ARTIGO ORIGINAL/ORIGINAL ARTICLE

Differences in Writing and Drawing may Help Differentiate Parkinson's Disease from Essential Tremor

Alterações em Tarefas de Escrita e Desenho podem Ajudar a Diferenciar entre Doença de Parkinson e Tremor Essencial

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Abstract

Introduction: The ability to draw figures requires preserving visuospatial functions and motor pathways. The floating door sign (FDS) reflects the inability to join the vertical lines of a door with the floor when a patient is asked to draw a house. This signal was described as a positive predictive factor for Parkinson's Disease (PD), but not essential tremor (ET). Nevertheless, conflicting literature has emerged recently. We aim to evaluate the features of the FDS and other graphomotor tasks in patients with PD and ET.

Methods: Patients recruited from 2 hospital centers were asked to draw 3 pictorial elements (house, flower, and sun), write a sentence and perform 2 cognitive evaluations (pentagons copy and clock drawing test). Clinical and demographic characteristics from both groups were obtained.

Results: A total of 54 patients (PD: 38; ET: 16) were included. FDS was more prevalent in PD patients (PD: 45% *vs* ET: 6%; $p = 0.005$), who also drew a significantly smaller house. PD patients drew a sun with a significantly smaller diameter, increased number of smaller sunbeams and a higher distance sun-sunbeam. Additionally, a significantly smaller flower and lower, flatter petals, with an increase distance petals-flower were also found in the PD patients' group. Comparing PD patients with positive *versus* negative FDS, we found that those with a positive FDS scored less on the pentagons copy (4.1 ± 1.8 *vs* 5.2 ± 1.2; p=0.025), with no significant differences in the UPDRS motor or micrographia-related scores.

Conclusion: Graphomotor tasks, including the FDS, can be useful in the distinction of patients with PD and ET. The presence of the FDS could be associated to a mild visuospatial cognitive dysfunction. This potential interplay warrants further exploration in future studies.

Resumo

Introdução: A habilidade de desenhar figuras requer a preservação de funções visuoespaciais e circuitos motores. O *floating door sign* (FDS) é um achado semiológico avaliado quando se solicita a um paciente que desenhe uma casa e é definido pela incapacidade de unir as linhas verticais que representam a porta com a linha horizontal do chão da casa. Este sinal foi primariamente descrito como fator preditivo positivo para o diagnóstico de doença de Parkinson (DP), mas não para tremor essencial (TE). No entanto, existem conflitos de resultados na literatura mais

recente. O objetivo do estudo foi avaliar as características do FDS e outras funções grafomotoras em pacientes com DP e TE.

Métodos: Os pacientes foram recrutados em 2 centros hospitalares. Foi requisitado que desenhassem 3 figuras (uma casa, uma flor e um sol), escrevessem uma frase e realizassem 2 avaliações cognitivas (teste da cópia dos pentágonos e desenho do relógio). Foram recolhidas variáveis clínicas e demográficas de ambos os grupos.

Resultados: Foram incluídos um total de 54 pacientes (DP: 38; TE: 16). O FDS foi mais prevalente nos pacientes com DP (DP: 45% *vs* TE: 6%; $p = 0,005$), os quais também desenharam casas significativamente mais pequenas. Os pacientes com DP desenharam um sol significativamente mais pequeno, com um número de raios maior e uma distância sol-raios mais elevada. Em relação às métricas da flor, os pacientes com DP desenharam uma flor mais baixa com pétalas mais curtas e estreitas e uma distância flor-pétala maior. Quando comparados os pacientes com DP e FDS positivo *versus* negativo, aqueles com um FDS positivo apresentaram uma pontuação menor no teste de cópia dos pentágonos (4,1 ± 1,8 *vs* 5,2 ± 1,2; p=0,025), sem diferenças em *scores* relacionados com a micrografia ou escala motora da MDS-UPDRS.

Conclusão: As funções grafomotoras, incluindo o FDS, podem ser úteis no diagnóstico diferencial entre DP e TE. A presença de FDS poderá estar associada a disfunção cognitiva visuoespacial. Esta potencial relação deverá ser avaliada em estudos futuros.

