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Original Research Article

A comparative study of long term average spectrum measures on spontaneous speech tasks between patients with Parkinson's disease and age matched normals

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ABSTRACT

Background: Long term average spectrum (LTAS) is a robust tool in assessing voice characteristics over a period of time. Individuals with Parkinson's disease (PD) exhibit speech impairments, which includes monopitch and monoloudness, reduced stress, tremulous voice and inappropriate silences. Since, there are no studies in Indian context to analyse the spontaneous speech of patients with PD through LTAS and spontaneous speech provides naturalness in speech, the present study is an attempt to compare spontaneous speech between patients with PD and age matched normals using LTAS.
Methods: A total of 30 participants aged 50-70 years were considered for the study among which 15 were patients with PD (group-I) and 15 were age matched normals (group-II). The LTAS parameters - mean spectral energy (MSE), first spectral peak (FSP), spectral tilt (ST), three spectral slope (SS) measures (SSF0-1kHz, SS1-5kHz, and SS ratio), four spectral moment analysis (mean, standard deviation, skewness, and kurtosis), jitter and shimmer were taken for analysis. Mann-Whitney U test was performed for statistical analyses.
Results: The results showed there was significant difference in mean values of MSE, FSP, ST, four SM measures, jitter and shimmer. However, there was no significant difference in mean values of three SS measures.
Conclusions: To conclude the study it can be said that patients with PD demonstrate specific LTAS characteristics that are different from normals.

Keywords: Parkinson's disease, LTAS, Acoustic analysis, Spontaneous speech

INTRODUCTION

Speech is the most efficient and frequently used mode of language expression. Speech is a coded complex acoustic signal which is produced by the action of vocal tract and consists of linguistic message. Speech production is complex, because it needs coordination between several systems (respiratory, phonatory, resonatory, and articulatory systems), between large number of muscles and among several millions of nerve fibres. Speech production is a process where the concepts, ideas and feelings are converted into linguistic code, linguistic code into neural code; neural code into muscular (articulatory) movement and finally muscular movement leads to acoustic signal.[1]

James Parkinson, in his 1817 literature on the "shaking palsy" was the first to describe a disease referred to as "paralysis agitans", now known as idiopathic Parkinson's disease (PD). PD (also known as idiopathic or primary Parkinsonism, hypokinetic rigid syndrome (HRS), or paralysis agitans) is a degenerative disorder of the central

nervous system. PD is caused by basal ganglia dysfunction and creates a movement disorder characterized by bradykinesia (slow movements), muscle rigidity, and resting tremor. PD often produces hypokinetic dysarthria, typified by imprecise articulation, prosodic abnormalities, disturbance of speech rate, and low vocal volume.[2-7] The Mayo Clinic characterization of hypokinetic dysarthria emphasizes the prominent characteristics seen in patients with PD as monopitch, reduced stress, monoloudness, imprecise consonants, inappropriate silences, short rushes, harsh voice, continuous breathiness, pitch level disturbances, and variable rate.[3] Speech rate and loudness have been consistently described as prominent features of Parkinsonian speech. Some patients with PD speak more slowly than controls and others more rapidly.[2,3,8,9] Use of levodopa to restore dopamine concentrations in the striatum seems to improve articulation, voice quality, and pitch variation, although some studies show no alteration in phonatory parameters.

Amongst different softwares used to measure the acoustic aspects of speech, Praat software was used significantly in a number of researches as documented in indexed journals and textbooks. Praat is a scientific computer software, which is used for analysis of speech in phonetics.

