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Timed tests of motor function in Parkinson's disease☆,☆☆

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ABSTRACT

Introduction: Timed tests of motor function in Parkinson's disease (PD) may be useful for the diagnosis of bradykinesia or to monitor disease progression or treatment response. However, normal ranges have not been established.
Aim: To define normal ranges of hand-tapping and timed walking tests in non-parkinsonian controls and compare with PD patients' performance.
Methods: We recruited PD patients and age- and gender-matched controls for a prospective community-based incidence study of parkinsonian disorders in North-East Scotland. We counted the times participants tapped between two counters in 30 s. We also timed a 6m get-up-and-go test. We assessed age and gender effects and calculated 95% reference ranges for controls. We compared PD patients with controls.
Results: We recruited 157 controls and 138 newly diagnosed, untreated PD patients (mean ages 75 and 73). The 95% control reference range for tapping scores with the dominant hand was 18–74 taps. Males and younger participants performed significantly better. PD patients performed less well (mean difference 15 taps, $p < 0.001$) but only 10% had tapping scores below the control range. The 95% control reference range for the get-up-and-go test was 9–27 s. Walking times increased significantly with age, but gender had no effect. PD patients were slower (median difference 4.5s, $p < 0.001$) but only 17% were slower than the control range.
Discussion: Although PD patients performed more slowly than matched controls, timed tests were not helpful diagnostically because few incident patients were outside the normal reference ranges. Further work is needed on their utility in monitoring disease progression.

1. Introduction

Timed tests of motor function are simple, quantitative, objective methods for assessment of patients with Parkinson's disease (PD) and include hand tapping tests (such as movement between two points) and walking tests ("get-up-and-go"). Various other timed tests have been studied previously, including pronation/supination movements, tapping a single key and tests of manual dexterity using a pegboard [1,2]. These are principally tests of bradykinesia, although several factors may also influence performance. They have previously been used to monitor the progression of PD and to monitor response to treatments in therapeutic trials, for example as part of the Core Assessment Program for Intracerebral Transplantation (CAPIT) in neuronal transplant trials [1] and in trials of subthalamic stimulation [3].

Previous studies have shown that timed tests of motor function correlate with age-related decline in motor function [4] and that timed tests correlate with objective scores of function in PD, for example, the motor UPDRS score and the Hoehn and Yahr scores [2,5,6]. Hand tapping also shows correlation with clinical scales of motor function in Huntington's disease [7]. We have been unable to find the normal ranges defined for any timed test of motor function or any data on the usefulness of timed tests in the diagnosis of PD.

2. Aim

Our aim was to define the normal ranges of a hand tapping test and a walking test in a cohort of patients without a parkinsonian syndrome and to compare with incident PD patients' performance.

3. Methods

3.1. Inclusion/exclusion criteria

As part of a prospective community-based study of the incidence and prognosis of parkinsonism in the North-East of Scotland (the PINE study), we tried to identify all patients with a newly diagnosed degenerative or vascular parkinsonian syndrome, along with an age-gender matched control in order to compare prognosis [8,9].

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☆☆ All assessments were carried out with the adequate understanding and written consent of the subjects involved and with the ethical approval of the local ethics committee.

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The diagnosis of parkinsonism required two or more of the cardinal features (rest tremor, bradykinesia, rigidity or unexplained postural instability). For each patient who consented to long-term follow-up, we tried to recruit an age- and gender-matched control from either the same primary care practice as the patient or from a community-based register of those interested in taking part in research [9,10]. The only exclusion criteria for controls were if the primary care physician felt that it was inappropriate for us to approach them (e.g. because of terminal cancer), they were unable to give informed consent because of dementia, or they were found to be parkinsonian on assessment.

All incident parkinsonian patients were asked to consent to long-term follow-up, but for this particular study we have only included those who were thought to have a clinical diagnosis of idiopathic PD after a mean follow-up of 2.5 years and who were not on dopaminergic treatment at their baseline assessment. We excluded those who were thought clinically to have other forms of parkinsonism, including vascular parkinsonism. Parkinsonian patients with overt dementia at baseline were also excluded as it was unlikely that they had idiopathic Parkinson's disease. The clinical diagnosis was made by a consultant neurologist with an interest in PD (CEC) guided by UK Brain Bank criteria although these were not strictly applied because few patients had been followed up long enough for the supportive criteria to be applied.

All consenting patients and controls had baseline assessments of motor function including the motor UPDRS score and timed tests (see below). We also recorded which side was more affected by PD, by adding the scores from the UPDRS motor scale domains which related to each side. We also obtained baseline data on co-morbidity and drug prescriptions from the participants themselves as well as review of their hospital and primary care records.

3.2. Timed tests

We used a test of hand tapping between two points rather than other timed tests of upper limb function because it is objective and has been shown to correlate with the UPDRS motor scale [5,6]. For this test, participants were asked to tap backwards and forwards between two counters 30 cm apart with one hand as fast as they could for 30 s (see Fig. 1). The highest number on either counter was recorded. We used the average number of taps from two attempts with each hand for our analysis. We also calculated the difference in number of taps between each hand as a measure of asymmetry and recorded the dominant hand.

