Finding the Optimal Deep Brain Stimulation Settings for Tremor Using Quantitative Finger Tapping

Mehmet C. Berk MD; David P. Lenar; Kim J. Burchiel MD; Valerie C. Anderson PhD

Department of Neurological Surgery, Oregon Health and Science University, Portland, Oregon, USA

CONGRESS OF NEUROLOGICAL SURGEONS
2011 ANNUAL MEETING
WASHINGTON, DC
OCTOBER 1-6, 2011

Introduction

Deep brain stimulation (DBS) of the ventral intermediate (Vim) thalamus is an effective treatment for medically refractory essential tremor (ET). However, there is no consensus on optimization of the DBS parameters required for successful long-term management of tremor. In this study, we investigated the suitability of quantitative finger tapping (QFT) to monitor tremor response to DBS parameter changes and to determine the optimal parameters for Vim DBS in ET patients.

Learning Objectives

The effects of deep brain stimulation parameters on tremor control in ET patients.

Methods

Response of tremor to unilateral Vim DBS was evaluated by QFT and clinical rating at nine frequency/pulse width (PW) combinations, in 15 ET subjects who were blinded to test settings, that were programmed in random order. Clinical rating was based on a 5-point clinical rating scale (CRS) in which 0=no tremor, and 4= severe/disabling tremor. Ratings were performed with: (1) arms and hands extended, (2) arms in flexion and hands in front of face, (3) repetitive finger-to-nose movement, and (4) while raising a cup to mouth level. The total CRS score was defined as the sum of ratings of all tasks (range 0-16). A postural subscale was defined as the sum of tasks (1) and (2), (range 0-8).

QFT was performed at each setting using an electronic keyboard with MIDI technology and interfaced to a PC. Subjects were seated at a waist-high table with their arm flexed to about 90 degrees at the elbow, and wrist resting on a firm pad that was level with the keyboard. Using the index and middle finger of the affected hand, subjects were asked to tap two adjacent keys alternately, without stopping and without taking their wrist off the pad. For each key-strike, the time at which the key was depressed and released and the velocity of the strike were recorded.

Three 30-second trials were performed for each setting combination. Subjects were instructed to perform the task as quickly as possible, while keeping the tapping as regular as possible.

Tapping data were analyzed using custom software (MATLAB) that allowed independent analysis of keystrike duration and the intertap interval. Analysis was performed over the middle 15-seconds of each 30-second trial. Tapping coefficient of variation (CV) varied by less than 2% among trials and was assessed for each subject as the mean of all three trials.

Primary outcomes were tremor severity, defined by the total CRS score, and regularity of keyboard tapping, as defined by the CV of the intertap interval.

Statistical analyses were performed using JMP 7. Values greater than three times the interquartile range were excluded. P values were calculated at the 0.05 significance level in two-tailed tests. No corrections for multiple comparisons were applied.

Results

Results are shown in Figure 1.

Compared to no stimulation, tapping variability was reduced by 37-50%, and total CRS score by 22-54% when DBS was activated.

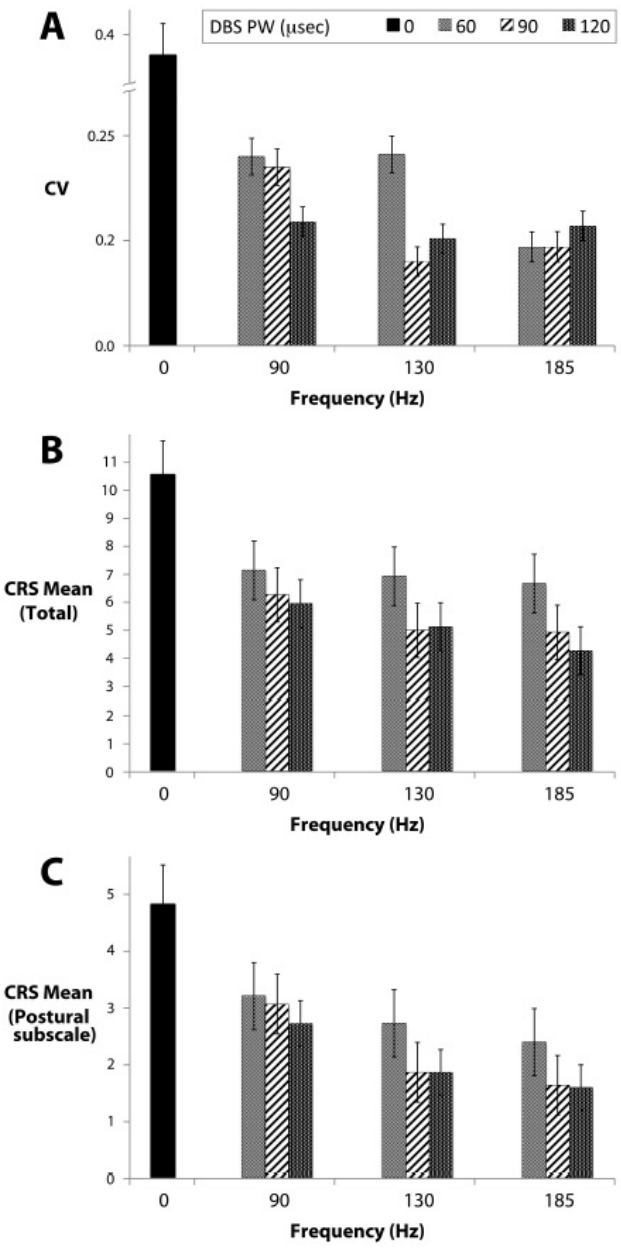
QFT showed reasonable sensitivity to changes in frequency and PW and identified the same 'optimal' settings as the CRS postural tremor score in 7/15 subjects.

Conclusions

In ET patients treated with DBS, QFT provides a sensitive, reproducible measure of tremor response to changes in stimulation frequency and PW.

If verified in a larger sample, QFT may be a quick and useful adjunct during DBS programming, especially when postural tremor is a major feature of the disease.

Figure 1



Mean (A) tapping CV, (B) total clinical rating scale (CRS) score, and (C) CRS postural tremor score for frequency/PW combinations. (error bars: SEM)