Introduction

Essential tremor (ET) is a condition to consider in the differential diagnosis of Parkinson's disease (PD). The ability of execution in some graphomotor tasks might help to discriminate between these two disorders, namely the spiral drawing test, the detection of micrographia and, more recently, the presence of a positive floating door sign (FDS) has been described. We read with great interest the study by Kulkarni *et al* where this sign was first reported and appeared to have a positive predictive value for PD.[1] This sign was present in 55% of PD patients and the authors hypothesized that it could be related to a shortened stroke size and hypometric hand movements, causing an undershooting in drawing tasks in people with PD. However, conflicting results emerged in a more recent study by Valtteri Rätya *et al*, where FDS was able to differentiate people with PD from healthy controls, but not from essential tremor patients, with no difference in micrographia scores between patients with positive and negative FDS.[2]

Our study aims to evaluate the features of the FDS and other graphomotor tasks in patients with PD and ET. Moreover, we analyzed clinical and sociodemographic data to explore potential underlying mechanisms in performing these drawing tasks.

Material and Methods

Patients were recruited from movement disorders outpatient clinics in two hospital centers, using a convenience sample with informed consent obtained and approval from the local ethics committee secured. Parkinson's disease and essential tremor diagnosis were established based on current guidelines.[3,4] Patients reporting cognitive complaints were not included. Participants were asked to write a sentence ("*Olhei e vi um ovo*") and to draw three pictorial elements – a sketch of a sun, a flower, and a house. In case the initial drawings did not fulfill the intended graphomotor evaluations, verbal commands were given to draw a sun including sunbeams, a flower with petals and a house with a door. Concerning the writing test, we analyzed the length of the sentence and the height of the first and last letters (the same letter 'O'). In the drawing test, we analyzed: i) the height of the sun, the number and length of sunbeams, and the distance between the sun core and the sunbeams; ii) the height of the flower, the number, width, and height of the petals and the distance from the petals to the flower center; iii) the height of the house and the distances from floor to the wall and the door (the so-called floating door sign - FDS). A positive FDS was considered if a distance > 1 mm between both vertical lines of the door and the

floor was present, as originally described.[1] Measurements were performed manually with a scale loupe. Visuospatial cognitive function was briefly assessed in both groups with the clock drawing test[5] and the intersecting pentagon test.[6] Finally, the MDS-UPDRS part III and Schwab and England Activities of Daily Living scales were also applied in PD patients.[5-8] Student t-test or Mann-Whitney test were used as appropriated to compare continuous variables and Fisher's exact test or Chi-square test to compare nominal variables between the two groups.

Results

A total of 54 patients (38 with PD and 16 with ET) were included. Demographic and clinical characteristics are described in **Table 1**. No significant disparities in age or sex were observed between groups. Mean duration of the diseases was 10 years for PD and 27 years for ET patients. PD patients' assessment was performed during an "on" state in 66% of the evaluations and there was no description of dyskinesias interfering with the motor evaluation.

Table 1. Demographics and clinical information of the PD and ET patients.

	PD (n=38)	**ET** (n=16)
Age, years (mean ± SD)	74 ± 8	75 ± 5
Sex, M/F	22/16	9/7
ADL scale, score (median ± IQR)	80 ± 30	90 ± 20
Disease duration, years (mean ± SD)	10 ± 7	27 ± 15
Clinical phenotype, akinetic-rigid/ tremor dominant	24/14	-
Hoehn and Yahr scale, score (median ± IQR)	2 ± 1	-

Performances in writing and drawing tasks in patients with PD and ET are displayed in **Table 2**. People with PD exhibited objective micrographia, expressed by a smaller ratio in height between the first and last letter (0.66 ± 0.23 *vs* 0.9 ± 0,1; $p<0{,}001$). Also, drawings were almost always smaller and with reduced stroke length compared to those from ET patients, specifically the house; height, the sun; diameter, the sunbeams; length, and several flower-related metrics. In patients with PD, we found an increase in the distance between the drawing of the sun core and the sunbeams, and between the body of the flower and the petals (**Fig. 1**). Importantly, the FDS was detected in 45% of PD patients, and in only 6% of ET patients ($p = 0.005$). Relevantly, people with PD had a lower score in the pentagons drawing test when compared to ET (4.7 ± 1.6 *vs* 5.7 ± 0.6; $p=0.007$).

