



Floating door sign does not differentiate Parkinson's disease from essential tremor

ABSTRACT

Diagnostic usefulness of the floating door sign was tested in 144 PD patients, 41 essential tremor patients and 38 controls. There were no differences in the presence of floating door sign between PD and ET patients. The sign does not seem to be a reliable differential diagnostic tool.

Parkinson's disease (PD) is associated with micrographia, as reflected in globally decreasing letter size throughout written text (consistent micrographia), or in gradually decreasing letter size while writing (progressive micrographia). [1] In 2013, Kulkarni et al. [2] reported a potentially important observation related to micrographia in PD. They suggested that when PD patients are instructed to draw a house, patients undershoot the drawing of the vertical lines of the door of the house and fail to connect the lines with the house floor. This 'floating door sign' would be a result of shortened stroke size and hypometric hand movements in PD and, importantly, no similar findings were reported in patients with essential tremor (ET). Thus, the sign could represent a simple qualitative test for PD vs ET differential diagnostics. However, the initial observation by Kulkarni et al. was limited by the sample size (81 PD patients, 19 ET patients) and lack of motor, cognitive or imaging measurements [2]. Here, we aimed to replicate and expand the previous findings with a considerably larger sample size and detailed clinical and imaging characteristics of the patients.

Altogether 144 PD patients, 41 ET patients, and 38 healthy controls were included in this study. The sample was a subsample of a previously described larger cohort [3], involving patients with valid drawing samples. On the day of the brain dopamine transporter (DAT) imaging, each participant was clinically examined 2–4 h prior to imaging. The examinations included the floating door sign, a clinical interview, the Movement Disorder Society-Sponsored Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS) part III, the Mini-Mental State Examination (MMSE) and the Beck Depression Inventory (BDI). Writing and drawing micrographia were also evaluated as described earlier. [3] For the floating door sign, we used the same protocol and cut-offs as in the original study describing the test [2]: subjects were instructed to draw a house with door and windows and the distance between the horizontal floor line and vertical door lines was measured. The test was considered positive if the vertical lines were more than 1 mm apart from the floor line. Groups were compared using one-way ANOVA with Tukey's method for pairwise comparisons, Kruskal-Wallis test with Dunn-Bonferroni method for pairwise comparisons or Chi-Square test as appropriate. P-values were corrected for multiple comparisons. The level of statistical significance was set at corrected $p < 0.05$.

The results showed that there was no difference in the presence of the floating door sign between PD and ET patients (Table 1), as 47 % of PD patients and 37 % of ET patients presented the sign ($p = 0.26$). Compared to healthy controls, PD patients showed more floating door sign (PD: 47 % vs HC: 24 % $p < 0.05$) but there were no differences between ET patients and healthy controls. There were no differences between floating door sign positive ($n = 67$) and negative ($n = 77$) PD patients in consistent (Median [IQR] area of handwriting sample: 3.7 [2.9] cm^2 vs 4.1 [3.1] cm^2 , $p = 0.12$) or progressive micrographia (mean [SD] β -value of regression line: -0.15 [0.22] vs -0.13 [0.20], $p = 0.72$).

Our results demonstrate that the floating door sign is a prevalent finding in both PD and ET patients and thus it does not represent a diagnostically useful specific marker for PD. The differential diagnosis between tremor-dominant PD and ET can be potentially challenging at early stages. Therefore, a simple bedside clinical test, such as the floating door sign, would have been a useful addition to the current diagnostic battery of tests. However, we revisited this issue and combined a large sample size with other clinical tests and brain functional dopamine transporter (DAT) imaging to verify the clinical PD and ET diagnoses. The results show that 1) the floating door sign is common in both PD and ET and 2) the sign is not related to PD micrographia. Micrographia, as evaluated using simple writing samples, may be more useful in a clinical setting as it may show diagnostic value in early and cognitively normal tremulous patients [3], particularly if combined with digital tablet technology and kinematic analyses [4]. Other paper and pen drawing tasks, such as Archimedes spiral and line drawing, may also provide better objective evidence of abnormal neurological function and aid differential diagnosis of tremor syndromes [5].

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

<https://doi.org/10.1016/j.prdoa.2023.100184>

Received 24 October 2022; Received in revised form 1 January 2023; Accepted 5 January 2023

Available online 27 January 2023

2590-1125/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Table 1

Demographic and clinical characteristics of studied subjects. Values are mean (SD), median [IQR] or n.

