and emotional change. Self-assessment thus plays a key role in evaluating the degree of voice disorders and treatment outcomes. However, neither objective acoustical assessment nor morphologic assessment of laryngoscope can reflect patients' feeling of voice disorders on their lives, work and social activities, or the impact of voice disorders on mental health.

Lam et al[2,3] reported formal testing of reliability and validity of the Chinese Hong Kong version of the VHI scale. Recently, Xu et al[4] reported their work on the Chinese edition of VHI scale, showing good reliability and validity in assessment. In China, the severity of voice disorder, evaluated in determining therapeutic effect and prognosis, has only recently been adopted by medical doctors. The assessment is based on the doctors' subjective opinion by hearing patients' voice. Such judgment is individual doctor-dependent, may lack a good reproducibility. With the development of computer-based assessment and medical research of voice, the objective voice detection methods are now available. These objective methods are designed primarily on voice detection of acoustics, aerodynamics, and physiological parameters.

Auditory Perceptual Evaluation of Voice primarily used in clinical settings is the most direct judgment used by clinical physicians and other professionals in evaluating patients' voice quality. The Auditory Perceptual Evaluation of Voice are mainly based on two criteria: (1) the GRBAS scale (grade, roughness, breathiness, asthenia, and strain scale), proposed by the Japanese Society for Logopedics and Phoniatrics and (2) the CAPE-V scale, proposed by the American Speech–Language–Hearing Association. The GRBAS scale is the most widely accepted scale for voice evaluation in clinics worldwide.[5–7] In China, subjective evaluations are the prevailing method and used only in large hospitals. The outcomes largely depend on doctors' clinical experience and assessment skills.

The integrated use of various test parameters to assess (quantify) the quality of voice is still a debated yet important topic in clinical practice. Thus, the purpose of this study was to establish a multiparameter voice assessment method to improve voice quality evaluation.

Accepted for publication March 20, 2014.

From the Department of Otolaryngology, Head and Neck Surgery, Shanghai Jiaotong University Affiliated First People's Hospital, Shanghai, 200080, China.

Address correspondence and reprint requests to Yu Ziwei, Department of Otolaryngology, Head and Neck Surgery, Shanghai Jiaotong University Affiliated First People's Hospital, 100 Haining Road, Shanghai 200080, China. E-mail: david545yu@yahoo.com

Journal of Voice, Vol. 28, No. 6, pp. 770-774
0892-1997/$36.00

http://dx.doi.org/10.1016/j.jvoice.2014.03.014

METHODS

Patients and therapeutic methods

Fifty voice disorder patients were included in the study from the period of June 2010 to October 2011. All patients were admitted to the Department of Otolaryngology, Head and Neck Surgery, Shanghai Jiao Tong University Affiliated First People's Hospital. The average age of patients is 47.08 ± 3.94 (standard deviation) years (range 25–70 years). Patients were diagnosed of vocal fold polyp (n = 32), vocal fold nodule (n = 5), vocal fold leukoplakia (n = 5), vocal fold cyst (n = 5), and vocal fold Reinke edema (n = 3). For each patient, the removal of vocal fold lesion was performed under self-retaining laryngoscope, and inhalation treatment of Pulmicort Respules (AstraZeneca Pty Ltd.) was applied for 1 week after surgery.

Instruments and voice assessment methods

Subjective voice quality assessment. All sound measurements were recorded in the acoustic room with a high-fidelity audio equipment (digital audio tapes). The distance between mouth and microphone was 10 cm. Each patient was asked to read an assigned sentence in his/her natural tone and loudness. The recorded materials from the digital audio tapes were then transferred to a computer. Three doctors were assigned to independently evaluate the voice quality. According to the grade of hoarseness (G) in GRABS system proposed by the Japanese Society for Logopedics and Phoniatrics, the voice quality was rated into one of four levels: 0 for normal voice, 1 for mild hoarseness, 2 for moderate hoarseness, and 3 for severe hoarseness. To minimize the assessment difference among the three doctors, thereby increasing the credibility of assessment results, each doctor was trained to recognize typical sound samples, and the subjects' samples were also randomly arranged and presented to a given doctor three times. Each sound sample was thus assessed three times per doctor and then averaged.

