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Speech and gait in Parkinson's disease: When rhythm matters

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ABSTRACT

Introduction: Speech disturbances in Parkinson's disease (PD) are heterogeneous, ranging from hypokinetic to hyperkinetic types. Repetitive speech disorder has been demonstrated in more advanced disease stages and has been considered the speech equivalent of freezing of gait (FOG). We aimed to verify a possible relationship between speech and FOG in patients with PD.

Methods: Forty-three consecutive PD patients and 20 healthy control subjects underwent standardized speech evaluation using the Italian version of the Dysarthria Profile (DP), for its motor component, and subsets of the Battery for the Analysis of the Aphasic Deficit (BADA), for its procedural component. DP is a scale composed of 7 sub-sections assessing different features of speech; the rate/prosody section of DP includes items investigating the presence of repetitive speech disorder. Severity of FOG was evaluated with the new freezing of gait questionnaire (NFGQ).

Results: PD patients performed worse at DP and BADA compared to healthy controls; patients with FOG or with Hoehn-Yahr >2 reported lower scores in the articulation, intellibility, rate/prosody sections of DP and in the semantic verbal fluency test. Logistic regression analysis showed that only age and rate/prosody scores were significantly associated to FOG in PD. Multiple regression analysis showed that only the severity of FOG was associated to rate/prosody score.

Conclusions: Our data demonstrate that repetitive speech disorder is related to FOG and is associated to advanced disease stages and independent of disease duration. Speech dysfluency represents a disorder of motor speech control, possibly sharing pathophysiological mechanisms with FOG.

1. Introduction

Gait and speech disorders belong to the spectrum of axial symptoms of Parkinson's disease (PD), occurring more frequently in later stages of the disease and responding only partially to dopaminergic treatments [1].

Gait in PD patients is characterized by a reduction of velocity and step length, decreased arm swing, and an increased cadence and stride-to-stride variability [2]. Among gait disturbances, freezing of gait (FOG) represents a frequent and disabling symptom most commonly experienced during gait initiation, turning, and when dealing with obstacles or other tasks. FOG is an episodic gait phenomenon consisting of sudden and often unexpected episodes during which patients' feet subjectively become “glued” to the floor” while their trunk continues to move forward [2]. Speech disturbances in PD are heterogeneous, including hypokinetic, hyperkinetic and iterative (or repetitive) abnormalities [3–5]. Repetitive speech disorder (variably referred to as stuttering, iterations, palilalia, oral festination) is characterized by variable speech iterations with immediately successive repetitions of syllables, words, or phrases causing speech arrest. It appears to be more frequent in advanced stages of the disease [5,6] and it is not influenced by levodopa administration [7]. Although repetitive speech disorder has been suggested as the speech equivalent of FOG [1,5], the association between these phenomena has not been explored in a large PD population; moreover, the influence of disease stage, disease duration and motor complications on such association is unknown, so far. Given these premises, aim of the

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present study was to evaluate speech, in both its motor and procedural components, in PD patients and in healthy controls and to verify a possible relationship between speech disorder and FOG in PD.

2. Methods

2.1. Participants

Consecutive PD patients fulfilling UK Brain Bank diagnostic criteria [8], were evaluated at the movement disorders out-patient clinic at University of Messina and they all agreed to participate to the study. We enrolled consecutive patients to avoid selection biases and include subjects with different disease stages and disease duration.

Exclusion criteria were the presence of severe hearing loss, any orthopedic or neurological deficit interfering with walking and with speech, respiratory insufficiency, brain trauma, and dementia (according to DSM IV criteria and a score <24 at Mini Mental State Examination). Each subject was evaluated by the same neurologist (M.B.) and speech therapist (A.G.), both experts in movement disorders. Patients were assessed in the ON medication condition, 60–90 min after the first levodopa intake in the morning, in order to avoid variability in cognitive functions and attention during the execution of the tasks. All subjects signed an informed consent, the institutional ethics approval was obtained and the study was conducted in accordance with the Declaration of Helsinki.

2.2. Clinical evaluation of Parkinsonism

Demographic and clinical data were collected, including age, educational level, disease duration, most affected side. Levodopa equivalent daily dose (LEDD) was calculated for all dopaminergic medication (total LEDD) and for dopamine-agonists (D-Ag LEDD) [9]. Patients underwent a complete neurological examination, including the Unified Parkinson's disease rating scale (UPDRS) part I–IV and the Hoehn-Yahr (HY) staging. The axial subscore of UPDRS-III defined as the sum of items 27–30 was calculated. Motor complications and presence and severity of FOG were evaluated by means of section II of UPDRS and the New Freezing of Gait Questionnaire (NFGQ). Overall global cognitive functions were assessed using the MMSE.

