Original Research Paper ENT

Acoustical Analysis of Running Speech in Persons with Parkinson's Disease

Dr. Santosh Kumar | Assistant Professor (Audiology & Speech Therapy), Department of ENT, Himalayan Institute of Medical Sciences, SRHU, Jolly Grant, Dehradun-248016 (Uttarakhand)

ABSTRACT

Parkinson's disease is a progressive motor system disorder due to loss of dopaminergic neurons of the substantia nigra. Dysfunction of the basal ganglia circuitry is the mechanism of Parkinson's disease. The previous studies described a partial response of speech and voice to dopa therapy, it was reported that speech may be related to a non-dopaminergic mechanism. The aim of the present study was to compare the speaking fundamental frequency, speaking fundamental frequency range, and intensity range between persons with PD and normal person. A total of 20 participants (10 persons with PD and 10 normal persons) were selected for this study. Participants have to describe a story "The thirsty crow". Mann Whitney U test revealed significant difference for speaking fundamental frequency between persons with Parkinson's disease and normal persons.

KEYWORDS Speech, Fundamental frequency, Intensity range

Introduction

The speech of Parkinson's disease (PD), although often breathy and of low intensity, does not always demonstrate the changes in a typical rhythmic fashion. Rather, the hypophonia is constant, with exacerbation by the articulatory difficulties and the cognitive problems associated with the disease. However, these changes in Parkinson's disease do not become clinically evident before a 60-80% decrease in dopamine (Bernheimer et al., 1973). Acoustic analysis can be done using method such as spectrographic analysis, inversing filtering, and computer based methods apart from using other instruments, which are economical both in terms of cost and time. Analyses of rate-related variables have been reported in a number of PD speech studies and results indicated either no differences (Goberman, Coelho, & Robb, 2002) or increases (Solomon & Hixon, 1993) in articulation rate. The deficits experienced by persons with PD can also include an increase in mean speaking Fo (Canter, 1963; Metter & Hanson, 1986; Goberman, Coelho, & Robb, 2002). Persons with PD have been noticed to demonstrate vowel reduction but significant differences were not obtained (Goberman, 2000; Weismer et al., 2001). Holmes, Oates, Phyland and Hughes (2000) used MDVP to examine vocal function in 30 persons with early-stage Parkinson disease, 30 persons with later-stage Parkinson disease, and 30 normal persons. Compared to the healthy control persons, both of the groups with Parkinson disease was also associated with high speaking f0 for males, and reduced f0 variability for females. In addition, Ho, Iansek and Bradshaw (2001) reported progressive intensity decay for the tasks of sustained vowel phonation and sentence reading performed by persons with Parkinson's disease.

Persons with PD have been shown to demonstrate reduced fundamental frequency (F0) range and variability during speaking tasks (Flint, Black, Campbell-Taylor, Gailey, & Levinton, 1992). Canter (1965) has noted decreased F0 range during syllable production, and a number of researchers have found decreased F0 range/variability during reading (Flint et al., 1992). Although normal speakers typically demonstrated a high F0 range and variability during speaking tasks, the decrease in F0 variation in persons with PD may reflect a prosodic deficit, corresponding to the perceptual feature of monotonus speech (Canter, 1963). However, Tanaka, Nishio, & Niimi (2011) studied speaking fundamental frequency on 39 idiopathic PD and compared with normal group. Voice samples of passage reading were acoustically analysed with Multi-Dimensional Voice Program software. Result revealed that speaking fundamental frequency was significantly higher in male persons with PD.

Further, not much information is available in Indian context on these parameters in persons with Parkinson's disease. Hence, the present study was taken up with the aim of determining the changes in acoustic parameters in the running speech of persons with Parkinsonism.

Method

The present study was conducted with the aim of determining the speaking fundamental frequency of persons with Parkinson's disease. The study incorporated an Ex-Post facto design where in the persons with Parkinsonism were selected and compared with normal matched subjects.

Participants were divided into two groups: experimental group and control group. Experimental group included 10 persons with PD (5 males and 5 females) in the age range 50-74 years (mean age 61.07 years). All the persons in the experimental group were under medication. The subjects were diagnosed as having Parkinson's disease by a qualified neurologist after MRI/CT scan/other necessary evaluations. The testing was done within 3-6 years of onset of symptoms. The subjects did not present any additional medical or neurological conditions such as cerebrovascular accident that could contribute to the observed speech disorder. None of the subjects presented with a history of hearing loss. As per the medical records and personal history revealed that subject hypertension and diabetes were under control.

Age and sex matched adults with no sensory/ speech /language and hearing problem served as the control group. This was ensured using informal testing of the subjects for speech, language and sensory impairments. Mini Mental Status Examination (Folstein, Folstein & McHaugh, 1975) was administered to rule out cognitive-linguistic deficits, if any.

Participants were informed in detail about the objectives and procedure of the study and their acceptance was documented. Test material used for the study consisted of six sequential picture cards depicting the story of "The Thirsty Crow" served as the test material as this is a familiar story. The data was collected seven hours after the intake of the medicine. The participants were made to be seated comfortably with the head-

phone (facility with microphone) at a distance of 5 cm from the mouth of the participants and it connected to the laptop. The samples were recorded in a quiet environment with no distractions.

