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Short Communication

Bradykinesia in patients with essential tremor

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ABSTRACT

We compared the level of bradykinesia during rapid alternating movements (RAM) in patients with essential tremor (ET) with that of patients with Parkinson's disease (PD) having either the "tremor dominant" or "akinetic-rigid" form of PD, and 10 healthy controls. We found an increase of pronation–supination cycle duration in the PD and ET group, suggestive of bradykinesia. RAM range was, however, similar between groups. The akinetic-rigid group showed a distinct increase in RAM amplitude fluctuation, suggesting that rigidity modified the characteristics of the observed bradykinesia. In conclusion, slow movements should then be considered as part of the ET symptomatology.

There is currently a debate on whether patients with essential tremor (ET) have slowed movements as part of their etiology. For instance, Montgomery et al. (2000) detected slowness of movement in patients with ET, during a fast wrist flexion/extension to target following a "go" signal. For that particular task, patients with ET had performance levels comparable to that of patients with mild Parkinson's disease (PD). More recently, a study by Ozekmekci et al. (2005) challenged the idea that patients with ET may present with typical bradykinesia seen in patients with PD. Their argument was based on the fact that, during movement initiation, the tremor of patients with ET may interfere on the motor act by increasing attentional demands or by delaying movement. In this case, ET would have a "mechanical" effect on motor performance rather than that of neural-network-induced (e.g. basal ganglia) bradykinesia. Note that both the Montgomery et al. (2000); Ozekmekci et al. (2005) studies used externally guided, target-directed movements to assess the level of bradykinesia. We believe that a rapid alternating movement (RAM) task, such as fast pronation–supination at the wrist, may provide a measure of bradykinesia without the speed/accuracy tradeoff strategies associated with target-directed movements that may confound the results. Furthermore, the signal-to-noise ratio of the RAM task (where the signal is the voluntary motor command and the noise represents the tremor) is very high, reducing the "mechanical" influence of tremor on movement. RAM tasks have been used successfully in the past to measure slowness of movement in different populations (Okada and Okada, 1983; Beuter et al., 1999; Duval et al., 2001, 2006). Accordingly, the goal of the present study was to assess the level of bradykinesia in patients with ET using a rapid alternating task. We compared their motor performance with that of patients with mild to moderate PD, having either the tremor-

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dominant or the akinetic form of the disease, and with healthy control subjects.

Ten patients who were previously diagnosed with essential tremor (ET), according to the ET criteria (Elble, 2000), were recruited for the study, along with two groups of ten patients diagnosed with Parkinson's disease (PD). These patients were either in the mild or moderate stages of PD (1 to 3 on the Hoehn and Yahr scale). The first group, named the RPD group, had predominant rigidity (more than 1.5 on the Unified Parkinson's Disease Rating Scale [UPDRS]), without the presence of clinically detectable tremor. The second PD group, named the TPD group, had typical parkinsonian tremor that was clinically detectable, but with little rigidity (less than 0.5 on the UPDRS scale). Patients showing signs of advanced PD such as motor fluctuations, dyskinesias or freezing episodes were not included in the study. Finally, ten age-matched control subjects were also asked to participate. Patients with PD were asked to refrain from taking their anti-parkinsonian drugs and patients with ET from taking their tremor suppressing drugs 12 h prior to testing. In all cases, testing occurred in the morning. The Internal Ethics Review Board approved the experimental design, and subjects provided written informed consent.

Tremor of the relaxed hand was recorded in patients with PD and control subjects using a laser displacement sensor (Duval and Jones, 2005; Duval et al., 2000, 2001, 2006). For the ET group, postural tremor was recorded. Here, the goal was simply to confirm, using clinical and physiological measures, the proper separation of groups within the patient population tested. Tremor was recorded on the side of the body most affected by their disease (determined by asking the patients, and confirmed by clinical observation). In all but three cases, the dominant hand was tested. Using a well-defined methodology (Duval and Jones, 2005; Duval et al., 2000, 2001, 2006), we examined tremor amplitude (root mean square of the signal) and power dispersion (width of a frequency band containing 68% of the power centered at the median power frequency).

