Effect of deep brain stimulation on acoustic speech parameters in patients with Parkinson's disease

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Introduction

Impairment of speech can affect almost 89% of patients with Parkinson's disease (PD) (Logeman et al, 1989). The speech of PD patients is described as hypokinetic dysarthria and an extensive range of perceptual acoustic and physiological studies have been devoted to its analysis.

Today, bilateral subthalamic nucleus deep brain stimulation (STN-DBS) is considered as the main surgical management approach for patients with PD. Tripoliti et al (2006) compared the effects of STN-DBS and medical (drug) treatment versus medical (drug) treatment alone over one year. They reported that the STN –DBS group improved the intensity of sustained phonation and the mean of long-term average spectrum of the monologue and reading sentences over one year while the medical group not. Both groups did not show an improvement on sentence intelligibility scores. This study was among the first to report changes in acoustic properties of speech, but the detailed nature of these changes and its relation to articulatory and cognitive executive functions has not been investigated.

In this presentation we report the preliminary results of seven cases patients with PD before and six months after surgical STN-DBS treatment, where we study in detail the acoustic properties of their speech in relation with articulatory and other cognitive motor executive tasks.

Method

Seven patients with PD (N= 7, mean age= 68.3 years), part of a larger trial, were recruited in the Department of Neurosurgery, Medical School, University of Athens, Greece. During the surgical procedure patients were implanted bilaterally with quadripolar electrodes model 3389 Medtronic. The postoperative neurological management involved progressive adjustment of the stimulation parameters and a parallel decrease of medication. The aim was to provide maximum overall therapeutic effect with minimum side effects.

Patient assessment: Patients were assessed 3 days before the surgical procedure "on medication" state and six months post operation (when their stimulator was fully regulated) "on stimulation" state. The assessment protocol consisted of number of tests. For cognitive executive measures, a motor time reaction task (press a button when see a light), a speech/ phonation reaction task (say /a/ when you see a light), and a cognitive executive function construction task were used. For articulatory functioning, the Greek version of Frenchay Dysarthria Assessment (FDA)was used. For acoustic measures and rate of speech we used the following tasks: sustained phonation, reading a list of words, reading texts, and one minute monologue describing the cookie theft picture of BDAE. The word list used for reading consisted of 40 words. The first ten words were chosen to contain the five Greek vowels /a, i, o, u, e/ between plosive sounds in the following conditions: open and closed syllables, stressed and unstressed. So for each vowel, data were collected in the following condition: open syllable stressed, open syllable unstressed, closed syllable stressed, closed syllable unstressed. The remaining 30 words were chosen to start with the six plosive consonant sounds /p,b,t,d,k,g/ followed by the five Greek vowels to measure voice onset time. The speech analyzer program was used for the recording and a home made program to measure the reaction time. All patients gave inform consent to participate in the study.

Data analysis: For the analysis of the recorded data we used the Praat program. For the statistical analysis the Wilcoxon Signed Ranks Test was used

Results

Articulatory and speech functions: There were no significance differences in any tasks of the articulatory functions as they are assessed by the FDA and in the speech rate during reading or speaking. However, post operatively a great variability among the subjects is observed compared to before the operation condition as the standard deviation observed was greater.

Acoustic measures: There were no significant differences in any of the acoustic measures which were evaluated with our protocol including, vowel duration in stressed and unstressed syllable, vowel pitch, F1, F2, F3, voice onset time, jitter, shimmer, speaking and reading pitch. However not differences in variability as seen with articulatory functions were observed.

Cognitive executive functions: There was a significant delay in the speech/phonation reaction time in the post operation condition comparing to the before operation condition ($z=2{,}201$, $p=0.016$) but not in the motor reaction task or in the other cognitive executive task. The variability among subjects observed in the articulatory functions was evident in these tasks too.

Discussion

Our data from seven patients demonstrated that there were no significant changes in the articulatory, speech and acoustic properties of speech in PD patients who have undergone STN- DBS treatment to improve their motor function. However, cognitive tasks related to speech have deteriorated post operation suggesting that the changes in speech reported elsewhere could be related not to acoustic properties of speech itself but to the cognitive functions related to speech. The discrepancy between the acoustic properties of speech and the cognitive speech related task still remains unclear but it could be associated to the neural pathways underline the speech mechanisms and the changes induced through the STN-DBS in these pathways. This has to be tested in further studies.

References

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