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Standardization of Acoustic Voice Measures in Non-Dysphonic Male Individual

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Abstract

Background and objective: Computerized voice analysis comprising acoustic voice analysis is one of the major advances in the study of voice, increasing the accuracy of diagnosis in this area. A normal standard data is necessary for such computerized voice analysis program. The aim of the present study is to standardize acoustic voice measures for non-dysphonic male individual.

Materials and methods: Values for acoustic voice measurements were obtained from 50 normal male individuals, without sign and symptoms of voice problems. The vocal data measurement was performed with Doctor Speech (DRS) Tiger Electronics, USA.

Results: Voice analyses were performed with a sustained vowel /i/. The average value of fundamental frequency (F0) was 131.39 Hz. The average values of jitter, shimmer and HNR were 0.33%, 0.57% and 34.37dB respectively.

Conclusion: Our results differ from the various literatures; therefore it is important to standardize the program that we use before applying the values for tests designed for a different kind of population.

Keywords: Acoustic analysis, fundamental frequency, harmonics to noise ratio, Perturbation, Standardized voice.

Introduction

Voice disorders are generally assessed subjectively by a laryngologist or by a speech language pathologist. Being subjective, perceptual analysis of voice disorders has significant limitations that can lead to confusion between the observers while treating a dysphonic patient. In search of more objective and consistent measures, computer based acoustic correlates of voice qualities are being introduced[1,2]. Objective voice analysis has several advantages as being quantitative and noninvasive and cost and time efficient. Acoustic voice analysis can also be used to create awareness among dysphonic patients regarding manners of voice production, self-monitoring, visual feedback, reinforcement as well as documentation in the form of statistical analysis and visual displays as evidence of progress[3]. Instrumental measures of the vocal function have now become an integral component of the clinical process, rather than just a supplement to assessment and treatment.

Acoustic voice parameters measure fundamental frequency (F0), Intensity (amplitude), perturbation (jitter

and shimmer), harmonic to noise ratio (HNR) and dynamic vocal range[4].

Normative or normal standards are needed for vocal analysis based on the extraction and quantification of precisely defined voice signal standards to guide voice care professionals, particularly because of a paucity of studies with acoustic measures of normal voice in Indian population. Acoustic analysis standardization makes voice evaluation simpler, saves time, money and effort and can be used in education and certification process. We evaluated the normal voice data of male volunteers for quick standard reference and to understand their normal vocal parameters.

Materials and methods

50 informed volunteers from age 18 to 60 years were included in the study. The persons with smoking habit, vocal abusers or recent history of cough and cold were excluded from the study. All of the volunteers were non singers.

The data were collected and analyzed with Dr. Speech (DRS) Tiger Electronics, USA in a room with a noise level below 40 dB. The microphone mouth distance was fixed at 10 cm, and the patient was asked to phonate the vowel /a/ for at least 5 seconds at the most comfortable level.

Analysis was performed in terms of fundamental frequency (F0), perturbation (jitter and shimmer) and harmonic to noise ratio (HNR).

Observation and Results

A total of 50 male volunteers were evaluated for the acoustic analysis. The evaluations were done in terms of fundamental frequency (F0), jitter, shimmer and HNR. The average values of all the four parameters are depicted in the **Table1**.

The average value of fundamental frequency (F0) among 50 subjects was 139.33 Hz. Highest F0 was seen in age group of less than 20 years (172.06 Hz). Lowest F0 was seen in sixth decade of life (124.24 Hz). In our study mean values of fundamental frequency (F0) showed decreased values with increasing age (**Table 2**).

Table 1: The average values of Acoustic voice parameters

Acoustic Voice Parameters	Average Value (N=50)	SD
F0 (Hz)	138	17.05
Jitter (%)	0.34	0.42
Shimmer (%)	1.80	0.95
HNR (dB)	26.80	5.95

F0- Fundamental frequency, HNR- harmonic to noise ratio,

SD- Standard deviation

Table 2: Average values of fundamental frequency (F0) in various age groups

Age (Years)	Average of F0 (Hz)	SD
<20	172.06	12.34
21-30	151.92	10.83
31-40	138.24	9.08
41-50	127.10	12.26
51-60	124.24	13.51

The average values of jitter and shimmer among 50 non-dysphonic male volunteers were 0.33% and 0.57% respectively. Higher values of jitter and shimmer were noted in fourth (jitter: 0.43%; shimmer: 1.99%), fifth (jitter: 0.45%; shimmer: 2.28%) and sixth decades (jitter: 0.35%; shimmer: 1.87%) of life as compared to early decades of life [second decade (jitter: 0.20%; shimmer: 1.62%); third decade (jitter: 0.19%; shimmer: 1.42%)]. No significant difference noted for harmonic noise ratio (HNR) with increasing age.