For the walking test, participants were timed standing up from the seated position on a hard chair (50 cm high), walking 6 m, turning around, walking back to the chair and sitting down again. Likewise, we recorded the average of two attempts for use in our analysis. Individuals who used a walking frame during this test were excluded from this particular analysis, but those who used a walking stick were included.

3.3. Analysis

We used a linear regression model to assess the effect of age and gender on tapping scores and walking times. We calculated 95% reference ranges (mean ± 2 standard deviations (SDs)) for both tapping scores (using dominant and non-dominant hands) and walking times for both the control group and the PD group [11]. We also calculated reference ranges for subgroups divided by age and gender if age or sex significantly affected the scores. For skewed data we performed a logarithmic transformation to obtain a more normal distribution of data to fit the assumptions for regression analysis. We assessed the effect of hand dominance using the paired *T*-test. We also assessed the difference between control and incident PD groups using the independent samples *T*-test for parametric data and the Mann–Whitney test for non-parametric data.

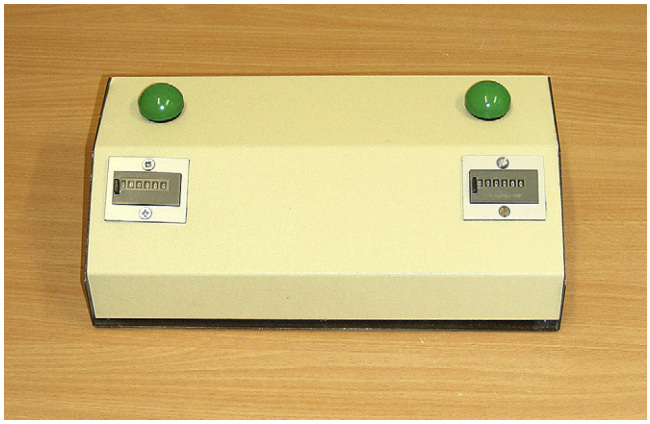

Fig. 1. Counters used for tapping test.

We calculated the proportions of PD patients with tapping scores below the lower limit of the control reference ranges; the number of PD subjects with greater hand tapping asymmetry than in the control range; and the number of PD subjects with walking times longer than the upper limit of the control reference range.

4. Results

We recruited 157 controls and 138 patients with untreated Parkinson's disease. Participant characteristics in each group are given in Table 1 including significant co-morbidities and number of medication repeats. Slightly more PD patients than controls had low MMSE scores.

4.1. Tapping test in controls

We have data available on all 157 controls for the tapping test. One participant was unable to perform the test with their dominant hand due to a right-sided hemiparesis. Another control was unable to use their non-dominant hand due to a left-sided hemiparesis. The data were normally distributed. The number of taps in 30 s by dominant hand ranged from 13 to 80 with a mean of 46, SD 14. The number of hand taps in 30 s by non-dominant hand ranged from 13 to 83 with a mean of 45, SD 13 (Fig. 2). The data for dominant and non-dominant hands showed high correlation (Pearson correlation coefficient was 0.97, $p < 0.001$). Controls performed slightly better with dominant than non-dominant hand (mean difference 1.3 taps, $p < 0.001$).

Linear regression analysis showed a significant effect of age and gender on the tapping scores ($p < 0.001$ for both) in dominant and non-dominant hands and so we calculated reference ranges for men and women separately in those under and over 75 years (the mean age) (Table 2). There was little difference in the reference ranges between the dominant and non-dominant hands.

The difference in number of taps between each hand in the control group ranged from zero to 13 taps; median difference was two taps. The data were skewed. 95% of the controls had a difference between hands of eight taps or fewer.

Table 1
Participant characteristics.

	Controls ($N = 157$)	Patients ($N = 138$)	
Number of men (%)	100 (64%)	79 (57%)	$p = 0.26$
Mean age in years (SD)	75 (9)	73 (10)	$p = 0.07$
Co-morbidities (*N*(%))			
Hypertension	78 (50%)	69 (50%)	$p = 0.96$
Hypercholesterolaemia	54 (34%)	43 (27%)	$p = 0.56$
Ischaemic heart disease	40 (25%)	30 (22%)	$p = 0.45$
Stroke	11 (7%)	17 (12%)	$p = 0.12$
Diabetes mellitus	19 (12%)	9 (6%)	$p = 0.10$
Arthritis	33 (21%)	34 (25%)	$p = 0.46$
Major joint replacement	20 (13%)	16 (12%)	$p = 0.76$
Median repeat prescriptions (range)	4 (0–20)	5 (0–20)	$p = 0.02$
MMSE[a] score < 24 (*N*(%))	2 (1.3%)	11 (8%)	$p = 0.006$
Median UPDRS[b] motor score (IQR)			
Total motor score	2 (0–5)	25 (17–32)	$p < 0.001$
More-affected side[c]		11 (8–14)	
Less-affected side[c]		5 (2–9)	

[a] Mini-mental state examination.
[b] Unified Parkinson's disease rating scale.
[c] Sum of scores from the following domains on the right or left side: resting tremor in hand and foot, postural tremor, rigidity in upper and lower extremity, finger taps, hand movements, rapidly alternating hand movements and heel tapping scores.