ORIGINAL ARTICLE

Freezing of Gait and Activity Limitations in People With Parkinson's Disease

Dawn M. Tan, M Physio, Jennifer L. McGinley, PhD, Mary E. Danoudis, M Physio, Robert Iansek, MD, PhD, Meg E. Morris, PhD

ABSTRACT. Tan DM, McGinley JL, Danoudis ME, Iansek R, Morris ME. Freezing of gait and activity limitations in people with Parkinson's disease. Arch Phys Med Rehabil 2011;92: 1159-65.

Objectives: To investigate the relationships between freezing of gait (FOG) and activity limitations in ambulant people with Parkinson's disease (PD), and to explore the contribution of FOG and gait hypokinesia to activity limitations after adjusting for the effects of disease severity.

Design: Retrospective, cross-sectional design.

Setting: Participants were recruited from neurologists' clinics and the general public in metropolitan Melbourne, Australia.

Participants: Volunteers were screened for eligibility using the following inclusion criteria: diagnosis of idiopathic PD, modified Hoehn and Yahr stages 0 to IV, without dementia. Participants (N=210) were tested (mean age ± SD, 67.9±9.6y; mean PD duration ± SD, 6.7±5.6y; median Hoehn and Yahr stage=2.5).

Interventions: Not applicable.

Main Outcome Measures: FOG was measured using the FOG questionnaire. Gait hypokinesia was quantified using both the 6-meter walk test and the Timed Up and Go test. Activity limitation was measured using the modified Unified Parkinson's Disease Rating Scale activities of daily living (ADL) section and the Schwab and England ADL scale.

Results: Severity of gait freezing correlated significantly with the level of activity limitation (Spearman correlation coefficient, $\rho = -.49$ to .48; $P < .001$). A hierarchic regression model showed that disease severity explained 37.5% of the variance in Schwab and England ADL score ($P < .001$). Gait hypokinesia and FOG severity scores explained an additional 9.1% of the variance in activity limitation (R^2 change=.091; $P < .001$).

Conclusions: FOG severity and gait hypokinesia were associated with reduced levels of activity after adjusting for disease severity.

Key Words: Gait disorders; Parkinson disease; Rehabilitation.

GAIT DISORDERS ARE a distinctive feature of idiopathic Parkinson's disease (PD). Freezing of gait (FOG) is a particularly disabling sequela in many people with advanced disease.[1,2] FOG can be distressing[3] and incapacitating[1] for people with PD. Effective management of FOG can be a challenge[4] for clinicians given its episodic nature and limited responsiveness to parkinsonian medication.[5] There is limited evidence of the impact of FOG on function and disability in people with PD. This study explores the relationship between FOG and activity limitations in ambulant adults with PD.

FOG is characterized by an inability to generate or sustain an effective stepping sequence,[6] leading to sudden blocks in walking.[7] It is frequently experienced during functional activities such as turning or step initiation. It can also be triggered by emotional stress,[8] environmental constraints,[9] dual tasking,[1] and directional change.[4] FOG has been associated with increased risk of falls[1,10,11] and can compromise quality of life.[12] In addition, people with PD may limit their community ambulation to minimize the occurrence of freezing episodes.[6] This may lead to reduced activity levels and exercise capacity.

FOG occurs more commonly with increased PD duration, increased disease severity, and long duration of levodopa treatment.[6,13] There are relatively few studies of the relationships among FOG, gait speed, and activity limitations.[14-16] The extent to which the results of previous studies can be generalized to the population of people with PD is limited by small sample sizes,[14,16] nonrepresentative populations from drug trials,[14-16] and a focus on patients with advanced disease.[2] Little is known about FOG in early PD.

This study describes the frequency and characteristics of FOG in an Australian sample of ambulant adults with PD. It also explores relationships between FOG severity and subtypes (start and turn hesitations) and activity limitations. The relationships between FOG severity and gait hypokinesia are also investigated given the inconsistent reports of the associations between hypokinesia and FOG.[17,18] It was hypothesized that the frequency and severity of FOG subtypes would vary according to disease stage. It was also predicted that relationships would exist between FOG severity and the severity of gait hypokinesia and between FOG severity and activity limitations.

METHODS

The study used baseline data from an existing trial that investigated the effect of exercise on mobility and falls.[19] A

List of Abbreviations

ADL	activities of daily living
FOG	freezing of gait
FOG-Q	Freezing of Gait Questionnaire
MMSE	Mini-Mental State Examination
PD	Parkinson's disease
TUG	Timed Up & Go
UPDRS	Unified Parkinson's Disease Rating Scale

From the School of Health Sciences, University of Melbourne, Melbourne (Tan, McGinley, Danoudis, Morris); Murdoch Children's Research Institute, The Royal Children's Hospital, Melbourne (McGinley); Clinical Research Centre for Movement Disorders and Gait: Victorian Comprehensive Parkinson's Program, Kingston Centre, Melbourne (Danoudis, Iansek), Australia; and Department of Physiotherapy, Singapore General Hospital, Singapore (Tan).

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Reprint requests to Dawn M. Tan, M Physio (Neuro), Department of Physiotherapy, Singapore General Hospital, Outram Rd, Singapore 169608, e-mail: *dawn.tan.m.l@sgh.com.sg*.

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total of 210 people diagnosed with PD who lived in metropolitan Melbourne were recruited according to the following inclusion criteria: idiopathic Parkinson's disease, modified Hoehn and Yahr[20] stages 0 to 4, ability to provide informed consent (determined by age and educational level-adjusted Mini-Mental State Examination (MMSE) normative scores[21,22]), no dementia, health status permitting safe participation in a strength training exercise program, and ability to attend an outpatient 8-week therapy program. We also recorded each person's age, sex, disease duration, and Hoehn and Yahr stage. Ethical approval was gained from the University of Melbourne Health Sciences Human Ethics Sub-Committee (no. 0828579), and all participants provided written informed consent. Assessments were conducted by physiotherapists trained in administration of the measurement protocol.

