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Sensitivity and specificity of the finger tapping task for the detection of psychogenic movement disorders☆

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ABSTRACT

Psychogenic movement disorders (PMD) represent a diagnostically challenging group of patients in movement disorders. Finger tapping tests (FTT) have been used in neuropsychiatric evaluations to identify psychogenic conditions, but their use in movement disorders has been limited to the quantification of upper extremity disability in idiopathic Parkinson disease (IPD). We evaluated the ability of the FTT to objectively identify PMD by screening 195 individuals from a movement disorder clinic with IPD, dystonia, essential tremor, or PMD and compared them to 130 normal adults. All subjects performed six-30 s trials using alternate hands. We compared mean FTT score and the coefficient of variation between diagnostic groups. FTT scores in IPD were inversely correlated with Hoehn and Yahr stage ($p < 0.001$) and the United Parkinson Disease Rating Scale III (motor) subscale ($p < 0.001$). FTT scores were significantly lower in PMD (mean = 41.72) when compared to the other diagnostic groups after controlling for age. The coefficient of variation was not significantly different between diagnostic groups. ROC analysis identified a cutoff FTT ratio of 0.670 or less was 89.1% specific and 76.9% sensitive for the diagnosis of PMD. We conclude the FTT can provide supportive evidence for the diagnosis of PMD.

1. Background

Psychogenic movement disorders (PMD) represent 3% of all movement disorder clinic patients [1]. While this represents a small percentage of the total clinic population, PMD patients are diagnostically challenging cases and can require a disproportionate amount of clinic resources and health care dollars [2,3]. In 1988, Fahn and Williams [4] proposed criteria for PMD categorizing patients based upon their clinical history and exam findings. This classification has been revised by subsequent authors [5–7] but to date there are no reliable, objective means of identifying a potential PMD in a clinic based setting.

Finger tapping tests (FTT) provide an objective measure of upper extremity fine motor skills and are a core component of neuropsychiatric testing for a variety of neurological illnesses including movement disorders, psychogenic conditions, and malingering [8–12]. FTTs also have a long history of use in movement disorders [13–16]; however, they have primarily been used to quantify the upper extremity impairment in patients with idiopathic Parkinson disease (IPD). Multiple authors have demonstrated FTTs inversely correlate with United Parkinson Disease Rating Scale III (motor) subscale (UPDRS III) [17] scores when adjusted for age [14,15,18]. No studies to date have looked at FTT scores in patients with PMD.

In neuropsychiatric testing, high variability and inconsistency between trials are considered an indication of malingering or psychogenicity [11,19,20]. Malingering is defined as purposefully exaggerating a physical symptom for a clear goal while psychogenicity concerns a broader group which may include malingering patients but also those with somatoform and conversion disorders demonstrating non-organic symptoms with no clear secondary objective [21]. FTTs are consistently reduced and more variable in both malingering and psychogenic disorders [8–11]. Arnold et al. compared FTT scores in subjects with suspected malingering to subjects with a variety of neurological illnesses including closed head injury, dementia, and depression. They found subjects with suspected malingering performed the FTT more slowly than their comparison group counterparts regardless of the neurological diagnosis [8]. Similarly, another study found naïve and coached malingerers performed significantly slower than control subjects

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on FTT [9]. Even pseudoseizure patients demonstrated scores in the impaired range on the FTT component of the Halstead-Reitan Neuropsychological Test Battery [11,22]. Matheson et al. devised a unique technique to measure the inconsistency in patients with non-organic symptoms and suspected malingering by examining the coefficient of variation (CV) between test trials [20]. Given the slow and highly variable FTT scores across groups with psychogenic disorders and malingering, we hypothesized that PMD patients would similarly demonstrate lower FTT scores and large CVs between trials when compared to patients with other common movement disorders.

2. Methods

2.1. Subjects

This study was approved by the Washington University School of Medicine Human Research Protection Organization. Subjects were recruited from the Washington University in St. Louis Movement Disorder Center between June 2006 and October 2008 and signed informed written consent. The sample consisted of 325 individuals divided into five groups: (a) IPD, (b) essential tremor (ET), (c) dystonia, (d) PMD, and (e) healthy adult controls. All subjects were evaluated and diagnosed by a movement disorder specialist. IPD patients were all classified as probable Parkinson's disease according to the United Kingdom brain Bank clinical criteria [23] and evaluated in the ON state. Dystonic subjects demonstrated the following patterns of primary dystonias: 18 cervical, 1 oromandibular, 4 blepharospasm, 2 craniocervical, 2 generalized, and 5 brachial (writer's cramp) [24]. All PMD patients were categorized as clinically established psychogenic movement disorders according to the Fahn and Williams classification defined as inconsistency (we included distractibility) or incongruity in the movement with one of the following: other neurologic signs that are definitely psychogenic, multiple somatizations, or an obvious psychiatric disturbance [4]. PMD movements were categorized using the criteria proposed by Hinson et al. [25]. In addition, three patients with paroxysmal movements also had video EEG monitoring with no electrographic correlate to their movements. All tremor patients were categorized as classic ET using criteria established by the consensus statement of the movement disorder society on tremor [26]. Control subjects were recruited from the healthy spouses and family members of patients seen in the movement disorder Center. All controls were screened for tremor and parkinsonism by a movement disorder specialist using the UPDRS III. Control subjects were excluded if they had a total UPDRS III score > 3 or rest, postural, or action tremor ≥ 1.