	PD	ET	HC	p-value ¹	p-value ² PD vs ET	p-value ² PD vs HC	p-value ² ET vs HC
n	144	41	38	–	–	–	–
Age, years	64.6 (10.2)	64.4 (10.2)	67.0 (9.2)	0.39	ns	ns	ns
Sex, male/female	71/73	19/22	19/19	0.93	ns	ns	ns
MMSE	28.0 [3.0]	28.0 [3.0]	28.0 [2.0]	0.19	ns	ns	ns
BDI	5.3 [7.0]	6.6 [9.2]	1.0 [6.0]	<0.001	ns	***	***
LEDD, mg	0.00 [1.00]	0.00 [0.0]	0.00 [0.0]	<0.001	**	***	ns
Levodopa, yes/no	28/116 (19 %)	1/40 (2 %)	0/38 (0 %)	<0.001	**	**	ns
MDS-UPDRS motor score	34.0 [21.3]	34.0 [21.0]	5.5 [7.3]	<0.001	ns	***	***
Mean striatum DAT SBR	1.58 (0.53)	2.99 (0.61)	2.41 (0.32)	<0.001	***	***	ns
Drawing micrographia, cm ²	23.0 [25.4]	27.1 [23.6]	25.8 [28.0]	0.457	ns	ns	ns
Writing micrographia (consistent), cm ²	3.98 [3.0]	5.36 [3.9]	5.48 [2.9]	<0.001	***	**	ns
Writing micrographia (progressive), β -value	-0.14 [0.25]	-0.06 [0.17]	-0.06 [0.32]	0.01	*	ns	ns
Floating door, yes/no	67/77 (47 %)	15/26 (37 %)	9/29 (24 %)	0.03	ns	*	ns

¹One-way ANOVA with Tukey's method for pairwise comparisons, Kruskal-Wallis with Dunn-Bonferroni method for pairwise comparisons or Chi-Square test as appropriate.

²P-values after correction for multiple comparisons. ***p < 0.001, **p < 0.01, *p < 0.05.

PD = Parkinson's disease, ET = Essential tremor, HC = Healthy control, SBR = specific binding ratio ((region/reference)-1), ns = non-significant.

MMSE = Mini-Mental State Examination score, BDI = Beck Depression Inventory score, LEDD = levodopa equivalent daily dose, UPDRS = Unified Parkinson's Disease Rating Scale, SBR = specific binding ratio.

Acknowledgements

We would like to thank RN Kari Lindholm and the staffs of the Departments of Nuclear Medicine at Turku and Helsinki University Hospitals for their time and devotion towards this project.

References

- [1] A. Letanneux, J. Danna, J. Velay, F. Viallet, S. Pinto, From micrographia to Parkinson's disease dysgraphia, *Mov Disord* 29 (12) (2014) 1467–1475.
- [2] O. Kulkarni, K. Lafaver, D. Tarsy, The floating door sign, *Parkinson's disease. Parkinsonism Relat Disord* 19 (9) (2013) 825–826.
- [3] M. Eklund, S. Nuutila, J. Joutsa, E. Jaakkola, E. Mäkinen, E. Honkanen, K. Lindholm, T. Vahlberg, T. Nojonen, T. Ihalainen, K. Murtoäki, T. Nojonen, R. Levo, T. Mertasalmi, F. Scheperjans, V. Kaasinen, Diagnostic value of micrographia in Parkinson's disease: a study with [¹²³I]FP-CIT SPECT, *J Neural Transm* (2022), <https://doi.org/10.1007/s00702-022-02517-1>.
- [4] M. Thomas, A. Lenka, P.K. Pal, Handwriting analysis in Parkinson's disease: current status and future directions, *Mov Disord Clin Pract* 4 (6) (2017) 806–818.

- [5] J. Althy, J. Cosgrove, D. Thorpe, P. Kempster, How to use pen and paper tasks to aid tremor diagnosis in the clinic, *Pract Neurol* 17 (6) (2017) 456–463.

Valtteri Rätty^{a,b}, Mikael Eklund^{a,b,c}, Simo Nuutila^{a,b}, Elina Jaakkola^{a,b}, Elina Mäkinen^{a,b,e}, Kirsi Murtoäki^e, Tanja Nojonen^e, Reeta Levo^e, Tuomas Mertasalmi^e, Juho Joutsa^{a,b,c,d}, Filip Scheperjans^e, Valtteri Kaasinen^{a,b,*}

^a Clinical Neurosciences, University of Turku, Turku, Finland

^b Neurocenter, Turku University Hospital, Turku, Finland

^c Turku PET Centre, Turku University Hospital, Turku, Finland

^d Turku Brain and Mind Center, University of Turku, Turku, Finland

^e Department of Neurology, Helsinki University Hospital, and Clinicum, University of Helsinki, Helsinki, Finland

* Corresponding author.

E-mail address: valtteri.kaasinen@tyks.fi (V. Kaasinen).