Normative Values of Voice Analysis Parameters With Respect to Menstrual Cycle in Healthy Adult Turkish Women

Emel C. Tatar, Mustafa Sahin, Dilek Demiral, Omer Bayir, Guleser Saylam, Ali Ozdek, and Mehmet Hakan Korkmaz, *Ankara, Turkey*

Summary: Objective/Hypothesis. Objective measurements are quite important for assessment of voice disorders. The first aim of this study was to establish a prototype database of normative values of voice analysis parameters in healthy Turkish adult female population. The second aim was to evaluate the variations of these parameters during physiological menstrual cycle.

Study Design. This is a prospective, single-blind study.

Methods. Eighty-nine healthy women (mean age, 31.5 ± 6.0 years) with normal physical findings and without vocal abuse or dysphonia were participated. Detailed physical and videostroboscopic larynx examination was done. Participants' voice samples of sustained /a/ and /i/ vowels were recorded, and voice analysis was done. GRBAS scale was done by four otolaryngologists, and subjects were asked to score their own voice quality using Voice Handicap Index-10 (VHI-10) at the premenstruation, during menstruation, and postmenstruation periods.

Results. Eighty-nine healthy Turkish women's some normative acoustic vocal parameters of three different phases of menstrual cycle were reported. The data indicated that during the premenstruation period; the mean jitter %, shimmer % and noise-to-harmonic ratio values were significantly higher than that of other two periods. Variations of computerized acoustic vocal analysis parameters through menstruation cycle were in concordance with the perceptual voice assessment (GRBAS) and the questionnaire of subjects' perception of their own voices (VHI-10).

Conclusions. In this study the normative values of voice analysis parameters of healthy adult Turkish women was reported. Adding computerized voice analysis parameters may improve the assessment and screening of voice in routine clinical practice because this is a simple and reliable method. Evaluation of voice can be performed regardless of the phases of menstrual cycle, but not performing acoustic analysis during the premenstrual period may prevent some of the unintended errors.

Key Words: Voice analysis–Female–Menstruation.

INTRODUCTION

Perceptual voice quality evaluation by experienced listeners is still considered to be the most reliable method in evaluation of pathologic voices although it has the lack of objective reproducibility. Nowadays, objective acoustic analysis with different computer-based systems is also an essential part of the evaluation of voice disorders as subjective evaluations performed by the clinicians and/or patients with some questionnaires and scales.[1] It is quite important to have objective, quantitative criteria in diagnosis and follow-up. Acoustic analysis may give some data to the clinicians that may aid a more sensitive diagnosis and increase the quality of follow-up during surgical interventions and voice therapy.[1,2] Moreover, this method also has the advantages of rapid and easy applicability, ponderability, and repeatability.

It is reasonably expected that people speaking different languages in different countries have different voice features because of the physical and cultural differences. As a matter of fact, in evaluation of voice disorders, principal features of the patient such as age, gender, job, and cultural context should not be omitted. To diagnose a voice as pathologic, first, the features of normal voice should be determined.[3] Therefore, many countries reported their own normative data of some voice parameters belonging to the adults in the literature.

During the evaluation of voice defects, the most commonly used voice analysis parameters belong to the frequency, intensity, and harmonics of the voices together with the parameters reflecting the alterations of these parameters between glottal cycles.[4] In literature, there are many studies reporting the features of pathologic voices, but there is an absence about the normal voice features of healthy Turkish women. The main aim of this study was, by analyzing voices of healthy adult women of Turkish population without any voice abnormality, to establish a database of baseline normative voice values which can be used in evaluation of patients admitted with voice faults, in identification of pathologic voice, and in comparison with the normative data of other countries.

Larynx is an organ that shows structural changes lifelong, and one of the causes of these changes is the sex hormones. Alterations in blood levels of sex hormones may affect the voice of women. It is reported that women may experience a voice change 4–5 days before menstruation which is called as premenstrual vocal syndrome.[5] During menstrual cycle, with a

Accepted for publication April 21, 2015.
This study was submitted as oral presentation at 10th Congress of the European Laryngologic Society, 9–12 April, 2014, Antalya, Turkey.
From the Department of Otorhinolaryngology, Diskapi Yildirim Beyazit Research Hospital, Ministry of Health, Ankara, Turkey.
Address correspondence and reprint requests to Mustafa Sahin, Department of Otorhinolaryngology, Diskapi Yildirim Beyazit Research Hospital, Ministry of Health, Irfan Bastug Boulevard, 06110, Diskapi, Ankara, Turkey. E-mail: iskebaha@gmail.com
Journal of Voice, Vol. 30, No. 3, pp. 322-328
0892-1997/$36.00

http://dx.doi.org/10.1016/j.jvoice.2015.04.014

decrease in estrogen levels, because of the alterations in the content of connective tissue of vocal folds, character of mucosal secretions and muscle tonicity may cause voice changes, especially reduction in voice stability. In clinical practice, symptoms about the vocal changes during menstrual cycles and postmenopausal period are reported in professional voice users.[5,6] The secondary aim of this study was to investigate the probable voice alterations in healthy women with repeated analysis in different periods of menstrual cycle and by this way to prevent the errors that may take place during the diagnosis and treatment of voice disorders in women.