2.2. Procedure

Handedness was determined from patient self-report. Finger tapping equipment consisted of a counter with two levers spaced 20 cm apart [27]. Each subject completed three-30 s trials for each hand starting with the dominant side and then alternating between hands. For each trial subjects were instructed to use the index finger of the indicated hand to alternate tapping between the two levers as many times as possible in the 30 s period. Scores were recorded for each 30 s trial. Mean tapping scores were calculated by averaging the 30 s trial scores. The CV was calculated as the quotient of the standard deviation divided by the mean. Mean tapping scores and CVs were calculated for dominant hand trials, non-dominant hand trials, and the combination of both hands (combined scores).

2.3. Statistical analysis

The difference in age between the five categories was analyzed using ANOVA. If the ANOVA demonstrated an overall significance at $p < 0.05$, a Scheffe test was used to examine the differences between diagnostic groups. A Fisher's Exact test was used to analyze the differences in gender between diagnostic categories. The relationship between age and FTT scores and age and CV were examined by Pearson's correlation. If the overall Pearson's correlation was significant at $p < 0.05$, correlations were analyzed for individual subgroups. The overall effect of gender on FTT score and CV was examined by Student's t-test. If the Student's t-test was significant at $p < 0.05$, t-tests were performed on individual subgroups. Associations between the Hoehn and Yahr stages [28] (H&Y stage), UPDRS III, FTT scores, and CV within the IPD group were analyzed by Pearson's correlation. ANOVA analysis was used to examine the differences in FTT scores between H&Y stages. If the ANOVA was positive at $p < 0.05$, Tukey's HSD post-hoc analysis was used to further examine the relationship between stages. The ANOVA and Tukey's analysis were also used to examine differences in FTT scores and the CV between the five diagnostic categories. Analysis of covariance (ANCOVA) using age as a covariate was further employed to analyze statistical differences among groups for FTT and CV. Specificity and sensitivity cutoff values for the PMD category were determined by visual inspection of the data and confirmed through ROC analysis. ROC analysis was performed on the raw FTT score and the ratio of expected to predicted FTT scores. The predicted FTT score was determined from the regression equation for control subjects based upon age. The statistical software SPSS for Windows v16.0 (Chicago, IL) was used for data analysis.

3. Results

There was a significant difference in age between the diagnostic groups ($p < 0.001$). Subjects in the PMD (49 ± 11.50 years) were younger than participants in the IPD, ET, dystonia and healthy adult groups. The difference between the PMD and dystonia groups was not statistically significant ($p = 0.176$). Gender was unevenly distributed between diagnostic categories ($p < 0.001$) with women over-represented in the PMD and dystonia categories (Table 1). Clinical phenomenology of the PMD group was highly variable. Using the criteria proposed by Hinson et al. [25], the frequency of clinical features was: 53.0% action tremor, 46.2% rest tremor, 15.4% dystonia, 30.8% bradykinesia, 30.8% myoclonus, 15.4% chorea, and 7.6% tics (Table 2). When all groups were included, average combined FTT scores negatively correlated with age ($r = -0.274$, $p < 0.001$). Subgroup analysis revealed combined FTT scores did not correlate with age for the PMD or dystonia groups but did correlate with age in the IPD ($r = -0.422$, $p < 0.001$), ET ($r = -0.480$, $p < 0.001$) and normal control group ($r = -0.338$, $p < 0.001$). The correlation between age and FTT scores in the normal control data indicated the FTT score would be expected to decrease by 0.338 taps for each additional year of age. Gender had no effect on FTT scores ($t = 0.735$, $p = 0.476$). Within the IPD category, combined FTT scores were negatively correlated with both the H&Y stage ($r = -0.406$, $p < 0.001$) and UPDRS III scores ($r = -0.528$, $p < 0.001$). ANOVA analysis revealed a significant difference between the H&Y stages ($F = 12.22$, $p \leq 0.001$). The Tukey's HSD showed that stage 1 subjects performed significantly more taps than stages 3–5. Means and standard deviations for combined FTT in IPD patients are reported by H&Y score in Table 3. The combined FTT means, standard deviations, adjusted combined FTT means, and 95% confidence intervals for the five diagnostic categories are reported in Table 4. There was a significant difference in combined mean FTT

Table 1
Demographic data by diagnostic category.

		Normal Control ($n = 130$)	IPD ($n = 101$)	ET ($n = 49$)	Dystonia ($n = 32$)	PMD ($n = 13$)	p value
Handedness	Right	116	92	41	30	10	
	Left	11	7	6	1	2	
	Ambidextrous	3	2	2	1	1	
Gender	Male	47	57	15	5	3	< 0.001[a]
	Female	83	44	34	27	10	
Age[b] (yr)		64 ± 11.09	69 ± 9.02	61 ± 16.02	58 ± 10.28	49 ± 11.50	< 0.001[c]

[a] Fisher's exact test.
[b] Values for age are mean ± SD.
[c] Scheffe test indicates a significant difference between PMD and the control, IPD, and ET categories.