

## Falls in Parkinson Disease: The Relevance of Short Steps

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### Abstract

Falls are a major risk for Parkinson Disease (PD) patients. Between 2010- 2011 we followed 404 PD patients, 204 of whom, 50.5%, fell. We compared non fallers and fallers. Seventy one of the fallers, 35%, fell more than once. Fallers were significantly older, 72.6 + 5.8 versus 66.9 + 6.1 years, had PD significantly longer 9.3 + 3.4 versus 5.4 + 2.2 years. Fallers walked with significantly shorter steps: 0.45 + 0.09 versus 0.60 + 0.13 meters. Fallers walked with significantly slower steps 0.75 + 0.21 versus 0.90 + 0.31 meters/second. Fallers were significantly more likely to have freezing of gait.

Between 2011- 2012 we followed 401 PD patients, 205 of whom, 51.0% fell. Of these patients 161 fell once and 44 fell more than once (recurrent fallers). We compared single fallers and recurrent fallers. Recurrent fallers had PD significantly longer, 12.6 + 7.0 versus 5.9 + 4.5 years. They walked with significantly shorter steps 0.52 + 0.12 meters versus 0.31 + 0.12 meters. They walked significantly slower: 0.85 + 0.27 meters/second versus 0.51 + 0.14 meters/second. Freezing of gait was significantly more common in recurrent fallers. The significance of the shorter step in relationship to falling is discussed.

**Keywords:** Parkinson disease; Fall; Short steps; Freezing of gait

### Introduction

Falls are a major cause of disability in Parkinson Disease (PD) [1-4]. In a study of 761 hospital admissions for PD only 15% were for management of PD while 39% were for falls [1]. And in a study of 138 PD patients followed for 10 years, 27% fractured a major bone because of a fall [2].

There is variability in the reported prevalence of falls in PD: from 11% to 68% [3-8]. The variability depends on whether specific fall risk factors are included or excluded. The risk factors encompass visual loss, neuropathy resulting in leg weakness or Proprioceptive loss, orthostatic hypotension resulting from anti-hypertensive, diuretics, or dehydration, or imbalance resulting from tranquilizers, sedatives, or alcohol. The variability in reporting depends upon whether only serious falls (requiring medical attention) and/or non- serious falls were recorded [3-16]. The variability also includes whether persons with evolving PD-plus disorders were included or excluded [17].

### Methods

We reviewed our records on PD patients seen in 2010-2011. We saw 460 PD patients. We excluded patients with a Parkinson plus disorders, disorders that while infrequent result in a high number of falls. These disorders include Progressive Supranuclear Palsy, Multiple System Atrophy, Corticobasilar Degeneration [17]. We excluded patients with PD and dementia, Mini- Mental Status Examinations, MMSE, <27. We excluded persons who were legally blind.

We excluded persons with orthostatic hypotension. Although orthostatic hypotension can be part of PD, it can also result from the

use of anti- hypertensive's, diuretics, selected anti- depressants, and dehydration [13,14].

We excluded patients with neuropathy when it resulted in impaired proprioception, as manifested by a positive Romberg test [15]. We excluded patients with neuropathy who had marked leg weakness.

In this first study we compared non- fallers and fallers.

In a second study of PD patients seen between 2011- 2012 we followed 401 patients, 205 of whom, 51.0% fell: 161 fell once and 44 fell more than once (recurrent fallers). In the second study we compared single fallers and recurrent fallers.

All persons, their families and care-givers were informed that the information collected could be used for research but that they personally could not be identified. Approval for the analysis was obtained by the St Joseph's Hospital IRB. No patients were compensated. As the evaluations were part of the person's routine care no signed consent was obtained.

We analyzed serious falls: falls that required medical attention. Approximately one- third of persons with PD visited an Emergency Room, one-third visited an Urgent Care Center or their family doctor, and one- third visited or called us.

All persons with PD were examined using the motor part of the revised UPDRS [18] and the axial portion of the revised UPDRS. All patients were questioned about freezing of gait (FOG). All persons with PD were timed while walking 7.63 meters (25 feet). This is a convenient length, one available in most medical offices. The number of steps were counted and the timed.

In the first study we compared non fallers and fallers (single plus recurrent fallers). In the second study we compared single fallers and recurrent fallers. The following were compared between groups: age, duration of PD, levodopa treatment, UPDRS motor score (maximum

132 points), UPDRS axial score (24 points), presence or absence of FOG, step length (meters/step) and step velocity (meters/second).

Continuous variables were analyzed using t-tests and categorical variables were analyzed using chi-square tests. We used the SAS 8.01 statistical software package.

