

Efficacy of voice laboratory in evaluation of treatment in Dysphonic patients

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Abstract

Introduction: Evaluations of voice disorders include clinical assessment (subjective) and Voice Laboratory Measurements (VLM) which use objective criteria to evaluate the severity of voice disorders. The purpose of this 2 years prospective team work study (during 2004 – 2006) was to determine the efficacy of voice laboratory analysis in evaluation of treatment in dysphonic patients, in comparison with clinical (subjective) evaluation.

Materials and Methods: This study was done on 50 patients (42 males and 8 females) with voice disorders. All of the patients underwent complete ENT and neurological examinations and also complete voice lab evaluation with Visi pitch instrument and computer speech lab (CSL), both before and after appropriate treatment. Then the results of objective and subjective evaluations compared statically with the last version of SPSS software. We performed at least 5 voice parameters including fundamental frequency, phonation quotient, pitch range, percentage voiced and perturbation.

Results: Only 8 patients (16%) had statistically significant improvement in data base of voice lab parameters and the rest patients (84%) although showed some improvement but without statistically significance. Overall, the sensitivity of voice lab was 80%. Some degree of changes was observed in all of the parameters before and after treatment. In the case of perturbation ($t = 3.53$ and $P < 0.01$) and jitter ($t = 2.43$ and $P < 0.05$) there was significant differences with good statistical correlations.

Key words: Voice disorders, Dysphonia, Voice laboratory, Visipitch instrument, Computer speech lab

Introduction

Voice is a complex acoustic phenomenon and voice production involves the interplay of different anatomic structures and physiologic systems. Therefore, characterization and quantification of the voice is a challenging and multidimensional undertaking (1, 2). Ability to measure vocal function has progressed immensely in recent years, resulting from advances in computer-assisted waveform analysis and from increasing understanding of how the vocal tract works.

Nevertheless, assessment of vocal function is in its infancy compared with audiology. This is a result of the variability in normal voice quality and a result of the fact that speaking, unlike hearing, is a voluntary motor task, subject to potential misuse and capable of tremendous enhancement by training (2).

In clinical practice the diagnosis of a voice disorder is established on the basis of the history and physical examination (Including office endoscopy and sometimes operative direct laryngoscopy).

The role of vocal function testing is to characterize and quantify the magnitude of the problem to target specific treatment goals and

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document treatment response (3). In clinical research, vocal function testing is important for testing and comparing treatment efficacy. In basic research vocal function testing is used to acquire detailed information on how voice is produced, how it is impaired by disorders and how such testing may guide the development of new strategies for therapeutic intervention (2,3).

The vocal function is a multidimensional function and there is no single measure either with which one can evaluate the entire aspects of the vocal function. The purpose of most tests presently in use is basically not to make a diagnosis of the etiologic disease of the voice disorder but to evaluate one or several aspects of the vocal function. Measurement of the following 5 voice parameters is important including Fundamental frequency, Phonation quotient, Pitch range, Percentage voiced and Perturbation (4, 5, 6). Fundamental Frequency is related to the perceived pitch of voice (4). The pitch of the voice is being an important factor symptomatically and possibly etiologically. It is reflective of the biomechanical characteristics of the vocal fold (4, 5).

Phonation Quotient is the value obtained when the forced vital capacity is divided by the maximum phonation time and gives a basic measurement of breath control (4). Percentage Voiced is when a person phonates a vowel; he should be producing sound for the whole length of that phonation. Frequency Perturbation or jitter is concerned with the short-term variability of the fundamental frequency.

