

Predicting Falls in Parkinson Disease Patients

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Abstract

Background: Falls are a major risk for Parkinson disease patients (PD). Single falls, in older people may be related to the underlying disease or may be accidental. Recurrent falls are more likely to be related to the underlying disease.

Objectives: To predict falls in patients with Parkinson disease.

Patients and Methods: Between July 1, 2011 and June 30, 2012 we examined 452 persons with PD in the Muhammad Ali Parkinson Clinic during their outpatient visits.

Results: We followed 401 persons with PD for a year, 205 of whom, 51.0% fell: 161 fell once and 44 fell more than once (recurrent fallers). Recurrent fallers had PD significantly longer, 12.6 + 7.0 versus 5.9 + 4.5 years, had significantly higher, worse, motor unified parkinson disease rating scale (UPDRS) scores 31.2 + 12.7 versus 19.7 + 8.3. The major difference between recurrent and single fallers was an inability of recurrent fallers to stand on one leg for < 3 seconds: 95% versus 11%, odds ratio 178 CI 95% 39.5 - 801.2.

Conclusions: Single fallers who are unable to stand on one foot for < 3 seconds may be at risk for recurrent falls. Gait and balance training focused on improving a patient's ability to stand on one leg may decrease the risk of recurrent falls in PD.

Keywords: Parkinson Disease Falls, Freezing of Gait, Postural Instability

1. Background

Falls, especially recurrent falls, are a major cause of disability in Parkinson disease (PD) (1, 2). 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 persons with PD followed for 10 years, 27% fractured a major bone because of a fall (2). A major risk for recurrent falls is a previous history of a fall (3, 4). Persons with PD who fall once may do so because of the underlying disease or because of factors such as poor eye-sight, leg weakness, orthopedic problems and environmental hazards. A single fall, although serious, may be only partly related or even unrelated to PD. However, some people with PD fall recurrently (3, 4). It is important to identify the factors for recurrent falls and if possible mitigate them.

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 excluded such as visual loss, neuropathy resulting in leg weakness or proprioceptive loss, major orthopedic problems involving the hips or knees, orthostatic hypotension resulting from anti-hypertensives, diuretics, anti-de-

pressants or dehydration, imbalance resulting from tranquillizers, sedatives, or alcohol. The variability in reporting depends upon whether only serious falls (requiring medical attention) or non-serious falls (not requiring medical attention) were recorded (3-16). The variability also includes whether persons with evolving PD-plus disorders such as progressive supranuclear palsy (PSP), corticobasilar degeneration (CBD), or multiple system atrophy (MSA), a small number of persons but with a high predilection to fall were included or excluded (6).

2. Objectives

To predict falls in patients with Parkinson disease.

3. Patients and Methods

Between July 1, 2011 and June 30, 2012 we examined 452 persons with PD in the Muhammad Ali Parkinson Clinic. We excluded persons with a Parkinson plus disorder, a disorder that while infrequent, results in a high

number of falls. These disorders include progressive supranuclear palsy, multiple system atrophy, and corticobasal degeneration (6). We excluded persons with PD and dementia, mini-mental status examinations (MMSE), < 27. Although dementia is part of PD and can be a risk for falling, more than half of our people with PD and dementia are without a care-giver for at least four hours and we were uncertain if they reported their falls. We excluded persons who were legally blind. We excluded persons with major orthopedic problems of their hips or knees, patients who needed hip or knee replacements.

We excluded persons with orthostatic hypotension. Although orthostatic hypotension, reflecting involvement of the autonomic nervous system (ANS), can be part of PD, it can also result from the use of anti-hypertensives, diuretics, selected anti-depressants, and dehydration (13, 14). As we often could not determine a fall from orthostatic hypotension resulting from impairment of the ANS from orthostatic hypotension resulting from drugs and dehydration we excluded such persons from our analysis.

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. We excluded persons who used alcohol daily and had a history of intoxication. The number of persons excluded was 51.

We analyzed 401 persons with PD. All persons were examined as part of their routine office visit and were examined every four months. All persons were instructed repeatedly to call us or visit us if they fell. All persons were examined in their "on" period, one to two hours after their morning dose of levodopa, when levodopa was working. Of the 401 persons with PD, 205, 51 %, fell. Of the 205 fallers, 78% fell once and 22% fell more than once. We analyzed the 205 fallers excluding the 196 persons with PD who did not fall. We did this because there have been several excellent reports comparing fallers and non-fallers with PD (3-8). Our focus was on distinguishing single from recurrent fallers. We sought to determine if we could find a simple "bedside" test that would enable us to distinguish single from recurrent fallers (3, 4). Such a "bedside" test might enable us to define strategies to lessen the chances of recurrent falls (5-11). 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.

We analyzed serious falls: falls that required medical attention. A serious fall was defined as:

- 1) The person fell to the floor, without loss of consciousness, all 4 limbs or the skull hitting the ground.
- 2) The person needed help in arising.
- 3) The person twisted a joint or sustained a fracture.

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 us.

All persons with PD were examined using the motor part of the revised UPDRS, total 132 points (17). This included the sub-tests for gait, freezing of gait (FOG) and postural stability (the "pull test"). The "pull test" is regarded as the best subtest for evaluating balance.

All persons with PD were examined using the Barrow Neurological Institute (BNI) balance scale (18). The scale, 20 points, consists of the sum of turning to the right, turning to the left, standing on the right foot unaided, standing on the left foot unaided, and tandem walking.

The following were compared between single and recurrent fallers: age, duration of PD, levodopa treatment, presence of dyskinesias, UPDRS motor score (maximum 132 points), UPDRS Gait sub-score > 3, UPDRS freezing of gait sub-score > 2 (there were insufficient persons with FOG score > 3 to use this metric). UPDRS pull-test > 3, Barrow Neurological Institute balance score (maximum 20 pts), turning score > 6, Standing on one foot score > 6, tandem gait > 3, step length, and step velocity.