The long-term average spectrum (LTAS) is widely accepted as a robust and effective tool for assessment of voice characteristics. LTAS analysis involves the examination of an averaged spectrum of all voiced sounds produced over a certain period of time.[10] The signal obtained by the LTAS is representative of the vocal behaviour taking place at the level of the larynx as sound is transferred through the vocal tract.[11] Thus, LTAS analysis may be appropriate for providing a gross description of source characteristics of individuals with PD since phonatory deficits are often observed in this population. Because the desired LTAS was an average of phonation, pauses and voiceless consonants were edited out of each singing sample before producing the LTAS.[11] There are a number of ways to analyse the averaged speech spectrum that is the result of LTAS analysis, some have used spectral moment analysis, where the shape of the speech spectrum is described based on the spectral mean, standard deviation, skewness, and kurtosis.[12,13] The four spectral moment measures (i.e., spectral mean, spectral SD, skewness, and kurtosis) are used to examine the concentration, variation, tilt, and peakedness of the energy distributions of the LTAS.[14] Spectral moment analysis has been used to identify within and between groups differences of vocal behaviour in studies examining sex-related voice differences, age-related differences, and treatment-related voice changes. In addition to spectral moment analysis, others have used analysis of spectral tilt, first spectral peak of the spectrum, and the mean spectral energy relative to the highest point.[10] These measures have been used in studies of infant cries, sex-related voice differences, and alaryngeal speech.[15,16] Each of these spectral measurements has been shown to relate to a specific physiological aspect of the voice. Spectral tilt (ST) has been shown to relate to glottal closure during phonation. A reduction in ST has been shown to represent hyper-adduction and increased ST has been show to represent hypoadduction.[11] The first spectral peak measure has been shown to relate to the average F0 of the voice, and mean spectral energy has been shown to relate to the average amount of laryngeal muscle tension present during phonation.[15]

There are different parameters of LTAS mainly used for acoustic analysis of various speech samples. The four spectral moment measures (i.e., spectral mean, spectral SD, skewness, and kurtosis) are used to examine the concentration, variation, tilt, and peakedness of the energy distributions of the LTAS.[14] Spectral moment analysis has been used to identify within and between group differences of vocal behavior in studies examining sex-related voice differences, age-related differences, and treatment-related voice changes. In addition to spectral moment analysis, others have used analysis of spectral tilt, first spectral peak of the spectrum, and the mean spectral energy relative to the highest point.[10] These measures have been used in studies of infant cries, sex-related voice differences, and alaryngeal speech.[15,16] ST has been shown to relate to glottal closure during phonation. A reduction in ST has been shown to represent hyper-adduction and increased ST has been show to represent hypoadduction.[11] The first spectral peak measure has been shown to relate to the average F0 of the voice, and mean spectral energy has been shown to relate to the average amount of laryngeal muscle tension present during phonation.[15] All these aspects of LTAS have greater clinical relevance to analyse the spontaneous speech of Parkinsonian patients.

Naturalness is usually depicted more strongly in spontaneous speech rather in phonation or oral reading. No studies have been done in Indian context to analyse the spontaneous speech of patients with PD through LTAS and LTAS analysis in Bengali is death of literature. Therefore, this is an attempt to analyse the spontaneous speech by using LTAS with reference to acoustic means in Bengali patients with PD, as these measures can be a significant therapeutic marker in the practice of speech language pathology. The aim of the study is to compare the Long-Term Average Spectrum measures on spontaneous speech task between patients with PD and age matched normals.

METHODS

Research design

The current study utilized cross-sectional comparative study design.

Participants

A total of 30 participants aged 50-70 years (mean age- 62.6 years, SD 4.21) were considered by using stratified sampling procedure for the study. These participants were

further categorized into two groups (group-I and group-II). Group-I consisted of 15 participants diagnosed with PD with mean age 64.2 years and SD 5.11. Group-II consisted of 15 normal participants with mean age 61.1 years and SD 4.22. All the patients with PD were diagnosed by neurologists in the Neurology Department of Institute of Neuroscinces, Kolkata. The Speech, Language, Hearing and cognitive functioning of all the participants were assessed by Audiologists and Speech Language Pathologists in ASLP Unit of AYJNISHD(D), Kolkata. The study was conducted from January 2025 to October 2025.

Selection criteria for group-I

The participants who were neurologically diagnosed as PD, had no history of language impairment, no deficits in cognitive and executive functions, had Hypokinetic dysarthria, absence of Apraxia of Speech, hearing thresholds were within normal limits and were native speakers of Bangla. All the participants were confirmed their diagnosis with six months of onset and were taking Syndopa with same type of doses.

Selection criteria for group-II

All the participants of the group-II had normal hearing, no speech and language impairments, no history of substance use and no history of any sort of medical conditions like hypertension.