Discussion

Acoustic voice parameters measure fundamental frequency (F0), Intensity (amplitude), perturbation (jitter

and shimmer), harmonic to noise ratio (HNR) and dynamic vocal range[4]. Frequency refers to the repeating cycles of vocal fold vibration in the acoustic waveform. It is measured in cycles per second, also called Hertz (Hz). The perceptual correlate of frequency is pitch. Intensity is the acoustic correlate of loudness.

Acoustic measures also include cycle-to-cycle variability of the acoustic signal (perturbation) and ratios of harmonic energy to noise energy. The most well-known perturbation measures are jitter (frequency perturbation) and shimmer (amplitude perturbation). These cycle-to-cycle variability reflect the slight differences in mass, tension and biochemical characteristics of the vocal folds, as well as slight variation in their neural control. The perceptual correlate of perturbation measures are voice quality (roughness, breathiness and hoarseness of voice)[4].

The harmonic-to-noise ratio (HNR) is the mean intensity of an average waveform (noise-free) divided by the mean intensity of the isolated noise component for the series of waveforms in the utterance[5]. This parameter correlates with the perception of vocal roughness[6]. As the degree of hoarseness increases the noise component increases and replaces the harmonic structure in the spectrogram as a result lower values of HNR is obtained.

Fundamental frequency observed in our study among non-dysphonic male volunteers was 139.33 Hz. In other acoustic studies among non-dysphonic males with the Dr. Speech (DRS) the average value of F0 obtained were 115.5 Hz (Belgian population) and 170 Hz (Nepalese adults)[7,8]. On reviewing the several studies the F0 for males has ranged from 115.0 to 129.0 Hz.

In our study decreased F0 was observed with increasing age. However, in another study no significant difference in F0 was noted between different age groups[8]. In the elderly people, studies indicate an increase of the fundamental frequency in non-smoking man and a decrease in women due to the aging process that causes anatomic and physiologic changes in the larynx and vocal cords. According to Beilamowicz et al. commercially available acoustic analysis programs agreed well, but not perfectly, in their measures of F0[9].

The average value of jitter among 50 normal male volunteers in our study was 0.33%. The normative range for the Dr. Speech (DRS) data is 0.5%. In other studies via Dr. Speech (DRS), average value of jitter observed in males were 0.40% and 0.14%[7,8]. Higher value observed was 0.81%, while lesser value observed was 0.037% [10].

As to the average jitter our result was lower than the one found by Smits et al.[7] (0.40%) and Higgins and Saxman[10] (0.38%); while higher than the one observed by Toran and Lal[8] (0.14%).

The average value of shimmer among 50 normal male volunteers in our study was 0.57% while the Dr. Speech (DRS) database normative range is 3.0%. In another study with Dr. Speech (DRS), average shimmer observed was 1.6% in males[8]. Similar data was also observed in other studies. But, our values for relative shimmer were much lower than those observed by Smits et al.[7], which were 3.98% for males. In other studies relative shimmer for males was 3.6%.

In our study higher values of jitter and shimmer are noted in fourth, fifth and sixth decades of life as compared to early decades of life. Increased Jitter or shimmer values can be attributed to phonatory instability due to aging and various laryngeal pathologies[11,12]. Voice perturbation is a probable indicator for a physiological disorder.

The average value of harmonic noise ratio (HNR) among 50 male volunteers in our study was 34.37dB. In another study via Dr. Speech (DRS) average harmonic-to noise ratio observed for normal males was 25.81dB[8]. Similar

HNR values for both the gender subgroups with respect to age were also observed in other studies[7]. In our study no significant difference was noted for harmonic noise ratio (HNR) with increasing age.

Conclusion

The average value of fundamental frequency (F0) observed was 131.39 Hz. The average values of jitter, shimmer and HNR were 0.33%, 0.57% and 34.37dB respectively.

Above mentioned results and discussions demonstrate, we have developed a reliable normal acoustic data for various parameters of acoustic analysis in different age groups in non-dysphonic male adults. Importantly, this standardized data can be used as a convenient reference to evaluate the voices.

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