Following tremor recording, RAM performance was quantified in patients and control subjects using a pronation–supination task. Subjects remained seated and their elbow rested on the foam-padded support. They were instructed to perform pronation–supination movements with the largest excursion possible, and as quickly as possible for 7 s while holding a small handball connected to an angular displacement sensor. Actual recording began approximately 1 s after movement initiation to ensure that the initiation component was not part of RAM performance analysis. Note that none of the patients had difficulty initiating movements. RAM data were sampled at 2 kHz and five trials were recorded, separated by a one-minute rest period.

RAM data in voltage were subsequently transformed into degrees and reduced to 100 Hz. Power related to frequencies below 0.1 Hz and above 10 Hz was set to zero. RAM signal peaks were first identified using an automated algorithm. Next, three RAM characteristics were computed: (a) mean duration of a full cycle of pronation–supination in seconds, a high value of this indicates the presence of bradykinesia; (b) mean angular displacement over a full cycle of pronation–supination in degrees, a low value indicates the presence of hypokinesia: finally, (c) RAM cycle amplitude irregularity score, obtained by calculating the standard deviation (SD) of the linear envelope from the normalized pronation–supination trace (mean of zero and SD of one). A high value here indicates more variability in RAM amplitude, hence more irregular movements.

A Kruskal–Wallis one way analysis of variance (*ANOVA*) on ranks was used to compare tremor and RAM characteristics between groups. When needed, a multiple comparison test, namely the Tukey *post hoc* analysis, was used to determine which groups showed statistically different tremor or RAM characteristics. Finally, we used a Spearman's rank correlation to assess the relationship between disease duration and RAM performance. The threshold for statistical significance for each of the above statistical tests was set at $p<0.05$.

Subgroup descriptions such as mean age, years since diagnosis and stages of disease are shown in Table 1.

In order to account for the possibility that disease duration influenced the RAM performance, a correlation was performed between RAM performance and disease duration of all patients with PD who participated in the present study. Results indicate that disease duration was weakly correlated with RAM performance duration: −0.12, $p>0.05$; range: −0.12, $p>0.05$; amplitude irregularity: 0.45, $p<0.05$), suggesting that differences in disease duration had little effect, if any, on RAM performance. This is certainly due to the fact that only patients with mild to moderate PD were selected for the present study.

Fig. 1 shows the mean tremor amplitude and power dispersion from each subgroup of patients and control subjects. *ANOVA* on Ranks reveals a group effect for amplitude ($H=33$, $p<0.05$) and power dispersion ($H=18$, $p<0.05$). *Post hoc* analysis reveals that the TPD group has significantly higher

Table 1 – Patients description

Groups	Men/Women	Mean age	Years since diagnosis	Stage (Hoehn and Yahr)	P/S score (UPDRS)
TPD	6/4	60±19 SD	8.3±7.6 SD	2.2±2.5 SD	1.8±2.0 SD
RPD	7/3	61±19 SD	9.8±8.1 SD	2.1±2.5 SD	2.4±2.9 SD
ET	6/4	58±14SD	9.1±7.2 SD	–	–
Controls	6/4	60±21 SD	–	–	–

No statistical differences were found when age (ANOVA; $H=1$, $p>0.81$), stage of disease ($H=2$, $p>0.05$) or duration of disease ($H=2$, $p>0.05$) were compared between PD groups. Rigidity scores in the RPD group ranged from 1.5 to 3.5 on the Hoehn and Yahr scale (mean of 2.5). TPD: patients with PD having high amplitude tremor; RPD: patients with PD having rigidity; P/S: pronation–supination; UPDRS: Unified Parkinson's disease ration scale; SD: standard deviation.