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S P T S

Review

Measures used for the evaluation of balance in individuals with Parkinson's disease: a systematic review

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Abstract. [Purpose] The present literature review was conducted on the use of different measures for the evaluation of balance in patients with Parkinson's disease. [Materials and Methods] The PubMed, Bireme, SciELO, Lilacs, and PEDro electronic databases were searched for relevant studies. [Results] The searches initially led to the retrieval of 3,623 articles, 540 of which were potentially eligible after limiting the search to clinical trials published in the last five years. A total of 264 duplicates were removed, and 276 articles were excluded based on their titles and abstracts. The full texts of 84 articles were analyzed, and only those with a PEDro score higher than four points (n=25) were included in the review. [Conclusion] Different methods, such as scales, tests, and equipment, are used for the evaluation of balance in patients with Parkinson's disease. More than one measure has been employed in most studies, and there is no consensus on a single precise measure for the evaluation of balance in this population.
Key words: Parkinson's disease, Balance, Postural control

INTRODUCTION

Parkinson's disease (Parkinson's) is a progressive, chronic, neurodegenerative disease[1] stemming from the atrophy of grey matter. It is estimated that 10 million individuals around the world suffer from Parkinson's, and this figure is expected to double by the year 2030[2]. The prevalence of Parkinson's ranges from 0.3% among individuals aged less than 60 years to 1% among those aged 60 or older[3]. The progressive nature of the disease causes both motor and non-motor alterations. The main motor alterations are associated with the risk of falls, which leads to a sedentary lifestyle and the reduction in activities of daily living exerts a negative impact on clinical aspects[1–5].

The main clinical manifestations of Parkinson's are shaking, stiffness, slowness of movement, postural alterations, and stooped gait, leading patients to adopt a flexed posture due to the dominance of pro-gravitational muscles, with forward leaning of the head, the chin tlited toward the thorax, kyphotic thorax, protracted shoulders, the arms rotated internally, and, flexion of the hips, knees, and elbows, which projects the body forward, compromising postural orientation and leading to

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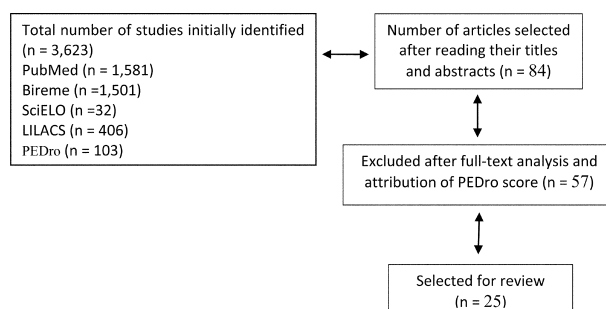
Fig. 1. Flowchart of studies included in the present literature review

impaired balance[6]. All these postural changes, together with other alterations, lead to postural instability, which is considered one of the main characteristics of patients with Parkinson's. This instability leads to a progressive reduction in both static and dynamic balance, affecting one's ability to remain standing without support or even sit down.

Researchers believe that postural instability is related to the loss of the capacity to control intentional movements of the center of body mass on the support base during activities that involve the transfer of weight. Many individuals with Parkinson's demonstrate inadequate interactions among the vestibular, visual, and proprioceptive systems, with consequent changes in the biomechanics of the body[7].

The motor rehabilitation process for patients with Parkinson's is normally directed toward static and functional balance training to provide greater interactions with the surrounding environment through treadmill training[8], balance training involving virtual reality programs[9], the combination of dance and motor training[10], etc. A set of assessment measures to determine the effects of particular interventions has been validated and reported in literature[11]. Assessment measures are important for analysis of functional changes in all stages of the disease and are particularly sensitive with regard to the evaluation of therapeutic intervention[12]. The Unified Parkinson's Disease Rating Scale (UPDRS)[13], Berg Balance Scale, Timed Up and Go Test[14], Six-Minute Walk Test (6WMT), 10-Meter Walk Test (10MWT)[15], and a force plate to determine the center of pressure[16] are among the measures used for the evaluation of balance. Moreover, a combination of different measures previously used in controlled clinical trials is often employed.