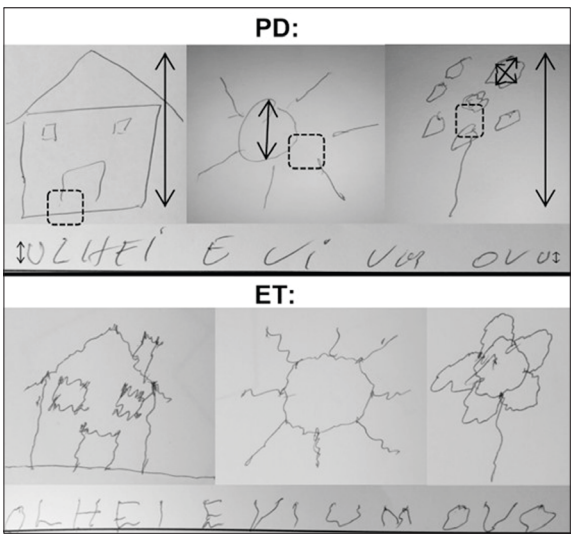

Figure 1. Examples of drawings tasks and sentence writing between Parkinson's disease (PD) and essential tremor (ET) groups.

Patients with PD were more likely to draw a house with a smaller height and a positive "floating door" sign (dashed line). When asked to illustrate a sun, PD patients' sketches showed a significant smaller sun diameter, higher number of sunbeams with reduced length and an increased distance from the sun core to the sunbeams (the "floating sunbeam" sign; dashed line). In the flower drawing, a shorter flower with smaller petals and increased distance between the petals and the flower was seen in the PD group (the "floating petal" sign; dashed line). In the sentence writing task ("OLHEI E VI UM OVO"), PD patients displayed micrographia with a reduced height of the last letter and a decreased ration between the last/first letter ("O").

When comparing PD patients with a positive and negative FDS (**Table 3**), we found a lower score in the pentagons test (4.1 ± 1.8 *vs* 5.2 ± 1.2; $p=0.025$), a higher sunbeams-sun distance (0.8 ± 1.3 *vs* 0.1 ± 0.2 mm; $p = 0.017$) and a smaller petals' width (3.5 ± 1.8 *vs* 5.6 ±3.4 mm; $p = 0.041$) in those with a positive FDS. No differences were observed in the activities of daily living (ADL) scale, the MDS-UPDRS part III total and subscale (bradykinesia, tremor, and rigidity) and micrographia scores between the FDS subgroups.

Discussion

Our study demonstrated several writing and drawing differences between patients with PD and ET, including the floating door sign. Several metrics in the pictorial elements were objectively measured, with consistent findings of reduced length and height. Additional findings, similar to the floating door were also noticed, as people with PD displayed an increased distance between the circle of the sun and the adjacent sunbeams and between the flower and the petals. Interestingly,

Table 2. Comparison between PD and ET groups in writing, drawing and visuospatial tasks.

	PD (n=38)	ET (n=16)	*p* value
Sentence			
Height 1st letter, mm (mean ± SD)	9.0 ± 3.2	8.1 ± 2.6	0.493
Height last letter, mm (mean ± SD)	5.6 ± 2.1	7.6 ± 2.3	0.009*
Sentence length, mm (mean ± SD)	118.3 ± 27.2	130 ± 31.4	0.215
Ratio last/first letter, (mean ± SD)	0.66 ± 0.23	0.9 ± 0.1	<0.001*
Micrographia (last letter <6 mm), n (%)	10/38 (26%)	0/16 (0%)	0.02*
House			
Height, mm (mean ± SD)	41 ± 18	43.7 ± 13.5	0.049*
Distance wall-floor, mm (mean ± SD)	1.0 ± 2.4	0.2 ± 0.2	0.287
Distance door-floor, mm (mean ± SD)	1.9 ± 2.4	0.1 ± 0.3	<0.001*
Floating door sign, n (%)	17/38 (45%)	1/16 (6%)	0.005*
Sun			
Diameter, mm (mean ± SD)	19.1 ± 6.5	26.4 ± 7.2	<0.001*
Number of sunbeams, n (mean ± SD)	11.2 ± 8.6	8.1 ± 1.1	0.002*
Length of sunbeams, mm (mean ± SD)	7.8 ± 3.6	14.4 ± 5.2	<0.001*
Distance sunbeams-sun, mm (mean ± SD)	0.4 ± 0.9	0.0 ± 0.0	0.016*
Flower			
Height, mm (mean ± SD)	34.9 ± 12.3	46.7 ± 12.7	0.003*
Number of petals, n (mean ± SD)	6.9 ± 2.9	5.9 ± 1.3	0.083
Width of petals, mm (mean ± SD)	4.7 ± 2.9	9.3 ± 2.9	<0.001*
Height of petals, mm (mean ± SD)	5.4 ± 2.4	8.4 ± 3.1	<0.001*
Distance petals-flower, mm (mean ± SD)	0,5 ± 1.3	0.0 ± 0.0	0.037*
Visuospatial tasks			
Pentagons, score (mean ± SD)	4.7 ± 1.6	5.7 ± 0.6	0.007*
Clock drawing test, score (mean ± SD)	7.3 ± 2.9	8.1 ± 2.6	0.372

