

Clinical indicators of gait freezing in Parkinson's disease

¹Olga Gavriiliuc, ²Alexandru Andrusca, ³Mihail Gavriiliuc

¹Scientific Laboratory of Functional Neurology, *Diomid Gherman* Institute of Neurology and Neurosurgery

²Department of Neurosurgery, ³Department of Neurology

Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, the Republic of Moldova

Authors' ORCID iDs, academic degrees and contributions are available at the end of the article

*Corresponding author: olgagavriiliuc@yahoo.com

Manuscript received May 05, 2020; revised manuscript May 29, 2020; published online June 10, 2020

Abstract

Background: Freezing of gait is a common (FOG) episodic gait disorder in advanced Parkinson's disease (PD). FOG is one of the main risk factors for falls; therefore FOG's consequences can be devastating. This symptom is difficult to study in a research laboratory because of its unpredictability which makes it difficult to select patients for clinical testing and make the right treatment decisions. Thus, clinical indicators may be useful to distinguish between patients with and without FOG. The aim of this study was to compare the number of steps and the time to perform a 180-degree turn in patients with Parkinson's disease with and without FOG.

Material and methods: The study was performed on 56 PD patients. Subjects were divided into 2 groups: a total of 28 patients with PD and FOG were compared with 28 patients with PD without FOG, according to item number 14, from the Unified Parkinson's Disease Rating Scale (UPDRS). The 2 subgroups were homogeneous in terms of age and disease severity.

Results: Significant differences were found between the two groups both in steps number ($P < 0.0001$) and in the time required to perform a 180-degree turn ($P < 0.0001$).

Conclusions: Performing more steps and more seconds to turn 180 degrees may be a useful indicator to distinguish the characteristics of PD patients with FOG. A PD patient which turns at 180-degree with more than 5 steps is most likely a patient with FOG.

Key words: Parkinson's disease, gait, freezing, turning, steps.

Cite this article

Gavriiliuc O, Andrusca A, Gavriiliuc M. Clinical indicators of gait freezing in Parkinson's disease. *Mold Med J.* 2020;63(2):31-33. doi: 10.5281/zenodo.3866002.

Introduction

Freezing of gait (FOG) is a common episodic gait disorder in advanced Parkinson's disease (PD). It is defined as a "brief, episodic absence or marked reduction of forward progression of the feet despite having the intention to walk" [1] and the patients often describe this symptom as like the feet are glued to the floor. Approximately 50% of PD patients experience FOG at least twice a month and in the more advanced stages 80% of the patients suffer from this symptom [2]. Because 26% of falls have been shown to be related to FOG [3], it has a significant impact on the quality of life of PD patients [4].

FOG's prevalence depends on disease duration [2, 4, 5], disease stage [2, 4] and the dose of administered levodopa [4]. The pathological mechanisms are not completely comprehended [6], but several FOG hypotheses were attributed like abnormal sequencing of steps, axial akinesia, asymmetric symptom severity [7] and frontostriatal disruption [8, 9].

One challenge that adds considerable complexity to FOG research is the fact that this phenomenon is hard to study in a research laboratory because of its unpredictability. FOG was shown to occur most often during turning [10]. While turning difficulties tend to be associated with FOG, there were only limited studies to describe these difficulties. In a previous study patients experiencing FOG were

found to have a higher rotational arch than patients without FOG [11], patients with FOG only get 75% of the necessary turning angle and need more time to complete the turn [12]. There are several studies showing that PD patients perform a greater number of turning steps compared to control group subjects [13, 14]. The current study hypothesizes that a greater number of steps and the longer time required to complete a 180-degree turn in patients with Parkinson's disease is an indicator of FOG, even if the patient does not have a FOG episode at the time of turn.

Material and methods

Fifty-six patients diagnosed with PD were included in the study. The patients were recruited in the Movement Disorders Clinic of the University Hospital of Kiel (Germany). The current research is a part of a larger project for research on the phenomenon of FOG in patients with PD that was approved by the Research Ethics Committee of *Nicolae Testemitanu* State University of Medicine and Pharmacy (No 44 / 53 of 12.04.2018). A special authorization for the use of patients' data for scientific and educational purposes has been signed by all patients in accordance with German law.

