INTRODUCTION

Current techniques for assessing tremor in multiple sclerosis (MS) patients involve use of clinical scales, which can be both subjective and unreliable. In order to more completely understand and assess treatments for MS patients, the tremor needs to be more objectively quantified. Methods for tremor measurement proposed to date typically have constrained the observed limb (Liu et al, 1997 and Elble et al, 1996). The purpose of this study was to develop a method for quantifying unconstrained tremor.

PROCEDURES

Ten outpatients (mean age = 44) diagnosed with either clinically definite MS or laboratory-supported definite MS were used in this study. Additionally, eight healthy subjects (mean age = 34) free from neurological deficits were also evaluated to assess the reliability of the technique and establish baseline numbers for “normal” amounts of tremor. All subjects were tested on two separate days. A three-dimensional magnetic tracking device (Flock of Birds, Ascension Technologies, Burlington, VT, USA) was attached to the subject’s dominant hand. Subjects were seated at a table with four target markers (the Left, Right and Far markers were on the tabletop, while the Near marker was elevated above the surface to chin-level). Position data was recorded at 144 Hz as a subject reached in turn between the left and right markers (LR reaches), as well as the the far and near markers (FN reaches). Each reach was performed and recorded ten times.

Hand position data was filtered with a fourth-order low-pass butterworth filter with a cutoff frequency of 10 Hz. Hand velocity was calculated using a central-difference formula. A 512-point Fast Fourier Transform (FFT) was calculated for each of the three orthogonal directions (with zero padding for files that required it). Power Spectral Densities (PSDs) were calculated from the FFTs. Mean spectra were calculated by averaging the PSDs for ten trials from each direction of reach, and the peak power of the modal frequency was extracted. The power level for each velocity component was then categorized as being either Intended (in the direction of the reach defined by the target markers) or Unintended (in the plane normal to the Intended direction). The total Unintended Velocity Power (UVP) was given by the vector summation of the modal frequency powers of both Unintended directions.

RESULTS

Figure 1 shows characteristic PSDs for A) Normal and B) MS subjects. UVP was between 20 and 40 times larger on average for MS patients than for normal controls.

Intravisit comparisons for both normal controls and MS patients revealed no significant differences in the UVPs (see Table 1), proving the repeatability of the test.
UVPs for the MS patients were compared to those of the normal subjects for each direction of reach using all responses. As shown by Figure 2, the groups are clearly separable, exhibiting large significant differences for both LR and FN reaches (Wilcoxon Rank Sums test, $p<0.0001$ and $p=0.0001$, respectively).

![Figure 1: 3-orthogonal PSD components of velocity for A) normal and B) MS subjects.](image)

![Figure 2: Quantile box plots depicting the differences in UVP of MS and normal subjects for A) LR and B) FN reaching.](image)

**DISCUSSION**

Vector summation of the peak powers of the modal frequency of hand velocity data is capable of quantifying the levels of patient tremor. Testing is repeatable and shows significant differences where they exist. This type of evaluation will be useful in more completely and precisely defining the severity of tremor, while avoiding error due to observational subjectivity.

**REFERENCES**

Liu et al. (1997). Mov Disord, **12**, 992-999.


**ACKNOWLEDGEMENT**

Support provided by the Mayo Foundation.