Instrumentation

Praat software (version 6.0.49) was used for the LTAS analysis. This particular software gives information about the acoustic analysis of signals in a wide variety of applications including assessment of disordered voice analysis. A high fidelity head mounted electret condenser directional microphone (HP B4B09PA over ear headphone) fitted with 3.5 mm output jack was used for the recording purpose. A 64 bit HP laptop (HP Pavilion Notebook Core i5 5th Generation), Windows 10 with digital sound recording facility was used for recording, tabulating and analysing. The recordings were done at mono recording mode as given in the software. The sampling frequency was fixed at 44100 Hz. The different features of LTAS those are included in the study are mean spectral energy (MSE), first spectral peak (FSP), spectral tilt (ST), and three spectral slope (SS) measures (SSF0-1 kHz, SS1-5 kHz, and SS ratio), four spectral moment analysis (mean, standard deviation, skewness, and kurtosis), jitter, shimmer, pitch profile, amplitude profile and pause.

Stimulus

A topic card was presented to each participant. Their task was to explain the pictures spontaneously by looking at the picture card.

Procedure

The participants were familiarized with the procedure involved in collecting data. A written consent was obtained from the subjects before initiation of the task informing about the detailed methodology, outcome and purpose of the research. The participants were recorded one by one. Each of the participants was asked to explain the picture given to them. They were asked to speak continuously without extraneous pauses. Data for each participant were recorded one by one. The recordings of participants were collected using a high quality unidirectional microphone in an acoustically treated room with low ambient noise, which was fed into the Praat software after being converted into 'wav' file. For all recordings, the mouth-to-microphone distance kept constant at approximately 4-6 cm. Voice recordings were digitized at a sampling frequency of 44100 Hz and 16 bits/sample quantization. Each participant was instructed to perform the following speech task using a speaking rate and loudness that felt most natural i.e. spontaneous speech by seeing the picture card. They were also instructed not to cough or produce any other non-speech sounds at the time of recording which might affect the analysis. The sample of each participant was retrieved separately for the purpose of acoustic analysis. The acoustic analysis was carried out to extract the LTAS parameters. The LTAS analysis was performed by the computer program Praat, version 6.0.49 developed by Boersma and Weenink (2017), Institute of Phonetic Sciences, University of Amsterdam. The analysis was performed with a filter bandwidth of 100 Hz and a frequency range from 0 to 8 KHz. According to Lofqvist (1986), the most important information is concentrated in the frequency range of 8 KHz. The average lengths of each speech sample was around 2 minutes. LTAS values were derived by compiling all the recorded data for each sample all-together and it was further analyzed for understanding different parametric influences for the same sample.

Statistical analysis

All the data were tabulated and statistically computed for the analysis of the data. All the statistical analyses were performed using the software package for the social sciences (SPSS) software version 20.0. Measure of central tendency (arithmetic mean) and dispersion (standard deviation) were undertaken to compare the LTAS parameters.

The data was subjected to Shapiro Wilks test of normality to see if the data follows normal distribution. These results revealed that was significantly deviating from normal distribution with p value of 0.03 (i.e., $p<0.05$).

Therefore, non-parametric statistics was used for the purpose of statistical analysis. Mann-Whitney U test was performed for the comparison of means between the groups. $p<0.05$ was considered as significant.

RESULTS

Mean Spectral Energy (MSE)

Mean value of MSE obtained from 15 patients with PD (group I) was -45.34 dB, median -48.4341 dB and standard deviation 3.27. Similarly, from 15 normal participants of Group-II, mean, median and standard deviation values were -36.85 dB, -37.7335 dB and 2.27 respectively. Mann-Whitney U test for significant difference in mean values of MSE showed p value of 0.000 with Z value of 4.66 which indicated that there is significant difference between the mean values of MSE obtained from group I and II as depicted in Table 1.

First Spectral Peak (FSP)

FSP mean, median and standard deviation obtained from PD patients (group I) were at 92.64 Hz, 108 Hz and 11.1. In case of normal participants, mean, median and standard deviation values were 115.17 Hz, 100 Hz and 10.2 respectively. Mann-Whitney U test revealed p value of 0.001 with Z value of 3.30 as shown in Table 2. Thus, the results indicated that there is significant difference in mean FSP values between the two groups.

Table 1: Comparison of MSE of patients with PD (group I) and age matched normals (group II).

	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
MSE	I	15	8.00	120.00	0.000	4.66	0.000*
	II	15	23.00	345.00			

*p<0.05.

Table 2: Comparison of FSP of patients with PD (group I) and age matched normals (group II).