The aim of the present study was to perform a systematic review of the literature for the analysis of different measures used in the evaluation of balance in patients with Parkinson's disease.

MATERIALS AND METHODS

The PubMed (National Library of Medicine), BVS Bireme, SciELO, LILACS and PEDro electronic databases were searched for relevant studies addressing balance in patients with Parkinson's disease. For this purpose, the following combinations of keywords were used: Parkinson's disease and balance evaluation, Parkinson Disease and balance alterations, Parkinson Disease and balance change, Parkinson Disease and change in balance, Parkinson Disease and Balance Control and Parkinson Disease and Postural Control Balance. The search was limited to randomized controlled, clinical trials published in the previous five years (inclusion criteria).

The searches initially led to the retrieval of 3,623 articles, 540 of which were potentially eligible based on the inclusion and exclusion criteria. A total of 264 duplicates were removed, and 276 articles were excluded based on their titles and abstracts. The full texts of 84 articles were analyzed, with the inclusion of only those that met the eligibility criteria and had a PEDro score higher than four points. Thus, 25 studies were selected for the present systematic review (Fig. 1).

RESULTS

Table 1 displays the PEDro scores of the 25 studies that met the eligibility criteria and were included in the present systematic review. Diverse methods for the evaluation of balance in individuals with Parkinson's were used in studies with different intervention protocols and comparisons between the experimental and control groups (Table 2).

DISCUSSION

In the context of chronic neurological disorders, efforts are made to diminish physical difficulties and allow affected individuals to perform activities of daily living with the greatest possible efficiency and independence[38]. Thus, assessment tools and specific measures that address more generic aspects, such as muscle strength, range of motion, functioning, and im-

Table 1. Scores of articles included in literature review

Reference	Eligibility	1- Randomized allocation	2- Confidential allocation	3- Similar prognosis	4- Blinded subjects	5- Blinded therapists	6- Blinded evaluators	7- Key results	8- Intention to treat analysis	9- Comparison between groups	10- Precision and variability	Score
Abud Qutubuddin et al., 2013[17]	Y	Y	N	Y	N	N	Y	N	N	Y	Y	5/10
Sara Pires et al., 2014[18]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10
Chirs J., Hass et al., 2012[19]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6/10
Fuzhong Li et al., 2012[20]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7/10
Xia Shen et al., 2015[21]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Natalie E., Allen et al., 2010[22]	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	6/10
Emma Stack et al., 2012[23]	Y	Y	Y	Y	N	N	Y	N	N	N	Y	5/10
Xian Shen et al., 2014[8]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	7/10
C., Tassorelli et al., 2014[24]	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	8/10
Nima Toosizadeh et al., 2014[25]	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	7/10
Alessandro Picelli et al., 2012[26]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	5/10
Nicola Smania et al., 2010[27]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Mohan Ganesan et al., 2014[28]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6/10
José Eduardo Pompeu et al., 2012.,[9]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10
Nan-yong Lee et al., 2015[10]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	5/10
Elisa Pelosin et al., 2010[29]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	6/10
Atefeh Azarpaikan et al., 2014[30]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Giuzeppe Frazzitta et al., 2014[31]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Colleen G., Canning et al., 2014[32]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	9/10
Margaret Schenkman et al., 2012[33]	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	10
Gustavo Christofoletti et al., 2010[34]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Gao Qiang et al., 2014[35]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Serene S Paulo et al., 2014[36]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Xia Shen et al., 2012[37]	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	7/10
Ryan P., Duncan et al., 2012[38]	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	7/10

Y: yes; N: no

provements in quality of life, are needed for individuals with Parkinson's. It is important for assessment methods to analyze functional changes in all stages of the disease and to be particularly sensitive in the evaluation of therapeutic interventions[39].