## Results

In the first study of 204 patients, 50.5% fell. Seventy- one of 204 patients, 35%, fell more than once. Age, duration of PD, UPDRS total

motor and axial scores were significantly higher (worse) in the fallers (Table 1). Step length was significantly shorter, and step velocity significantly slower among fallers (Table 1). Among fallers 43 patients, 21.3% had FOG. Among non- fallers 21 patients, 10.5% had FOG. Fallers were more likely to have FOG non-fallers: Odds Ratio 2.28 95% CI 1.30- 3.99. P<0.0042.

	No Falls 200 patients	Falls 204 patients	p-value
Age	66.9 ± 6.1	72.6 ± 5.8	0.019
Duration	5.4 ± 2.2	9.3 ± 3.7	0.0026
UPDRS Motor Score	18.9 ± 8.3	29.3 ± 10.9	<0.001
Axial Score	5.1 ± 2.7	9.2 ± 3.5	<0.001
Step Length Meters/ Step	0.6 ± 0.13	0.45 ± 0.09	<0.001
Step velocity Meters/ Second	1.0 ± 0.29	0.80 ± 0.28	<0.001

**Table 1:** Comparison of age, disease duration, motor scores, step length and velocity between patients having falls and not having falls. (With critical level  $\alpha=0.05$ )

Among the fallers 84% were on levodopa, among the non- fallers 80% were on levodopa.

In the second study among 161 fallers, 44 patients, 22% of all patients who fell, fell at least twice in the year: 38 of them, 86%, fell more than twice. Recurrent fallers had PD significantly longer than single fallers (Table 2). UPDRS motor scores were significantly higher (worse) in the recurrent fallers (Table 2). Recurrent fallers were more

likely to have freezing of gait than single fallers: 47.7% of recurrent fallers versus 5.6% of single fallers, odds ratio 15.4 CI 95% 6.3- 37.7 p<0.001. Recurrent fallers walked significantly slower with shorter steps than single fallers.

Among the 161 single fallers, 87.5% were on levodopa, among the 44 recurrent fallers 100 % were on levodopa.

	Single –Fallers 161 patients	Recurrent Fallers 44 patients	p-value
Age (years)	67.4 ± 8.7	69.7 ± 9.3	NS
PD Duration (years)	5.9 ± 4.5	12.6 ± 7.0	0.001 *
UPDRS Motor Score	19.7 ± 8.3	32.3 ± 12.6	0.001*
Step length (meters)	0.52 ± 0.12	0.31 ± 0.12	<0.001*
Step velocity (meters/sec)	0.85 ± 0.0.27	0.51 ± 0.14	0.001*

**Table 2:** Comparison of single versus recurrent fallers Critical level at p <0.05.

## Discussion

The prevalence of falls is comparable to that reported by others: approximately half of PD patients fall at least once a year, and approximately one-third fall more than once a year [3-10]. It's estimated that 33% of all people over age 65 years, an age comparable to most PD patients fall at least once a year. That is 55% more PD patients fall than people without PD.

Fall-related injuries in addition to reducing mobility and independence often result in hospitalization [19]. The costs associated with fall-related injuries are high and estimated to reach \$30 billion by 2020 by the Rand Corporation [19]. With an aging population, and a growing number of injuries, the costs are estimated to rise to \$240 billion by 2040. These figures will be proportionately higher in PD, because a higher percent of people with PD fall. If falls, and especially recurrent falls, can be reduced in PD, they possibly can be reduced in other disorders [20-23]. However, before effective preventive measures can be undertaken it is important to understand why people with PD fall.

In the first study, fallers were significantly older than non-fallers, and had PD longer. In the second study recurrent fallers were not older than single fallers, but had PD longer. This suggests that recurrent falls, as distinct from single falls, are more likely related to disease duration than age.

In both studies fallers were more disabled, had higher UPDRS scores than non-fallers and in the second study recurrent fallers were more disabled than single fallers. However, in an individual patient a UPDRS motor score is not sufficient to predict a fall. This is because the UPDRS is weighted toward upper extremity rigidity, tremor, and bradykinesia, metrics that don't predict falls.

Fallers take significantly shorter and slower steps than non-fallers. Recurrent fallers take significantly shorter and slower steps than single fallers (Tables 1 and 2). We postulate that the short step in fallers, and especially in recurrent fallers, is an "adaptation" to the patient's perceived lack of balance. This in turn creates a "mismatch" between the displacement and speed of the upper versus the lower body, resulting in the upper bodies "tipping over", and the patient falling. This is usually preceded by freezing of gait. Education, exercise, gait and balance training focusing on increasing step length and velocity may reduce falls [21-24].

## Author Contributions

A. Lieberman designed the study, obtained the data, and wrote the manuscript.

## Disclosures

The study was part of the office practice of the authors, there is nothing to disclose. We thank the Bob and Renee Parsons Foundation and the Celebrity Fight Night Foundation for their on-going support.

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