	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
FSP	I	15	10.00	154.00	34.00	3.30	0.001*
	II	15	20.73	311.00			

*p<0.05.

Table 3: Comparison of ST of patients with PD (group I) and age matched normals (group II).

	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
ST	I	15	20.33	305.00	40.00	-3.00	0.003*
	II	15	10.67	160.00			

*p<0.05.

Table 4: Comparison of SSF0- 1 KHz, SS 1- 5 KHz and SS ratio of patients with PD (group I) and age matched normals (group II).

Parameters	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
SSF0- 1KHz	I	15	15.20	228.00	108.00	-0.187	0.852*
	II	15	15.80	237.00			
SS1-5KHz	I	15	17.47	262.00	83.00	-1.22	0.221*
	II	15	13.53	203.00			
SS RATIO	I	15	17.87	268.00	77.00	-1.472	0.141*
	II	15	13.13	197.00			

*p<0.05.

Table 5: Comparison of SM mean, SM SD, SM skewness and SM kurtosis of patients with PD (group I) and age matched normals (group II).

Parameters	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
SM mean	I	15	11.13	167.00	47.0	-2.71	0.007*
	II	15	19.87	298.00			
	I	15	12.00	180.00	60.00	-2.178	0.029*

Continued.

Parameters	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
SM SD	II	15	19.00	285.00			
SM skewness	I	15	19.80	297.00	48.00	-2.67	0.007*
	II	15	11.20	168.00			
SM kurtosis	I	15	18.67	280.00	65.00	-1.97	0.049*
	II	15	12.33	185.00			

*p<0.05.

Table 6: Comparison of jitter of patients with PD (group I) and age matched normals (group II).

Jitter	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
	I	15	19.00	285.00	60.00	-2.17	0.029*
	II	15	12.00	180.00			

*p<0.05.

Table 7: Comparison of shimmer of patients with PD (group I) and age matched normals (group II).

Shimmer	Group	N	Mean rank	Sum of ranks	Mann-Whitney U	Z	P value
	I	15	19.13	287.00	58.00	-2.26	0.024*
	II	15	11.87	178.00			

*p<0.05.

Spectral Tilt (ST)

PD patients exhibited mean, median and standard deviation values of ST of 0.82, 0.87 and 0.4584 respectively, where as normal participants showed mean, median and standard deviation values of 0.60, 0.57 and 0.5648 respectively. As shown in Table 3, Mann-Whitney U test exhibited p value of 0.003, with Z value of -3.00. The results indicated that there is significant difference in mean values of ST between Group I and II.

Spectral Slope (SS)

SSF0- 1 KHz

From 15 PD patients (group I), it had been seen that mean, median and standard deviation values of SSF0- 1 KHz were -0.001284, -0.00135 and 0.000416 respectively. Likewise, from 15 normal participants of group II, mean, median and standard deviation values were -0.00130, -0.00125 and 0.000341 respectively. As illustrated in Table 4, Mann-Whitney U test showed p value of 0.852, which was greater than 0.05 at 95% confidence interval with Z value of -0.187. As p>0.05 is deliberated to have no significant difference between the values of two groups, thus the results indicated that there was no significant difference in mean values of SSF0- 1 KHz between group I and II.

SS1-5KHz

Further, PD patients exhibited mean, median and standard deviation values of SS1- 5 KHz of -0.000221, -0.00021 and 0.0000842 respectively, whereas normal participants exhibited mean, median and standard deviation values of -0.000241, -0.00023 and 0.00005241 respectively. Mann-Whitney U test showed p value of 0.221, which was greater than 0.05 at 95% confidence interval with Z value of -1.22 as shown in Table 4. Thus, the results indicated that there was no significant difference in mean values of SS1- 5 KHz between group I and II.

SS ratio

From 15 PD patients of group I, mean, median and standard deviation values of SS Ratio were obtained as 6.17, 5.7128 and 1.79 respectively whereas, from 15 normal participants of group II, mean, median and standard deviation values were obtained as 5.32, 5.1371 and 1.04 respectively. Mann-Whitney U test showed p value of 0.141, which was greater than 0.05 at 95% confidence interval with Z value of -1.472 which is shown in Table 4. Thus, the results indicated that there was no significant difference in mean values of SS ratio between group I and II.