Outcome measures. Data for 210 participants were analyzed. The primary outcome measures included measures of hypokinesia (TUG[23] and gait speed calculated from 6-m walk test[24,25] scores) and FOG (Freezing of Gait Questionnaire [FOG-Q]).[14,15] The FOG-Q is a validated and reliable self-reported questionnaire.[14-16] It is composed of 6 items (item score ranges 0–4) that are summed to yield a total score (ranging 0–24). Higher total scores indicate more severe FOG. A FOG-Q modified total score that quantifies FOG severity was obtained by adding the score of questions 3, 4, 5, and 6 because these are questions specific to FOG. Questions 1 and 2 were not included because they are general questions relating to gait. Activity limitations were assessed with the Unified Parkinson's Disease Rating Scale (UPDRS) Section II–ADL[26,27] (higher score indicates greater activity limitation) and Schwab and England activities of daily living (ADL) scale (higher score indicates lower level of activity limitation).[28] The original UPDRS ADL scores were modified by excluding gait-related scores (UPDRS items 14 on FOG and 15 on gait) similar in construct to the independent variables (FOG and gait hypokinesia) so that the assumptions of independence for correlation and regression analyses were not violated.[29] The Schwab and England gives a percentage of the ability to perform ADL, whereas the UPDRS ADL assesses the ability to perform a range of specific ADL tasks and motor function (speech, salivation). Hence, both instruments were used as measures of disability. Disease severity was measured using the UPDRS Section III–motor score.[30,31]

Statistical Analysis

Data were analyzed using SPSS statistical software (Version 18.0).[a] Demographic data, FOG occurrence, and FOG characteristics were initially analyzed using descriptive statistics. Participants were identified as having FOG if they obtained a score of more than 0 for the FOG-Q items 3,[15] 4, 5, or 6 because these questions are specific to FOG. Because FOG-Q items 1 and 2 are related to general walking difficulties, they were not included in analyses of FOG. Participants were categorized into (1) very early disease, Hoehn and Yahr stages 0 to 1.5; (2) early disease, stages 2 to 2.5; (3) moderate disease, stage 3; and (4) advanced disease, stage 4.[20] The association between disease state and FOG was analyzed using the chi-square test. The McNemar test was used to investigate differences between the incidence of start and turn hesitations among participants who experienced FOG.

The Kruskal-Wallis test was used to explore the differences in FOG severity (FOG-Q modified total score), FOG frequency (FOG-Q item 3), FOG duration (FOG-Q item 4), severity of start hesitation FOG (FOG-Q item 5), and severity of turning hesitation FOG (FOG-Q item 6) in participants with different disease states. We performed post hoc tests using Bonferroni corrections to the alpha levels to control for type 1 errors to investigate further the differences among the 4 groups. The Kruskal-Wallis test was also used to investigate whether turn hesitation severity was greater than start hesitation severity in patients with different disease states. The nonparametric version of the 1-way analysis of variance test was necessary because the assumption of homogeneity of variance was violated.

Spearman correlation coefficients were used to analyze the relationships between participant demographics and activity limitations, FOG severity (modified FOQ-Q total score) and activity limitations, and gait hypokinesia and activity limitations, because these variables were not normally distributed. Hierarchic multiple regression was used to assess the contribution of gait hypokinesia and FOG severity (modified FOG-Q total score) to levels of activity limitation after adjusting for the influence of disease severity. Preliminary analyses were conducted to ensure that the assumptions of normality, linearity, multicollinearity, and homoscedasticity were not violated. The alpha levels for all tests were set at .05 unless otherwise indicated.

Table 1: Clinical Characteristics of Participants

Clinical Characteristic (Measure)	Mean ± SD	Range	n
Age (y)	67.9±9.6	44–89	210
Disease duration (y)	6.7±5.6	0.2–30	210
Cognition (MMSE score)	28.3±1.8	23–30	210
Disease severity (UPDRS total)	32.3±13.1	11–80	209
FOG severity (FOG-Q total score)	5.9±5.4	0–23	209
Activity limitation			
UPDRS ADL section	11.5±5.9	1–38	209
Schwab and England ADL scale	80.7±14.5	20–100	209
Stage of disease (HY)	2.5±0.9	0–4	210
Very early (HY stage 0–1.5)			34
Early (HY stage 2–2.5)			89
Moderate disease (HY stage 3)			63
Advanced disease (HY stage 4)			24

Abbreviation: HY, Hoehn and Yahr.

RESULTS

Of the 210 participants, 140 (66.7%) were men and 70 (33.3%) were women. The clinical characteristics of the participants are detailed in table 1. One hundred ten (52%) of the participants experienced FOG. The subtypes, frequency, and duration of FOG are summarized in table 2 and figure 1. The occurrence of FOG was higher in people with more advanced disease states ($\chi^2[2,n=209]=36.7$; $P<.001$). The proportions of participants in the very early, early, moderate, and advanced disease states who experienced FOG were 27.3%, 38.2%, 76.2%, and 79.2%, respectively.

Characteristics of FOG in Participants With Early, Moderate, and Advanced Disease

FOG severity (modified FOG-Q total score) was found to differ across the 4 PD disease-stage groups ($\chi^2[3,n=209]=39.24$; $P<.001$). The group with moderate disease recorded the highest median FOG total score of 6 compared