Self-assessment. On the VHI scale, the impact of voice disorder on patients' quality of life is based on the assessment of functional (F), physiological (P), and emotional (E) components. The total score of the three components is T and to separate from the impact of E, sum of F and P is used as T_{vH} ($T_{vH} = F + P$). Each component is evaluated based on 10 questions. Patients were asked to rate each question based on the frequency of occurrence: 0 for never, 1 for seldom, 2 for sometimes, 3 for regularly, and 4 for always. The score of each component range from 0 to 40, and the total score (T) is from 0 to 120. A higher score on a particular component indicates a greater impact of the voice disorder on this aspect for the patient; a higher total score means a worse self-recognition of the patient on voice disorder.

Acoustic analysis. Acoustic test was conducted in an acoustic room. A microphone was placed 10 cm away from patients' mouth. Subjects were then asked to pronounce the vowel /a/ for 3 seconds. Sound samples were recorded and then transferred into the computer for analysis using the voice analysis software. Acoustic analysis was conducted under the voice analysis computer system (Tiger Electronics Co., Ltd) using the software Dr. Speech windows, version 4.0.[8] Three parameters were selected for analysis: jitter (J, cycle-to-cycle variation in frequency), shimmer (S, cycle-to-cycle variation in intensity), and normalized noise energy (NNE, relative level of vocal noise to that of harmonics).

Statistical analysis

Matched *t* test was performed to analyze the differences between preoperation and postsurgery. Spearman correlation was carried out to analyze the correlations among the parameters. All data analyses were performed with SPSS version 13.0 (SPSS, Chicago, IL).

RESULTS

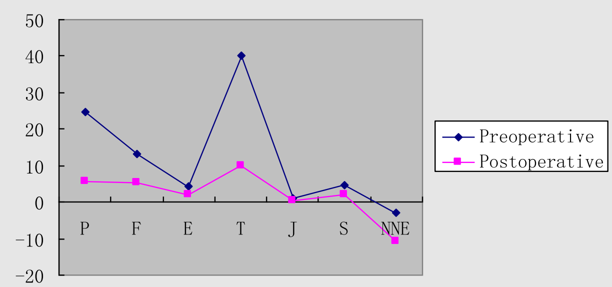
VHI scale assessment and acoustic analysis

The results of VHI scale assessment and acoustic analysis show that both self-assessment and acoustic index significantly decreased 1 week after surgery ($P < 0.01$) compared with preoperative (Table 1).

Correlation analysis of subentries on VHI scale

Table 2 shows the correlation analysis results of self-assessment. Both before and after surgery, there were significantly strong positive correlations between F, P, and the sum T_{vH} ($T_{vH} = P + F$). Preoperatively, the Spearman correlation

TABLE 1.
Comparison of VHI Parameters and Acoustic Analysis Preoperative and 1 Week After Surgery (Mean ± Standard Deviation)



Variable	Preoperative	Postoperative	*P* Value
VHI parameters			
P	21.43 ± 3.24	4.02 ± 1.53	0.008
F	11.29 ± 1.76	3.77 ± 1.63	0.007
E	2.85 ± 1.44	1.54 ± 0.58	0.007
T	36.95 ± 3.05	8.02 ± 1.94	0.008
Acoustic analysis			
J	0.82 ± 0.31	0.19 ± 0.22	0.005
S	4.58 ± 0.14	1.42 ± 0.50	0.005
NNE	−4.88 ± 2.13	−12.95 ± 2.01	0.006

All subentry P, F, E, and T scores of VHI were significantly reduced 1 week after surgery ($P < 0.01$), and J, S, and NNE of acoustic analysis were significantly reduced 1 week after surgery ($P < 0.01$).