Among the specific Parkinson's classification measures used in the studies analyzed, the UPDRS is a validated scale that provides an objective perspective and allows the classification of individuals with Parkinson's. The UPDRS is also widely used by physiotherapists for the evaluation of balance in clinical practice, as it has specific items for the assessment of this characteristic. The scale was found to be precise and sensitive according to the results of 14 articles analyzed in the present systematic review, the study populations of wich were subject to different intervention protocols[40]. The scale was validated for the population with Parkinson's and, in contains items for the assessment of balance. Volpe et al.[41] conducted a study involving 24 patients with Parkinson's allocated to two groups and assessed balance using the UPDRS. Regarding the motor skills section of the scale, the authors found a significant improvement in the experimental group (dance) in comparison with the control group (conventional physical therapy).

Eleven studies included in the present review used the Berg Balance Scale for the assessment of balance. This scale is composed of 14 tasks that are common in daily living. Each item is scored from 0 to 4 points, with a maximum score of 56

Table 2. Characteristics of the studies included in the present systematic review

Authors and year of publication	Study design	Intervention	Outcomes
Abud Qutubuddin et al., 2013[17]	Clinical trial	Forced exercise on stationary bike (EG)	1-UPDRS 2-BBS 3-Finger Taping Test 4-PDQ-39
Sara Pires et al., 2014[18]	Clinical trial	Combination of musical auditory cues and regular physical therapy (EG) Regular physical therapy alone (CG)	1-UPDRS 2-BBS 3-TUG 4-PDQ-39
Chirs J.Hass et al., 2011[19]	Clinical trial	PRT program (EG) No intervention (CG)	1-FRT 2-TUG 3-UPDRS
Fuzhong Li et al., 2012[20]	Clinical trial	Adapted Tai Chi program Tree groups; Tai chi, resistance training, and stretching	1-Isokinetic dynamometer 2-GAITRite 3-FRT 4-UPRDS 5-TUG
Fuzhong Li et al., 2012[20]	Clinical trial	Technology-assisted balance and gait training (EG) Strengthening exercises (CG)	1-Single-leg stance test
Natalie E. Allen et al., 2010[22]	Clinical trial	Minimally supervised exercise program	1-Algorithm 2-Coordinated stability test 3-Sway meter 4-BBS 5-FOG Questionnaire 6-SPPB 7-Short -FES 8-PDQ-39
Xian Shen et al., 2014[8]	Clinical trial	Balance and gait training with enhanced feedback (EG) Lower limb strength training (CG)	1-ABC 2-Limits-of-stability test 3-Single-leg stance test
C. Tassorelli et al., 2014[24]	Clinical trial	Injection of botulinum toxin type A + intensive program (EG) Saline solution + intensive program (CG)	1-Kinematic analysis of movement 2-EMG 3-UPRDS 4-VAS
Nima Toosizadeh et al., 2014[25]	Clinical trial	Electroacupuncture (EG) Sham treatment (CG)	1-SF-12 2-Short-FES 3-MMSE 4-UPRS
Alessandro Picelli et al., 2012[26]	Clinical trial	Robot-assisted treadmill training (EG) Treadmill training alone (CG)	1-BBS 2-ABC 3-TUG 4-10MWT
Nicola Smania et al., 2010[27]	Clinical trial	Balance training (EG) General physical exercises (CG)	1-BBS 2-ABC 3-Postural transfer test 4-COP 5-UPRDS 6-H&Y 7-Staging scale 8-GDS