The inclusion criteria were: (1) PD diagnosed according to Brain Bank criteria, (2) the ability to walk independently

and perform a 180-degree turn in the OFF phase of the disease. Exclusion criteria: (1) comorbidities that could influence gait, (2) the presence of cognitive impairment, measured by mini-mental examination (MMSE <24 points). An equal number of patients was recruited with and without FOG, according to item No 14 of the Parkinson's Disease Rating Scale (UPDRS). Patients with MI were considered those who had item No 14 > 0. The severity of the disease was determined according to the UPDRS scale, part III. Homogeneous patients were selected in terms of age and disease severity.

The protocol requires subjects to stand up from the chair, walk 8 m towards examiner, turn 180 degrees, and return to the chair. The number of steps and the time required for turning were calculated for each patient by 2 blind raters, who did not know the patient's status (with/without FOG). All patients were examined in the OFF phase, with levodopa being stopped for 12 hours and dopaminergic agonists for 72 hours. Patients who experienced a FOG episode during turning were excluded.

Statistical analysis was performed using SPSS, version 23.0. Data are expressed by mean and standard deviation in the case of normal distribution or median and range values for variables with non-normal distribution. The differences between the two groups of patients were analyzed with the t-test or Mann-Whitney test, as appropriate. In all analyses, p values <0.05 were considered significant.

Results

A total of 56 patients were included in the study, divided into 2 groups, 28 patients with PD and FOG were matched for age, disease severity and compared with 28 patients with PD without FOG, according to item number 14, from the Unified Parkinson's Disease Rating Scale. The demographic data and characteristics of the patients included in the study are presented in Table 1. The number of steps performed during 180 degrees turn, as well as the time required to perform the rotation are statistically significantly higher in patients with FOG than those without FOG (p = 0.0001 for both measurements).

Assessing the number of steps performed by patients with and without FOG, we determined that in the patients

which have FOG median is 5 and those without FOG the median is 3 steps. We also noticed that patients without FOG have performed a maximum of 5 steps. We may therefore infer that if a PD patient performs more than 5 steps at 180 degrees turn, it is most likely a patient with FOG (fig. 1).

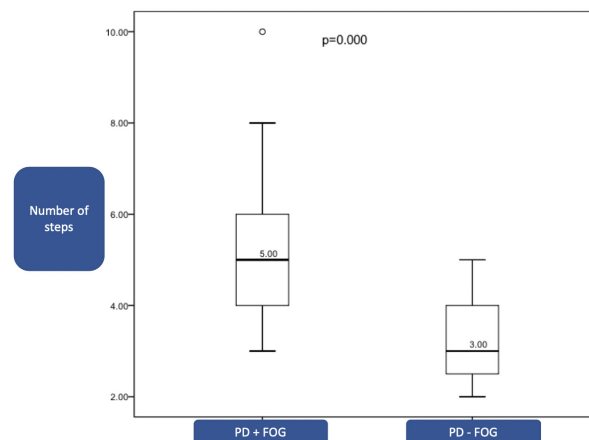


Fig. 1. The number of steps performed during the 180-degree turning in patients with PD), with and without FOG.

Also, there is a tendency to increase the number of steps with increasing FOG severity (fig. 2). As there were no patients with grade 4 severity and only 3 patients with grade 3 in the group of patients, this is not applicable for the group of most affected patients.

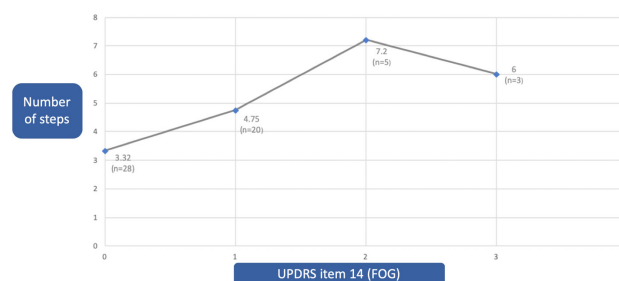


Fig. 2. Number of steps performed during the 180-degree rotation in patients with PD relative to the FOG severity according to item 14 of the UPDRS scale.