* Statistically significant *p* value.

these signs appear to be correlated, as PD patients with a positive FDS also revealed a lower stroke size and height in other drawing metrics when compared to those with a negative FDS.

Even though the included PD patients expressed no cognitive complaints, subclinical visuospatial dysfunction may have been present, which is hinted at by the lower score in the intersecting pentagons. Additionally, the pentagons test score was significantly lower in the group of PD patients with a positive FDS, and no differences in the micrographia or motor subscales scoring were found. Taken together, these findings could shed some light on the pathophysiological mechanisms behind this sign. We hypothesize that the presence of the FDS could be associated with a mild visuospatial cognitive dysfunction in addition to the presence of bradykinesia and micrographia, as previously suggested.[1] Indeed, PD patients present a progressive impairment of object perception and visuospatial construction skills as the disease progresses, as well as difficulties in visual acuity and image processing.[9] Together with fine motor control, all these factors play a role in the ability to draw objects. In our study, the mean age of the PD patients and disease duration were superior to those reported in the literature of previous FDS studies (74 [our study] versus 66 [Kulkarni *et al*] *versus* 65 [Raty *et al*]). Hence, this factor could have contributed to a higher proportion of subclinical cognitive impairment and the subsequent prevalence of FDS in our patients.

Conclusion

We present evidence that the quantitative evaluation of writing and drawing tasks of three simple pictorial elements differs between PD and ET patients. These bedside examinations, including the floating door sign, might be a useful clinical tool in the differential diagnosis of these disorders. The potential interplay between visuospatial cognitive dysfunction and performance in

Table 3. Comparison between patients with positive vs. negative floating door sign (FDS) in MDS-UPDRS part III scores, writing, drawing and visuospatial tasks.

	FDS positive (n=21)	FDS negative (n=17)	*p* value
ADL scale	75.5 ± 16.7	71.2 ± 20.0	0.609
PD duration	9.8 ± 8.5	9.4 ± 5.3	0.690
UPDRS			
Total rigidity	5.2 ± 2.8	4.59 ± 3.0	0.399
Total bradykinesia	16.8 ± 8.9	14.4 ± 9.5	0.222
Total tremor	6.4 ± 5.8	5.2 ± 5.4	0.552
Hoen and Yahr	2.6 ± 0.8	2.7 ± 0.9	0.886
Total score	29.1 ± 21.9	24.4 ± 24.3	0.377
Sentence			
Height 1st letter, mm (mean ± SD)	9.3 ± 3.6	8.7 ± 2.8	0.889
Height last letter, mm (mean ± SD)	5.7 ± 2.0	5.4 ± 2.3	0.410
Sentence length, mm (mean ± SD)	118.0 ± 26.1	118.8 ± 29.4	0.903
Ratio last/first letter, (mean ± SD)	0.7 ± 0.2	0.6 ± 0.2	0.728
Micrographia (last letter <6 mm), n (%)	4/21 (19%)	6/17 (35%)	0.276
House			
Height, mm (mean ± SD)	43.3 ± 20.3	38.4 ± 14.7	0.205
Distance wall-floor, mm (mean ± SD)	0.4 ± 0.7	1.6 ± 3.4	0.302
Sun			
Diameter, mm (mean ± SD)	20.4 ± 6.8	17.5 ± 6.0	0.282
Number of sunbeams, n (mean ± SD)	11.7 ± 11.2	10.7 ± 3.5	0.458
Length of sunbeams, mm (mean ± SD)	7.9 ± 3.5	7.6 ± 3.9	0.511
Distance sunbeams-sun, mm (mean ± SD)	0.1 ± 0.2	0.8 ± 1.3	0.017*
Flower			
Height, mm (mean ± SD)	37.2 ± 12.2	32.2 ± 12.2	0.190
Number of petals, n (mean ± SD)	6.3 ± 1.7	7.8 ± 3.7	0.072
Width of petals, mm (mean ± SD)	5.6 ±3.4	3.5 ± 1.8	0.041*
Height of petals, mm (mean ± SD)	6.1 ±2.9	4.6 ± 1.6	0.132
Distance petals-flower	0.2 ± 0.7	0.8 ± 1.7	0.063
Visuospatial tasks			
Pentagons, score (mean ± SD)	5.2 ± 1.2	4.1 ± 1.8	0.025*
CDT (Sunderland: 1-10), score (mean ± SD)	8.0 ± 2.8	6.4 ± 3.0	0.114