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.

4. Results

Forty four persons with PD, 22% of all people who fell, fell at least twice in the year: 38 of them, 86%, fell more than twice. Unified Parkinson disease rating scale motor and Barrow Neurological Institute balance scores were significantly higher (worse) in the recurrent fallers (Table 1). Sub-scores of gait, postural stability, turning, standing on one foot, and tandem gait were significantly worse in recurrent fallers (Table 2). Recurrent fallers were unable to stand on one foot for < 3 seconds than single fallers: 95.4% of recurrent fallers versus 10.8% of single fallers, odds ratio 177.9 CI 95% 39.5 - 801.2, $P < 0.001$. 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 $P < 0.001$. From examination after the fall it was estimated that 45% of recurrent fallers with freezing of gait fell during a freeze.

Among the 161 single fallers with PD, 87.5% were on levodopa, among the 44 recurrent fallers 100% were on levodopa. Sixty-five of 161 single fallers, 40.4%, had dyskinesias. Twenty-five of 44 recurrent fallers, 56%, had dyskinesias. Although a higher percent of recurrent fallers had dyskinesias we cannot comment on the contribution of dyskinesias to falls. This is because we recorded only the presence, not the severity of dyskinesias. The reason a higher percent of recurrent fallers were on levodopa was because their PD was more advanced

Table 1. Comparison of Single Versus Recurrent Fallers^a

	Single Fallers, n = 161	Recurrent Fallers, n = 44	P Value ^b
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
BNI balance score	6.5 ± 3.4	15.7 ± 2.3	< 0.001

^aAbbreviations: BNI, Barrow Neurological Institute; PD, Parkinson Disease; UPDRS, Unified Parkinson Disease Rating Scale.

^bValues at P < 0.05 are Significant.

Table 2. Comparison UPDRS Motor and BNI Balance sub-scores in Single vs Recurrent Fallers^a

UPDRS & BNI Sub-Scores	Single Fallers, n = 161 ^b	Recurrent Fallers, n = 44 ^b	Odds Ratio	P Value ^c
UPDRS gait score > 3	15 (9.3)	25 (56.8)	12.8 CI 95% 5.8 - 28.5	< 0.001
UPDRS freezing of gait score > 2	9 (5.6)	21 (47.7)	15.4 CI 95% 6.3 - 37.7	< 0.001
UPDRS postural stability score > 3	35 (22.0)	29 (65.9)	7.0 CI 95% 3.4 - 14.4	< 0.001
BNI turning score > 6	15 (9.3)	27 (61.4)	15.5 CI 95% 6.9 - 34.6	< 0.001
BNI stand one foot score > inability stand one foot < 3 seconds	17 (10.8)	42 (95.4)	177.9 CI 95% 39.5 - 801.2	< 0.001
BNI tandem gait score > 3	35 (21.7)	31 (71.4)	8.6 CI 95% 4.1 - 18.1	< 0.001

^aAbbreviations: BNI, Barrow Neurological Institute; UPDRS, Unified Parkinson Disease Rating Scale.

^bThe values are presented as No. (%).

^cChi-square Significance level P < 0.05.

5. Discussion

The prevalence of falls, single and recurrent, in our series is comparable to that reported by others: 51% of people with PD fell at least once in the year, and 22% fell more than once (3-10). It's estimated that 33% of all people over age 65 years, an age comparable to most persons with PD, fall at least once a year. That is 55 % more people with PD fall than people without PD. Fall related injuries in addition to reducing mobility and independence often result in hospitalization. The costs associated with fall related injuries in older people are high and estimated to reach \$30 billion by 2020 by the Rand Corporation. 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 and fall recurrently. If falls, and especially recurrent falls, can be reduced in PD, they probably can be reduced in other disorders (19-22). However, before effective preventive measures can be undertaken it is important to understand why people with PD fall recurrently.

Recurrent fallers have PD longer and are more disabled: they have higher unified Parkinson disease rating scale scores than single fallers. However, in an individual person with PD who falls the duration of PD may be insufficient to predict another fall. This is because the UPDRS is

weighted toward upper extremity rigidity, tremor, and bradykinesia, metrics that don't predict falls.

Recurrent fallers are significantly more likely to be unable to stand one foot for < 3 seconds: 95.4% of recurrent fallers compared to 10.8% of single fallers, odds ratio 177.9 CI 95% 39.5 - 801.2, P < 0.001. This, to us, appears to be the single best predictor of recurrent falls in patients with or without freezing of gait. Recurrent fallers are more likely to have freezing of gait: 47.7% of recurrent fallers compared to 5.6% of single fallers, odds ratio 15.4 CI 95% 6.3 - 37.7, P < 0.001. Freezing of gait is a good predictor of recurrent falls (23, 24) but not as good as an inability to stand on one foot for < 3 seconds. Inability to stand on one foot for < 3 seconds and freezing of gait were more likely to predict recurrent falls than the subtests of gait, and postural stability (the pull test) of the UPDRS.

The Barrow Neurological Institute balance scale is a useful addition to the UPDRS scale especially in predicting recurrent falls.

Education, exercise, gait and balance training focusing on improving the ability to stand on one foot including the strengthening the muscles of the leg and stabilizing the upper trunk while balancing on foot may be reduce recurrent falls (19-22).

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Footnotes

Authors' Contributions: Abraham Lieberman, principal author, designed the study, obtained the data, and wrote the manuscript. Abraham Lieberman, Narayanan Krishnamurthi, Rohit Dhall, Naomi Salins, Di Pan and Aman Deep were involved in interpretation of the data, critical evaluation of the manuscript, and gave their final approval.

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