The story was narrated to each participant before the recording was done. The story was presented to the subjects in a structured manner i.e., the sentences to be used in describing the story was given to them in the form of simple sentences. This was done for the purpose of maintaining uniformity across the different subjects taken for the study in terms of the sentences used, and to eliminate morphological variability, which would facilitate the comparison between each group. Each subject was required to narrate the story of "The Thirsty Crow" after listening to it. Five sentences which were common in all the samples were selected and were subjected to analysis. The PRAAT software was used for the acoustic analysis. Acoustic analysis was done to extract the parameters such as speaking fundamental frequency, speaking fundamental frequency range, and intensity range.

Results and Discussion

The speech samples were extracted using PRAAT software. Mann Whitney U test was executed as a part of statistical analysis. Figure 1 presents the mean values of the speaking fundamental frequency, speaking fundamental frequency range, and intensity range of normal persons and persons with Parkinson's disease.

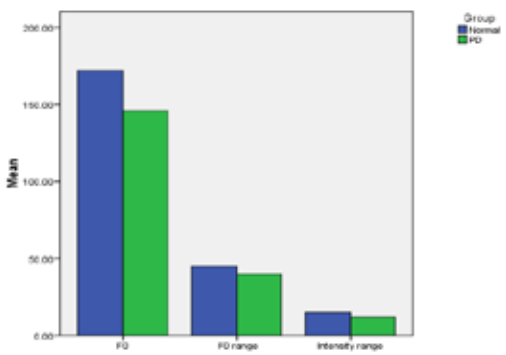

Figure 1: Comparison of mean speaking fundamental frequency & range and intensity range of normal persons and persons with Parkinson's disease.

Mean speaking fundamental frequency were 172.51 for normal persons and for the persons with Parkinson's disease were 146.38. The results of Mann Whitney U test revealed a significant difference between the Parkinson group and normal in terms of speaking fundamental frequency. However, results revealed no significant difference between the Parkinson group and normal in terms of speaking fundamental frequency range and intensity range in speech. The mean speaking fundamental frequency range were 45.08 in normal persons and for the Parkinson's disease group were 40.25. Mean intensity range was 15.13 for normal persons and for the Parkinson's disease were 12.77. The results imply that the persons with Parkinson's disease exhibit differences in speaking fundamental frequency may be due to the inappropriate control of the laryngeal musculature. This might be due to hypokinesia and rigidity of laryngeal and respiratory muscles. Flint et al., (1992) incorporated with the present study. However, Canter (1963) reported that the deficits experienced by persons with PD can include an increase in mean speaking F0.

References

1. Bernheimer, H., Birkmeyer W., Hornykiewicz, O., et al., (1973). Brain dopamine and the syndromes of Parkinson and Huntington. Journal of Neurological Sciences, 20, 425-455.
2. Canter, G. (1963). Speech characteristics of patients with Parkinson,s disease I: Intensity, pitch and duration. Journal of Speech & Hearing Disorders, 28, 221-229.
3. Canter, G. (1965). Speech characteristics of patients with Parkinson's disease II: physiological support for speech, Journal of Speech & Hearing Disorders, 30, 217-224.
4. Flint, A., Black, S., Campbell-Taylor, I., Gailey, G., & Levinton, C. (1992). Acoustic analysis in the differentiation of Parkinson's disease and major depression. Journal of Psycholinguistic Research, 21, 383-399.
5. Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-Mental State": A practical method for grading the mental state for the clinician. Journal of Psychiatric Research, 12, 189-198.
6. Goberman, A. (2000). Acoustic characteristics of Parkinsonian speech before versus after morning medication: The ON and OFF states. Dissertation Abstracts International, 61/08B, 4114.
7. Goberman, A., Coelho, C., & Robb, M. (2002). Phonatory characteristics of Parkinsonian speech before and after morning medication: the ON and OFF states. Journal of Communication Disorders, 35(3), 217-239.
8. HO, A. K., Iansek, R. & Bradshaw, J. L., (2001). Motor instability in Parkinsonian speech intensity. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 14, 109-116.
9. Holmes, R. J., Oates, J. M., Phyland, D. J., & Hughes, A. J. (2000). Voice Characteristics in the progression of Parkinson's disease. International Journal of Language Communication Disorders, 35, 407-18.
10. Metter, E. J. & Hanson, W. R. (1986). Clinical and acoustic variability in hypokinetic dysarthria. Journal of Communication disorders. 19, 347-366.
11. Solomon, N. P., & Hixon, T. J. (1993). Speech breathing in Parkinson's disease. Journal of Speech and Hearing Research, 36, 294-310.
12. Tanaka, Y., Nishio, M., & Niimi, S. (2011). Vocal acoustic characteristics of patients with Parkinson's disease. Folia Phoniatr Logop, ***63(5), 223-230.***
13. Torp, J. N., & Hammen, V. L. (2000). Perception of Parkinsonian speech rate. Journal of Medical Speech-Language Pathology, 8, 323-329.
14. Weismer, G., Jeng, J., Laures, J., Kent, R., & Kent, J. (2001). Acoustic and intelligibility characteristics of sentence production in neurogenic speech disorders. Folia Phoniatrica Logopaedica, 53, 1-18.