* Statistically significant *p* value.

graphomotor tasks in PD patients warrants further exploration in future studies. ■

Contributorship Statement / Declaração de Contribuição

DF: Conceptualização do artigo, recolha e análise de dados, escrita e edição do manuscrito.

CS e CD: Conceptualização do artigo, recolha de dados, escrita e edição do manuscrito.

MJR e RA: Conceptualização do artigo, análise de dados, supervisão e revisão do manuscrito.

Responsabilidades Éticas

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.

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Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.

Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia revista em 2013 e da Associação Médica Mundial.

Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

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Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the

regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2013).

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References / Referências

1. Kulkarni O, Lafaver K, Tarsy D. The "floating door sign" in Parkinson's disease. Parkinsonism Relat Disord. 2013;19:825-6. doi: 10.1016/j.parkreldis.2013.04.013.
2. Räty V, Eklund M, Nuuttila S, Jaakkola E, Mäkinen E, Murtomäki K, et al. Floating door sign does not differentiate Parkinson's disease from essential tremor. Clin Park Relat Disord. 2023;8:100184. doi: 10.1016/j.prdoa.2023.100184.
3. Bhatia KP, Bain P, Bajaj N, Elble RJ, Hallett M, Louis ED, et al. Consensus Statement on the classification of tremors. from the task force on tremor of the International Parkinson and Movement Disorder Society. Mov Disord. 2018;33:75-87. doi: 10.1002/mds.27121.
4. Postuma RB, Poewe W, Litvan I, Lewis S, Lang AE, Halliday G, et al. Validation of the MDS clinical diagnostic criteria for Parkinson's disease. Mov Disord. 2018;33:1601-8. doi: 10.1002/mds.27362.
5. Sunderland T, Hill JL, Mellow AM, Lawlor BA, Gundersheimer J, Newhouse PA, et al. Clock drawing in Alzheimer's disease. A novel measure of dementia severity. J Am Geriatr Soc. 1989;37:725-9. doi: 10.1111/j.1532-5415.1989.tb02233.x.
6. Bourke J, Castleden CM, Stephen R, Dennis M. A comparison of clock and pentagon drawing in Alzheimer's disease. Int J Geriat Psychiatry. 1995;10:703-5. doi: 10.1002/gps.930100811.
7. Schwab RS, England AC. Projection technique for evaluating surgery in Parkinson's disease. In: Gillingham FJ, Donaldson IML, editors. Third symposium on Parkinson's disease. Edinburgh: E S Livingstone;1969. p. 152–7.
8. Movement Disorder Society Task Force on Rating Scales for Parkinson's Disease. The Unified Parkinson's Disease Rating Scale (UPDRS): status and recommendations. Mov Disord. 2003;18:738-50. doi: 10.1002/mds.10473.
9. Weil RS. Visual Dysfunction and Parkinson's Disease. Mov Disord. 2020;35:1499-501. doi: 10.1002/mds.28212.