Spectral moment (SM)

SM mean

The values of mean, median and standard deviation of SM Mean were 246.08, 283.432 and 151.72 obtained from PD patients respectively and 368.32, 379.5607 and 104.8 from normal participants respectively. Mann-Whitney U test revealed p value of 0.007 with Z value of -2.71 as represented in Table 5. The results indicated that there is significant difference in mean values of SM Mean between group I and II as p<0.05 is considered to have significant difference between two groups.

SM SD

PD patients exhibited mean, median and standard deviation values of SM SD as 321.6, 390.212 and 122.22 respectively. Similarly, normal participants exhibited mean, median and standard deviation values of 518.95, 551.6315 and 151.90 respectively. Mann-Whitney U test revealed p value of 0.029, with Z value of -2.178 which are shown in Table 5. For instance, $p<0.05$ is considered to have significant difference between two groups, thus the results indicated that there was significant difference in mean values of SM SD between group I and II.

SM skewness

The mean, median and standard deviation values of SM Skewness obtained from PD patients (group I) were 7.40, 7.92 and 2.40 respectively. Similarly, the values were 5.22, 4.7 and 1.63 respectively for normal participants. Mann-Whitney U test revealed p value of 0.007 with Z value of -2.67 as indicated in Table 5. The results indicated that there was significant difference in mean values of SM skewness between group I and II, as $p<0.05$ is deliberated to have significant difference between two groups.

SM kurtosis

Mean, median and standard deviation values of SM Kurtosis obtained from 15 PD patients were 124.85, 118.565 and 83.71 respectively. Similarly, from normal participants of group II, mean, median and standard deviation values were 67.38, 44.76 and 54.70 respectively. Mann-Whitney U test revealed p value of 0.049 with Z value of -1.97 and are described in Table 5. The results indicated that there was significant difference in mean values of SM Kurtosis between group I and II, as $p<0.05$ is deliberated to have significant difference between the two groups.

Jitter

Mean, median and standard deviation values of Jitter obtained from PD patients (group I) were 1.86, 0.737 and 1.96 respectively. In addition, the values of mean, median and standard deviation exhibited by normal participants were 0.897, 0.373 and 0.990 respectively. As shown in Table 6, Mann-Whitney U test revealed p value of 0.029 with Z value of -2.17. As $p<0.05$ is deliberated to have significant difference between the values of two groups, thus the results indicated that there was significant difference in mean values of Jitter between group I and II.

Shimmer

PD patients exhibited mean, median and standard deviation values of Shimmer were 11.30, 10.87 and 2.77 respectively. Moreover, from normal participants of group II, mean, median and standard deviation values were 3.45, 9 and 1.77 respectively. Mann-Whitney U test revealed p value of 0.024 with Z value of -2.26 which are shown in Table 7. As $p<0.05$ is deliberated to have significant difference between the values of two groups, thus the results indicated that there was significant difference in mean values of shimmer between group I and II.

DISCUSSION

Mean spectral energy

The patients with PD exhibited lesser MSE values as compared to normals. MSE is correlated with laryngeal muscle tension during phonation.[17,18] The MSE values approaching to zero are associated with increased laryngeal muscle tension and the values that are further from zero are associated to decreased laryngeal muscle tension, the MSE findings are consistent with a conclusion of reduced laryngeal muscle tension during spontaneous speaking task in patients with PD compared to normal participants.[19]

First spectral peak

The mean scores between two groups indicated the first spectral peak in patients with PD is generated faster as compared to normal participants. FSP is the average F0 produced across the speaking sample over the period of time. The F0 indicates how quickly the vocal folds vibrate during phonation and relates to vocal fold stiffness or tension.[17,18] According to frequency-tension formula given.

$$f1 = \frac{\sqrt{\frac{T}{m}/L}}{2L}$$

Where, ‘f1’ represents frequency, ‘m’ represents mass, ‘L’ represents length and ‘T’ represents tension. So, frequency is directly related with tension. The faster occurrence of spectral peak in patients with PD may be due to reduced tension in vocal folds during spontaneous speech task.

Spectral tilt

The mean score of spectral tilt associated with patients with PD is higher than normal participants. The normal participants exhibit spectral tilt at 0.67 (0.10).[19] Lower spectral tilt values are suggestive of vocal fold hyperfunction and higher spectral tilt are suggestive of vocal hypofunction.[11] In the present study, the higher value of spectral tilt allied with patients with PD during spontaneous speech task may be due to hypofunction of vocal folds in these patients.