Materials and Methods

Many specialists involved in this two years prospective teamwork study; including otolaryngologist, neurologist, speech therapist, statistician and so on. Between January 2004 and June 2006, fifty patients (42 males and 8 females) who had various voice disorders, were enrolled to this study. The mean age of the patients was 46 years (range, 24 to 69 years). Dysphonic patients were selected from

the patients who referred to our voice clinic and had problems such as vocal palsy, Reinke edema, spastic dysphonia and so on. All of the selected patients underwent complete ENT and neurological examinations for their problems before and after treatment. The examination included routine ENT assessments and endoscopic laryngeal examination (e.g.; stroboscopy, direct and indirect laryngoscopy, flexible laryngeal endoscopy). The main point in our study was to show that regardless of the pathology and the method of treatment, whether the clinical improvements seen in the patients, correspond to the improvement of voice lab database. We confirmed this improvement with questionnaire from the patients and especially from attending doctors. Clinical judgment about the improvement has been based on an arbitrary scale of 0 to 5 (0=No improvement, 1=minimal improvement, 2=some improvement, 3=moderate improvement, 4=good improvement, 5= complete improvement). Then, all of the patients underwent complete voice lab evaluation with Visi-pitch instrument and computer speech lab (CSL) before and after appropriate treatment in our voice lab. The Visi-pitch is a computer package that provides visual biofeedback and analysis of a patient's speech/voice characteristics recorded from the subject speaking into Visi-pitch's microphone. CSL is a computer based system that analyses the speech and gives spectrum of the patient speech, pitch, jitter, shimmer, etc (Fig. 1).

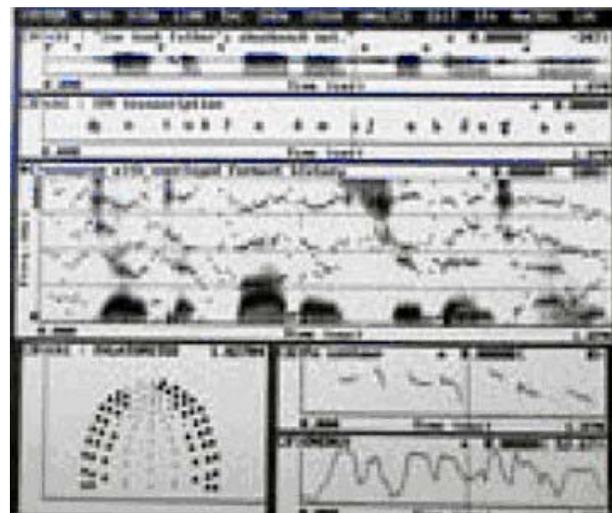


Fig. 1: CSL Diagram

At first for each patient the parameters average frequency, perturbation, average pitch, jitter and schimmer were measured by CSL and Visi-pitch instruments and the results were recorded. Then the patients were subjected to treatment for two months according to the instructions of the specialized doctors. At the end of the period, improvements in the status of the voice and speech of each patient was clinically measured and recorded. After treatment the five voice test parameters were measured for each patient again. Voice tests were conducted by a speech therapist. All of the examinations and tests were performed by the same team of doctors and the tests included the pronunciation of the vowel (a), uttering the sentence; emrooz baran barid; that means "It rained today," and an easy every day sentences. The time considered for pronouncing the vowel (a) was 4 seconds and the microphone was at a distance of 3 centimeters from the mouth of the patient and the A or B modes belonged to men and women respectively. At the end, the status of the laboratory parameters before and after treatment as well as the correspondence between clinical improvements and laboratory improvements were compared and statistically analysis was performed by the last version of SPSS software.

Results

Fifty patients, 42 males (84%) and 8 females (16%) completed the study. The average age of the subjects was 46 ± 1.2 . The factors causing voice and/or speech disorders were Vocal palsy 35%, Parkinson disease 30%, Spastic dysphonia 20% and Reinke edema 15% respectively. The changes in the parameters of voice are presented in (table 1).