2.3. Speech evaluation

Speech was evaluated in its motor and procedural components respectively by means of the Italian version [10] of the Dysarthria Profile (DP) [11] and of subsets of the screening Battery for the Analysis of the Aphasic Deficit (BADA) [12]. The italian version of DP is composed of 8 sub-sections assessing different features of speech: respiration, phonation, facial musculature, diadochokinesis, articulation, intellibility, rate/prosody, eating and swallowing. The subsection rate/prosody investigates the rate and rhythm of speech; specifically some of the items of this subsection investigate the ability to maintain the same rhythm and the presence of festination when speaking (i.e. maintenance of rate, increase of velocity, maintenance of rhythm).

Different BADA subsets were administered in order to evaluate the logical, lexical-semantic and syntactic abilities. In details: phoneme discrimination, oral picture naming of nouns and actions (to explore word-finding abilities), pseudo-words reading aloud, pseudo-words repetition, sentences and sintagma repetition. Finally phonological and semantic verbal fluencies were assessed (number of generated words for letter F and number of generated names of birds during a period of 60 s each; perseverative responses were subtracted from the total count).

2.4. Statistical analysis

Analysis was performed clustering patients according to different clinical criteria: presence/absence of FOG, HY stage (≤2/>2); presence/absence of motor complication (stable responders/complicated); disease duration (≤8/>10 years).

For each variable (demographic, clinical, and speech data) comparisons between groups were made using either Mann-Whitney *U* test or factorial ANOVA according to deviation from normality. Normal distribution was investigated using the Kolmogorov-Smirnov test. Spearman correlation was employed to explore a relationship between variables related to FOG (NFGQ) and speech (sections of DP scale, phonological and semantic fluency) and clinical variables. Conditional to significant effect in the univariate analysis, logistic regression models were employed to verify which variable was associated to FOG in PD. Multiple linear regression analysis was used to verify which variable were correlated with severity of FOG, by NFGQ score. A p-value <0.05 was considered significant. Error bars refer to standard deviations.

3. Results

Forty-three consecutive PD patients (mean age: 68.3 ± 11.7 years; females: 12; mean disease duration: 7.7 ± 6.0 years) met the criteria for our study and were included in the analysis. Twenty healthy controls (HC) subjects comparable for age and gender were selected. Table 1 shows demographical features, motor and procedural components of speech of PD patients and HC subjects. All items of DP were significantly lower in PD compared to HC. Regarding procedural component of speech, HC performed significantly better than PD in the following assessments: pseudo-words reading and repetition, phonological verbal fluency and semantic verbal fluency.

Table 2 shows demographical and clinical variables of PD patients grouped according to presence/absence of FOG and HY stage. Total score of DP did not significantly differ when categorizing PD sample according to presence/absence of FOG ($p = 0.3$) and HY > 2 ($p = 0.7$). When analysing each sub-section of the DP scale, patients with FOG reported lower scores in the articulation, intellibility, rate/prosody subsections (Table 3); analyzing each single items of the rate/prosody section of DP, PD patients with FOG reported significantly lower scores in items correlated with rhythm ($p = 0.001$), velocity ($p = 0.002$) and rate maintenance ($p = 0.0002$) (Fig. 1 ,panel A). Similar results were also obtained when categorizing PD patients according to HY stage >2 (Table 3); in addition, PD with HY stage >2 had lower performance at the sections respiration and facial musculature. When categorizing PD patients according to either presence/absence of motor complications or disease duration >10 years, we did not find any significant difference in DP total score (respectively $p = 0.6$ and $p = 0.3$) and in any section of the DP scale.

No significant difference in any score of the different sub-sets of BADA was revealed between PD patients according to HY stage, presence/absence of FOG (Table 3), disease duration and presence/absence of motor complications. The only exception was for semantic verbal fluency ($p = 0.008$), which was lower in patients with more advanced disease stages (H&Y > 2 group) and in patients with FOG (Table 2). No significant difference was found in any score of the sub-sets of BADA when categorizing PD patients according to disease duration >10 years and presence/absence of motor complications.

Severity of FOG as per NFGQ score positively correlated with the UPDRS-III axial score ($p = 0.003$) (Fig. 1, panel B), total LEDD

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