Discussion

This study is an attempt to identify clinical indicators of gait freezing in patients with Parkinson's disease. Finding the number of steps performed while turning 180 degrees and the time required for this maneuver proved being an excellent way to identify FOG patients.

Although there are studies that report the turning difficulty in patients with PD [12, 13, 15], to our knowledge this is the first study to confirm that this deficit is associated with FOG. Patients that experience FOG are likely to have problems with many daily activities and should therefore benefit from rehabilitation. FOG evaluation is not trivial, it is a variable symptom and difficult to provoke in clinical conditions [16]. Patients or relatives may confuse FOG with

Table 1 PD patients with and without FOG

Variables	PD + FOG (n=28)	PD - FOG (n=28)	P-value
Age, years (mean ± SD)	59.2 ± 7.1	60.5 ± 6.5	0.5
UPDRS III (mean ± SD)	40.1 ± 12.1	33.7 ± 8.4	0.2
Number of steps performed during turning (median, min-max)	5 (3 - 10)	3 (2 - 5)	0.0001^a
Time required to complete turning, seconds (mean ± SD)	5.2 ± 1.4	3.1 ± 1.2	0.0001^b

PD – Parkinson's disease, FOG – freezing of gait, SD – standard deviation, UPDRS – Unified Parkinson's Disease Rating Scale. ^a – Mann-Whitney test. ^b – T independent test.

other symptoms, such as steps shortening present in PD or falls in atypical forms of Parkinsonism like progressive supranuclear palsy. It is simple when this sign is seen in the clinic, however it does not occur during a regular examination in around half of the patients [6]. For this reason, a simple test such as the patient's 180-degree rotation, which can be easily done in the clinic that can help identify FOG, is definitely a good one. We have shown that greater number of steps and more time to turn 180 degrees is distinctive for PD patients with FOG. Therefore, we conclude that a patient with PD which performs the 180-degree rotation maneuver with more than 5 steps is probably a patient with FOG, even if he does not have an episode of FOG at the moment of examination. Though we cannot tell the opposite according to our data, a patient who performs less than 3 steps may still be a FOG patient.

Another interesting result is the severity of MS and the greater number of steps. According to item No 14 (FOG) of the UPDRS scale, the severity of the FOG is graded as: (0) FOG missing, (1) blocks rarely occur during walking, pause can occur at the beginning of walking, (2) occasional blockages while walking, (3) frequent FOG episodes, often block-related falls, (4) frequent FOG falls. The results of the current study show that the higher the number of steps, the more severe the FOG could be.

Conclusions

The present study has shown that it may be useful to distinguish the characteristic of PD patients with FOG from that of PD patients without FOG by the number of steps and the time used to perform the 180-degree turn.

References

- Giladi N, Nieuwboer A. Understanding and treating freezing of gait in Parkinsonism, proposed working definition, and setting the stage. *Mov Disord.* 2008;23:423-425. doi: 10.1002/mds.21927.
- Macht M, Kaussner Y, Moler JC, Mo, Stiasny-Kolster K, Eggert KM, Kruger HP. Predictors of freezing in Parkinson's disease: a survey of 6620 patients. *Mov Disord.* 2007;22:953-956. doi: 10.1002/mds.21458.
- Michałowska M, Fiszer U, Krygowska-Wajs A, Owczarek K. Falls in Parkinson's disease. Causes and impact on patients' quality of life. *Funct. Neurol.* 2005;20:163-168.