Changes were observed in the degree of all the parameters before and after treatment. In the case of perturbation, ($t = 3.53$ and $P < 0.01$) and jitter ($t = 2.43$ and $P < 0.05$) the difference was significant. As for improvement, 27 patients (54%) showed clinical improvement while 23 patients (46%) showed no clinical

improvement. Based on laboratory standards, 42 patients (84%) showed an improvement while 8 patients (16%) showed no improvement. The statistical test shows no significant difference between these two groups (clinical results vs. laboratory results). ($t = 1.69$, $P = 0.19$). As seen in table 2, the t-test shows no significant difference, with respect to any of the parameters under laboratory study, between the two groups with and without clinical improvements.

Table 1: Voice lab data before and after treatment of 50 patients with voice disorders

Voice lab parameter	Before	After	Diff.mean	p value
Average frequency				
Mean	154/88	174/10	-19/22	0.070
S.deviation	$\pm 71/23$	$\pm 64/03$		
Perturbation				
Mean	7/40	4/71	2/69	0.001
S.deviation	$\pm 5/16$	$\pm 3/71$		
Average Pitch				
Mean	185/80	174/71	11/09	0.174
S.deviation	$\pm 60/72$	$\pm 69/33$		
Jitter (%)				
Mean	1/33	0/88	0/45	0.019
S.deviation	$\pm 1/35$	$\pm 0/62$		
Schimmer (db)				
Mean	0/45	0/43	0/02	0.339
S.deviation	$\pm 0/34$	$\pm 28/1$		

Table 2: Voice lab data compare with patient's improvement

Voice lab parameter	Clinical Situation	t	p value
Average frequency	Improvement	142	0.88
	Not improvement	145	0.88
Perturbation	Improvement	1/75	0.08
	Not improvement	1/80	0.07
Average pitch	Improvement	1/31	0.19
	Not improvement	1/25	0.22
Jitter	Improvement	-0/95	0.34
	Not improvement	-0/98	0.33
Schimmer	Improvement	-1/07	0.28
	Not improvement	-0/99	0.33

Discussion

Voice has a multi-dimensional function. Therefore, any study of voice should take into account all the related dimensions. Considering the nature of Voice and the possible mistake in the examiner's subjective evaluation of voice, it is necessary to develop an objective system for the evaluation of the patient's status of voice and speech, which will be able to show the treatment procedure (6-8).

As already noted, while voice laboratory measurements (VLM) such as jitter, shimmer, noise-to-harmonic ratio and maximal phonation time provide certain insights regarding voice impairment severity as compared to the expected normal voice, they fail to indicate why patients with similar voice disorders experience different levels of handicap severity (9-11). Voice problems affect multiple aspects of a patient's life, including emotional, physical, functional, economic and others. Therefore, symptoms of dysphonic disease include not only a husky voice, but also run deeper to include complex problems for each patient (13, 14). Jitter, shimmer, noise-to-harmonic ratio and maximum phonation time of VLM are routinely observed in order to benchmark a patient's condition, both pre-operatively and post-operatively. These measurements are objective in nature and yield information very useful for treatment efficiency (13).

In our study, VLM parameters collectively show a strong correlation ($P < 0.01$) for dysphonic patients preoperatively. This indicates that these parameters are sufficiently sensitive and reliable to assess disease severity. However, there is a large discrepancy between the measurements returned by clinical assessments and VLM. A patient's subjective feelings regarding his/her dysphonic problem cannot be evaluated using objective measurements. This resulted in our frequent observation of patients who did not rate their treatment as particularly effective despite excellent VLM test results (13, 14).

A comparison of the results of the parameters of the voice laboratory in this article shows a significant difference before and after treatment. It can therefore, be a criterion for the study of the treatment procedure and the evaluation of the status of the patient's voice and speech. However, it should be noted that no significant differences were observed between the laboratory parameters of the two groups. Therefore we should not totally rely on this criterion; rather, a combination of the results of clinical observations and laboratory results will be more useful in the evaluation of the patient's treatment procedure. With respect to the diagnostic value of laboratory tests, if clinical improvement is considered as the golden criteria for the improvement in speech disorder, the sensitivity of these tests was 77%, specificity 8%, the positive predictive value 50% and the negative predictive value 25%. In mind, the accuracy of the tests was 46%. In another study with the same goal, Piccirillo performed objective voice evaluation on 97 dysphonic patients using a statistical approach similar to the one described here.

