Cepstral Analysis of Connected Speech of Hypokinetic Dysarthria and Normal Speakers

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Abstract. The aim of the present study was to investigate the characteristics of hypokinetic dysarthric speech through difference of measured cepstral values of speech assignment between normal adults and patient's with Parkinson's disease in Korea. Subjects of the study were 17 males with Parkinson's disease and control group was 28 healthy male adults without cranial nerve damage or disorder. The cepstral analysis was used to Analysis of Dysphonia in Speech and Voice Model 5109. As the result of independent t-test, there was significant difference in CPP, L/H ratio and CSID of sustained vowel phonation between groups. Based on the results of this study, analysis on connected speech other than sustained vowel phonation is essentially required in order to precisely identify the speech characteristics hypokinetic dysarthria.

Keywords: Parkinson's disease, Cepstral analysis, Connected speech

1 Introduction

Treatment of Parkinson's disease generally focuses on maintaining functions in order for patients to keep ordinary life by relieving degenerative symptoms. Especially, since communication ability is essential in the interaction with other people and affects quality of life, it is important to investigate characteristics of hypokinetic dysarthria to enhance the quality of life of the patients with Parkinson's disease.

As the result of study on the speech characteristics of hypokinetic dysarthria, major characteristics reported were monopitch, reduced stress, monoloudness, imprecise consonants, inappropriate silences, harsh voice, breathy voice and variable rate [1]. These results, however, mainly reflect auditory-perceptive characteristics and have following limitations. First, although auditory-perceptive assessment is mainly used as method of evaluating speech characteristics of Parkinson's disease, this assessment lacks reliability and validity [2]. Second, most of the preceding studies which

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acoustically analyzed Parkinson patients' speech excluded severe cases of Parkinson's disease from their researches, which make them difficult to interpret as general characteristics of Parkinson's disease [3]. Third, there is lack of studies on Korean speakers with Parkinson's disease. Fourth, although preceding studies reported speech characteristics in vowel prolongation task [4], it is difficult to find out precise speech characteristics of Parkinson's disease with vowel prolongation task alone. Especially, even though these studies used Multi-Dimensional Voice Program (MDVP) as a measuring tool, MDVP can draw out reliable results only in the case when subjects can pronounce vowel for more than 3 seconds and what is more, its reliability decreases for aperiodic voices [4]. Therefore, reliable acoustic analysis is required which includes irregular voices.

This study investigated the characteristics of Parkinson's disease patients' speech through difference of measured cepstral values of speech assignment between normal adults and patient's with Parkinson's disease in Korea.

2 Methods

2.1 Subjects

Subjects of the study were 17 males with Parkinson's disease and control group was 28 healthy male adults without cranial nerve damage. They were given sufficient explanation regarding the purpose and experimental method of this study before participating and gave voluntary consent. Standard for Parkinson's group were those who passed more than 2 years after the breakout of the disease with stage 3 or lower in Hoehn-Yahr scale [5] and without stroke or depression.

2.2 Measurements

This study used Analysis of Dysphonia in Speech and Voice (ADSV) Model 5109 of KayPENTAX Corp. for recording (Fig 1). During collection of data, distance of 5cm was maintained between microphone and mouth. As for recording environment, sampling rate was set in 44,100 Hz and quantization in 16bit.

Major measuring indexes included CPP (dB), L/H ratio (dB), CPPF0 (Hz), CSID.

2.3 Analysis

For natural voice production of vowel, subjects were asked to utter their names and comfortably pronounce vowel /a/ for 5 seconds and repeated it twice. By referring to preceding studies [6], connected speech was collected by using a 4-syllable Korean sentence of "Onul kalga naeul kalga?".
Difference of measured value between the groups was confirmed with independent t-test.

Fig. 1. Analysis of dysphonia in speech and voice

3 Results

As the result of independent t-test, there was significant difference in CPP, L/H ratio and CSID of sustained vowel phonation between groups. In CPP, Parkinson's disease patients were 11.3dB while normal adults were 14.1dB and in L/H ratio, Parkinson's disease patients were 28.5dB while normal adults were 33.3dB, showing that normal adults were much higher than Parkinson's disease patients (p<0.05). In CSID, Parkinson's disease patients (8.3) were significantly higher than normal adults (-1.5) (p<0.05). In CPPF0, there was no significant difference between the two groups. In connected speech, all the measured values have no significant difference between the two groups except CPP. Normal adults (8.8dB) had significantly higher CPP than Parkinson's disease patients (7.1dB) (p<0.05).

4 Discussion

In connected speech of this study, there was no significant difference in the value of L/H ratio (dB) between groups, which is deemed to be the result of respiratory characteristics caused by the length of speech of Parkinson's disease patients. In a preceding study which analyzed the characteristics of Parkinson's disease patients' passage reading [7], Parkinson's disease patients had significant less syllables per breath than normal adults and short time to produce speech. In addition, in sentence reading assignment, Parkinson's disease patients had inappropriate stop in respiration, which caused inappropriate silences as well [8]. This study, however, used a short sentence with 4 syllables for connected speech assignment and 'pause' was excluded in the process of analysis. Therefore, it is supposed that, inappropriate respiration and
resulting dysphonia were not observed in Parkinson’s disease patients in connected speech assignment which used a short sentence unlike in preceding studies [7, 8].

In sum, Parkinson’s disease patients had difference in speech characteristics depending on speech assignment (sustained vowel phonation, connected speech).

References