METHODS

This prospective, single-blind study was carried out at the voice disorders unit of otorhinolaryngology department at a research and educational hospital. It was approved by the research ethics committee (27.02.2012/01/32). Each case was verbally informed by the specialists in a comprehensive way and signed the informed consent form. The participants were native Turkish speaker women who defined their voices as normal. Detailed medical and voice habituation history was obtained via a detailed questionnaire prepared just for this study. Detailed otolaryngologic and neurologic examination was performed. Self-assessment of voice quality was scored using Turkish version of Voice Handicap Index-10 (VHI-10). VHI-10 is a questionnaire composed of 10 questions. Subjects give a point of 0–4 for each question. Increased scores define increased problems.[7]

Perceptual voice quality was evaluated by GRBAS scale by four experienced specialists who did not know the subjects. GRBAS is a reliable and valid scale which is universally used for auditory-perceptual voice evaluation. GRBAS scale consists of five parameters: grade (G), roughness (R), breathiness (B), asthenia (A) and strain (S). For each parameter, four different scores from 0 to 3 are given according to the severity of dysphonia (0 is normal, 1 is slight degree, 2 is medium degree, and 3 is high degree of severity).[8] GRBAS scoring method was performed by judges over samples of a reading passage in Turkish which comprises 219 words with rich and balanced phonemes. The compatibility between evaluators was analyzed using Fleiss Kappa and intraclass correlation before the study, and it was found out that this compatibility was statistically significant (82%, $P = 0.01$). If subject's initial VHI-10 score was ≥ 2 and mean GRBAS score was ≥ 1, the subject was not included in the study. Other exclusion criteria were as follows: history of smoking, intensive alcohol consumption, being a professional voice user, history of any respiratory, neurological, psychiatric, and endocrinologic diseases, laryngeal surgery, head and neck trauma, radiotherapy to head and neck region, chemotherapy, hearing impairment, voice therapy, vocal training, any vocally abusive or misusive behaviors, any laryngopharyngeal reflux complaint, using oral contraceptive, irregular menstrual cycles, any sign of postmenopause. Videolaryngostroboscopy (VLS) examination and voice analysis were performed in three different times. There were no sign of upper airway infection during evaluation. The first evaluation was in between the second and fifth days of menstruation, the second analysis was in postmenstruation period (between 10th and 14th days of menstrual cycles) while the third investigation was in premenstruation (between 22nd and 28th days of menstrual cycles) periods. VLS procedure was done (Xion EndoStrob DX, Berlin, Germany) by an otolaryngology specialist. If a mucosal waveform irregularity was recognized, subject was not included in the study. Voice samples were recorded in a sound-insulated room at a sound level that patients feel themselves relaxed and upright seated with high-quality omnidirectional microphone (Shure SM48, Niles, USA). The distance between the microphone and mouth was adjusted to 15 cm approximately. Microphone was positioned 90° to the mouth. Each patient was given a short practice period before the first recording to adapt to procedure. Subject was instructed to phonate sustained vowels \a\ and \i\ at a habitual pitch and comfortable loudness for 5 seconds at least. The task was repeated three times for each subject, and each trial was captured on hard disk at a 44.100-Hz sampling rate and a 16-bit resolution. *Computerized Speech Lab* (KayPENTAX CSL model 4500; Montvale, USA) software (CSL main program and multidimensional voice programme) was used to capture and analyze the voice samples. The beginning and at the end of 1 second of samples were extracted to avoid unintended irregularities and variability on voicing onset and offset. The mean values then were calculated for each subject. Eleven acoustic parameters of voice samples were fundamental frequency (*F*0), intensity (Int), jitter percent (Jitt), pitch period perturbation quotient (PPQ), shimmer percent (Shim), amplitude perturbation quotient (APQ), noise-to-harmonic ratio (NHR), relative average perturbation (RAP), voice turbulence index (VTI), cepstral peak prominence (CPP), and maximum phonation time (MPT). MPT was calculated as the measurement of the time periods of vowels \a\ and \i\ told after maximum inspiration. The longest time of the three different measurements was regarded as the MPT. A 2048-point Fast Fourier Transformation was used for the data which were sampled at the rate of 22 kHz, and frame duration was 50 ms while calculating CPP.

SPSS Version 17.0 was used for statistical analysis. The correlation analysis between variables was measured via Spearman correlation test, changes between different time periods within the group were evaluated via Friedman and Wilcoxon signed rank test, the comparison between groups in different time periods was evaluated via Mann-Whitney *U* test. The numerical results were submitted as mean ± SD. Statistical significance level was determined as $P < 0.05$.

RESULTS

The data of 89 adult women suitable for the criteria with a mean age of 31.5 ± 6.0 years (minimum 20, maximum 42 years) were assessed. The vocal analysis parameters of subjects with sustained /a/ and /i/ vowels during, after, and before menstruation are summarized in Table 1. The *P* values about the statistical significance of differences of these parameters determined in three different periods of menstrual cycle are summarized in Table 2.