- Perez-Lloret S, Negre-Pages L, Damier P, Delval A, Derkinderen P, Destée A, Meissner WG, Schelosky L, Tison F, Rascol O. Prevalence, determinants, and effect on quality of life of freezing of gait in Parkinson disease. *JAMA Neurol.* 2014;71:884-890. doi: 10.1001/jamaneurol.2014.753.
- Contreras A, Grandas F. Risk factors for freezing of gait in Parkinson's disease. *J Neurol Sci.* 2012;320(1-2):66-71. doi: 10.1016/j.jns.2012.06.018.
- Nutt JG, Bloem BR, Giladi N, Hallett M, Horak FB, Nieuwboer A. Freezing of gait: moving forward on a mysterious clinical phenomenon. *Lancet Neurol.* 2011;10(8):734-744. doi: 10.1016/S1474-4422(11)70143-0.
- Plotnik M, Hausdorff JM. The role of gait rhythmicity and bilateral coordination of stepping in the pathophysiology of freezing of gait in Parkinson's disease. *Mov Disord.* 2008;23:S444-450. doi: 10.1002/mds.21984.
- Ehgoetz Martens KA, Hall JM, Georgiades MJ, Gilat M, Walton CC, Matar E, Lewis SJG, Shine JM. The functional network signature of heterogeneity in freezing of gait. *Brain.* 2018;141(4):1145-1160. doi: 10.1093/brain/awy019.
- Factor SA, Scullin MK, Sollinger AB, Land JO, Wood-Siverio C, Zanders L, Freeman A, Bliwise DL, Goldstein FC. Freezing of gait subtypes have different cognitive correlates in Parkinson's disease. *Parkinsonism Relat Disord.* 2014;20(12):1359-1364. doi: 10.1016/j.parkreldis.2014.09.023.
- Schaafsma JD, Balash Y, Gurevich T, Bartels AL, Hausdorff JM, Giladi N. Characterization of freezing of gait subtypes and the response of each to levodopa in Parkinson's disease. *Eur J Neurol.* 2003;10(4):391-398. doi: 10.1046/j.1468-1331.2003.00611.x.
- Willems AM, Nieuwboer A, Chavret F, Desloovere K, Dom R, Rochester L, Kwakkel G, Van Wegen E, Jones D. Turning in Parkinson's disease patients and controls: the effect of auditory cues. *Mov Disord.* 2007;22(13):1871-1878. doi: 10.1002/mds.21445.
- Mak MKY, Patla A, Hui-Chan C. Sudden turn during walking is impaired in people with Parkinson's disease. *Exp Brain Res.* 2008;190(1):43-51. doi: 10.1007/s00221-008-1446-1.
- Bong-sam C, Woo-taek L. The number of steps and time to accomplish turning during timed up and go test in community-dwelling elderlies with and without idiopathic Parkinson's disease. *Phys Ther Korea.* 2016;23(4):47-54.
- Mirelman A, Bonato P, Camicioli R, Ellis TD, Giladi N, Hamilton JL, Hass CJ, Hausdorff JM, Pelosin E, Almeida QJ. Gait impairments in Parkinson's disease. *Lancet Neurol.* 2019;18(7):697-708. doi: 10.1016/S1474-4422(19)30044-4.
- Stack E, Ashburn A. Dysfunctional turning in Parkinson's disease. *Disabil Rehabil.* 2008;30(16):1222-1229. doi: 10.1080/09638280701829938.
- Ziegler K, Schroeteler F, Ceballos-Baumann AO, Fietzek UM. A new rating instrument to assess festination and freezing gait in Parkinsonian patients. *Mov Disord.* 2010;25(8):1012-1018. doi: 10.1002/mds.22993.

Authors' ORCID iDs and academic degrees

Olga Gavriluc, MD, Researcher, PhD Applicant – <https://orcid.org/0000-0003-0677-5467>.

Alexandru Andrusca, MD, Researcher, PhD Applicant – <https://orcid.org/0000-0001-6174-7114>.

Mihail Gavriluc, MD, PhD, Professor of Neurology – <https://orcid.org/0000-0002-5789-2842>.

Authors' contribution

OG drafted the first manuscript; AA collected the data; MG designed the trial and revised the manuscript critically. All the authors revised and approved the final version of the manuscript.

Funding

The study was supported by *Diomid German* Institute of Neurology and Neurosurgery and *Nicolae Testemitanu* State University of Medicine and Pharmacy. The authors are independent and take responsibility for the integrity of the data and accuracy of the data analysis.

Ethics approval and consent to participate

The research protocol No 44 of April 12, 2018 was approved by the Research Ethic Board of *Nicolae Testemitanu* State University of Medicine and Pharmacy.

Conflict of Interests

The authors have no conflicts of interests to declare.