A total of 14 parameters were measured, three of them are the same as in our study (6). In an attractive study by Professor Hirano from Japan it was shown that the most popular voice lab test all around the world were indirect laryngoscopy, voice recording and maximum phonation time and voice frequency evaluation (5). We performed at least 5 voice lab tests for every patient. In our study the sensitivity of over 77% and 50% positive predictive value of the laboratory parameters can also help in showing an improvement in the patient's clinical status, even though because of its low quality, it cannot be a definitive criterion for the confirmation of improvement or lack of improvement. In this research, the accuracy of about 46% for the laboratory parameters of voice confirms the fact that using these

tests, along with other tests, can help the doctors study in the procedure of improvement in the patient's voice and speech disorders. Finally, the results of the voice laboratory do not provide clinical evidence of the disorder, but the doctor, taking into account various aspects of the function of voice, can use them in his study of the status of voice and speech as well as the improvement procedure. In other hand the purpose of voice lab is not to make a diagnosis but it is ideal for patient biofeedback, research, medico legal and so on.

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خلاصه

کارآیی لابراتوار صدا در ارزیابی درمان در بیماران مبتلا به دیس فونی

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مقدمه: ارزیابی اختلالات صدا شامل بررسی بالینی (سوئزکتیو) و سنجش های لابراتوار صدا (VLM) می باشد که در آن از معیارهای عینی (ابژکتیو) برای برآورد شدت اختلالات صوتی استفاده می گردد. هدف این مطالعه تیمی آینده نگر ۲ ساله (۱۳۸۵-۱۳۸۳)، تعیین کارآیی آنالیز لابراتوار صدا جهت ارزیابی نتایج درمان بیماران دیس فونیک در مقایسه با ارزیابی های بالینی (سوئزکتیو) بوده است.

روش کار: این مطالعه بر روی ۵۰ بیمار (۴۲ مرد و ۸ زن) مبتلا به اختلالات صوتی انجام پذیرفته است. تمام بیماران علاوه بر معاینات کامل گوش، گلو، بینی و عصبی، قبل و بعد از درمان در لابراتوار صدا با دستگاه Visi Pitch و دستگاه رایانه ای آزمایشگاه گفتار (CSL) نیز بررسی شدند. سپس مقایسه آماری نتایج حاصل از این ارزیابی های سوئزکتیو و ابژکتیو با استفاده از آخرین نسخه نرم افزار SPSS انجام شده است. ما در این مطالعه حداقل ۵ مولفه صدا را شامل فرکانس اساسی، کسر فوناسیون، محدوده زیر و بمی صدا، درصد تولید صوت و اختلال یا آشفتگی فرکانس بررسی نموده ایم.

نتایج: بر اساس معیارها و مولفه های لابراتوار صدا، فقط ۸ بیمار (۱۶٪) بهبود قابل توجه آماری داشتند و بقیه (۸۴٪) هر چند درجاتی از بهبودی را نشان دادند ولی از لحاظ آماری قابل اعتنا نبود. روی هم رفته، درجه حساسیت لابراتوار صدا حدود ۸۰٪ بود. در مقادیر قبل و بعد از درمان تمامی مولفه های صدا، درجاتی از تغییر مشاهده گردید که در مورد مولفه Perturbation ($t = 3/53$ و $P < 0/01$) و مولفه Jitter ($t = 2/43$ و $P < 0/05$) این تغییرات قابل ملاحظه و از لحاظ آماری معنی دار بود.

واژه های کلیدی: اختلالات صدا، دیس فونی، لابراتوار صدا، دستگاه Visipitch، لابراتوار رایانه ای گفتار.