Table 2. Continued

Authors and year of publication	Study design	Intervention	Outcomes
Mohan Ganesan et al., 2013[28]	Clinical trial	Tree groups: dopamine, dopamine + conventional treadmill training, dopamine + PWSTT	1-UPDRS 2-Dynamic posturography 3-BBS 4-POMA
José Eduardo Pompeu et al., 2012[9]	Clinical trial	Training performed with 10 Wii Fit™ games (EG) Balance exercises (CG)	1-UPRS
Nam-Yong Lee et al., 2015[10]	Clinical trial	NDS + FES + Dance (EG) NDS + FES (CG)	1-BBS 2-Modified Barthel Index 3-Beck Depression Inventory
Elisa Pelosin et al., 2010[29]	Clinical trial	Physical therapy + strategic video (EG) Physical therapy + video of landscapes (CG)	1-FOG Questionnaire
Atefeh Azarpaikan et al., 2014[30]	Clinical trial	NFT training period	1-BBS 2-ECG 3-Isokinetic dynamometer
Giuzeppe Frazzitta et al., 2014[31]	Clinical trial	Intensive aerobic exercises (EG) Non-intensive exercises (CG)	1-UPDRS 2-BBS 3-6WMT
Colleen G. Canning et al., 2014[32]	Clinical trial	Minimally supervised exercises –PD WEBB (EG) Habitual care (CG)	1-Coordinated balance stability test 2-FOG Questionnaire 3-FES-I 4-Physical Activity Questionnaire 5-SF-12V2 6-SF-6D 7-PDQ-39
Margaret Schenkman et al., 2012[33]	Clinical trial	Supervised FBF and AE physical exercise program (EG) Conventional at-home physical exercise (CG)	1-CS-PFP 2-FRT 3-UPRDRS 4-PDQ-39
Gustavo Christofoletti et al., 2010[34]	Clinical trial	Balance and motor function stimulation exercise protocol (EG)	1-BBS 2-TUG
Gao Qiang et al., 2014[35]	Clinical trial	Yang-style Tai Chi exercise protocol (EG) No intervention (CG)	1-BBS 2-TUG 3-UPDRS
Serene S Paulo et al., 2014[36]	Clinical trial	Muscle strength training of legs with pneumatic equipment (EG) Simulated low-intensity exercise (CG)	1-Muscle strength 2-10MWT 3-TUG 4- Single-leg stance test
Xia Shen et al., 2012[37]	Clinical trial	Training with repetitive steps on preparatory visual tracks (EG) UM-detook (CG)	1-UPRDS 2-Limits-of-stability test 3-GAITRite
Ryan P. Duncan et al., 2012[38]	Clinical trial	Tango dance program (EG) No intervention (CG)	1-UPRDS 2- Mini BESTest 3-FOG Questionnaire 4-6WMT 5-9HPT 6-GAITRite

points. The points are based on the time for which a position is held, the distance to which the upper limb is capable of reaching out in front of the body, and the time required to complete each task[42]. This is a fast, precise assessment tool for detecting changes in balance among individuals with Parkinson's. In a previous systematic review with meta-analysis, Chih-Hsuan Chou et al. [43] found that a reduction in the gait velocity score on the Berg Balance Scale was correlated with impairment regarding the performance of activities of daily living.

The Timed Up and Go Test is used to quantify functional mobility based on the time (in seconds) required to perform the task of standing up from a chair (seat approximately 46 in height and armrests 65 cm in height), walking three meters, turning around, returning to the chair, and sitting down again[42]. This measure has a specific relationship with gait speed and functional mobility. In the population studied, the Timed Up and Go Test is a good predictor of the risk of falls. Although it was not specifically designed for the assessment of balance, the importance of this measure to the evaluation of dynamic balance related to mobility was evident in the studies analyzed in the present review. In a systematic review with meta-analysis involving 53 studies, Schoene et al. [44] found that the Timed Up and Go Test was a sensitive assessment tool for the evaluation of gait stability and balance in more than 50% of the studies, which is in agreement with the findings of the present systematic review.

A large portion of the studies employed three or more assessment tools, which were always accompanied by tests and equipment. Several studies have addressed the use of assessment measures for the evaluation of balance among individuals with Parkinson's with the aim of designing interventions that favor an improvement in quality of life and a reduction in the risk of falls. Thus, the studies analyzed evaluated individuals in a complex fashion with functional approaches that were adaptable to the needs of such patients.

The present review shows that a variety of different assessment tools are used for the evaluation of balance in patients with Parkinson's disease, such as scales, tests, and equipment. The majority of studies employed more than one measure, and there is no consensus regarding a single, precise assessment tool for the evaluation of balance in this population.

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