Acoustic characteristics of vowel sounds in patients with Amyotrophic lateral sclerosis

Sunghyoun Cho¹, Haewon Byeon*²

¹ Department of Physical Therapy, Nambu University, Gwangju 506-706, Republic of Korea
E-mail: shcho@nambu.ac.kr

² Department of Speech Language Pathology & Audiology, Nambu University, Gwangju 506-706, Republic of Korea
E-mail: byeon@nambu.ac.kr

Abstract. The aim of the present study was to investigate the difference between measured spectral and cepstral values of normal adults and those of Amyotrophic lateral sclerosis (ALS) speakers in Korea. Subjects were 8 women with ALS and 20 normal women with no difficulty in physical activities as control group. As the result of independent t-test, measured spectral and cepstral value had significant difference in F₀, SPI, jitter, NHR, CPP, L/H ratio, and mean CPP F₀ between groups (p<0.05). ALS had higher score of jitter, shimmer and NHR which reflect voice quality than normal adults due to weakening of respiratory and vocalization muscles.

Keywords: Amyotrophic lateral sclerosis, Cepstral analysis, Spectral analysis

1 Introduction

Since cause of ALS has not precisely elucidated yet and there is no known treatment so far, understanding the characteristics of the subjects and management of general symptoms becomes the principle of treatment. Therefore, purpose of treatment of the disease is to prevent complications and enhance quality of life through comprehensive management of symptoms such as rehabilitation therapy, kinesitherapy, respiration management and nutrition management [1-2].

Communication capability is essential in the interaction with other people and has great effect on the quality of life. Especially, nonlinguistic messages such as voice, quality and accent take up a large proportion of communication and ALS patients tend to avoid social relationship due to their speech problem [3-4]. Thus, assessment on the characteristics of abnormal speech of ALS becomes important.

This study investigated the difference between measured spectral and cepstral values of normal adults and those of ALS speakers in Korea and provides basic material for characteristics of ALS speech.

* Corresponding author
2 Methods

2.1 Subjects
Subjects were 8 women with ALS (average age: 52.5±3.1) and 20 normal women (average age: 52.1±2.5) with no difficulty in physical activities as control group.

2.2 Tools
This study used Multi-Dimensional Voice Program (MDVP) Model 5105 and Analysis of Dysphonia in Speech and Voice (ADSV) Model 5109 of Kay PENTAX Corp for recording and analysis (Fig. 1).

![Fig. 1. Analysis of Dysphonia in Speech and Voice](image)

2.3 Analysis
For natural voice production, subjects were asked to utter their names and comfortably pronounce vowel /a/ for 5 seconds and repeated it twice. If the subjects could not sustain vowel /a/ for 5 seconds, they were asked to produce the sound as long as they could.
IBM SPSS version 22.0 (IBM Inc., Chicago, Illinois, USA) was used for all analyses and significance level was 0.05 in two-sided test.

3 Results

As the result of independent t-test, measured spectral value had significant difference in fundamental frequency ($F_0$), soft phonation index (SPI), jitter, shimmer and noise to harmonic ratio (NHR) values ($p<0.05$).

As the result of Pearson's correlation analysis, measured cepstral value and spectral value had significant correlation. Jitter ($r=-.745$, $p<0.05$), NHR ($r=-.799$, $p<0.05$) of CPP and measured spectral value had significantly negative correlation and especially, CPP and shimmer had highly negative correlation ($r=-.831$, $p<0.05$).

4 Conclusion

As the result of investigation on the relationship among measured cepstral values and spectral values, there was significant negative correlation between CPP and jitter, shimmer and NHR, which is the result of the fact that jitter, shimmer and NHR are the variables based on cycles because CPP responds well to periodic signals [5]. As MDVP's perturbation analysis automatically analyzes voice based on algorithm, it does not have problem in analyzing perturbation of normal adults' voices but has difficulty in analyzing periodicity of perturbation of vocal cord in the case of voice with quite irregular vibrations of vocal cord [5]. Thus, in order to analyze periodicity of changeable voices such as ALS, using measured cepstral value would be more effective than spectral value.

In sum, ALS had higher score of jitter, shimmer and NHR which reflect voice quality than normal adults due to weakening of respiratory and vocalization muscles.

References