Spectral slope

The mean values of SSF0-1 KHz, SS 1-5 KHz and SS ratio for PD patients was slightly higher than normals. Electroglottographic studies reported patients with PD exhibit reduced laryngeal muscle tension, which results in bowing of vocal cord.[20] Due to bowed vocal folds, the air escapes along with the phonation during spontaneous

speech tasks may result in higher energy concentration in the speech spectrum as compared to normals. Although, the mean value of SSF0-1 KHz, SS 1-5 KHz and SS ratio for PD patients was slightly higher than normals, the results of Mann-Whitney U test revealed that there were no significant differences in mean values of SSF0-1 KHz, SS 1-5 KHz and SS ratio between two groups.

Spectral moment

The mean values of spectral moment measures revealed lower SM mean, SM SD and higher SM skewness and SM kurtosis for patients with PD as compared to normal participants during spontaneous speech task. The mean values of SM skewness and kurtosis of the present study revealed the patients with PD exhibited more positive values than normal participants. Patients with PD suggested a weakness in the upper harmonics, with the main acoustic power in the voice being concentrated towards the lower frequencies whereas normal participants exhibited a broader distribution of energy across the spectrum. The concentration of energy in the low frequency region exhibited by patients with PD may be due to reduced tension in the laryngeal muscle.

Jitter

The mean jitter values showed patients with PD exhibited higher Jitter values as compare to normal participants. According to Gath and Yair (1988), patients with PD shows voice quality, which is tremulous. More variations in frequency exhibited by patients with PD in the present study may be due to presence of voice tremor. A study was conducted to find out the acoustic voice analysis of patients with PD and they found that there were significant differences in mean values of jitter between patients with PD and normals.[21] Their results are in consonance with the present study that patients with PD showed higher jitter values than normals.

Shimmer

The mean shimmer values suggested that patients with PD demonstrated higher values than normal participants. The most prominent voice characteristics reported to be present in patients with PD are breathy or rough voice quality, decreased loudness, decreased inflection and vocal tremor.[22] The higher shimmer values obtained from patients with PD in this study may be due to tremors present in muscles of vocal cords. The present study finding is in favour of the study done by Jimenez- Jimenez et al (1997) who conducted a study to find out the acoustic voice analysis of patients with PD and they found that there were significant differences in mean values of shimmer between patients with PD and normals. Their results also showed higher shimmer values than normals. For the present study, only 15 patients with PD were chosen. A large number of participants may be considered later to generalize the findings to the broader PD populations. Due to some inevitable barriers, the severity of PD was not taken into consideration which is a major limitation of this study that can be addressed further to analyse the effect of severity on LTAS outcomes.

CONCLUSION

A total of 30 participants aged 50-70 years were considered for the study. These participants were further categorized into two groups. Group-I contained 15 patients with PD and group-II contained 15 age matched normal participants. The acoustic analysis was done to extract the LTAS parameters. The LTAS parameters used in the study were MSP, FSP, ST, three SS measures (SSF0-1 kHz, SS1-5 kHz, and SS ratio), four spectral moment analysis (mean, standard deviation, skewness, and kurtosis), jitter and shimmer. Statistical analysis was done for the analysed data using SPSS software version 20.0. Mann-Whitney U test was performed for the comparison of mean between the groups where $p<0.05$ was considered as significant. Out of seven parameters of LTAS used in the current study, six parameters showed significant difference between two groups. Mann-Whitney U test results showed there was significant difference in mean values of MSE, FSP, ST, four SM measures, jitter and shimmer. However, there was no significant difference in mean values of three SS measures. The significant differences in MSE, FSP and SM parameters between two groups is due to reduced muscle tension exhibited by patients with PD, significant difference in ST is due to hypofunction of vocal folds in patients with PD. The significance in jitter and shimmer between two groups is due to tremor in the vocal cords.

To conclude the study, it can be said that patients with PD demonstrate specific LTAS characteristics that are different from normals. As LTAS gives acoustic information over a period of time and spontaneous speech gives naturalness to speech, acoustic analysis of spontaneous speech through LTAS in these populations has greater clinical relevance.

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