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Vinícius Horn Vieira Mabilia

Somatosensory disruptions in Parkinson's disease and its implications on functional mobility

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Trabalho de Conclusão de Curso de Fisioterapia, da Universidade Federal de Ciências da Saúde de Porto Alegre, como requisito parcial para obtenção do título de Bacharel em Fisioterapia

Orientador: Aline de Souza Pagnussat
Coorientador: Giulia Palermo Schifino

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RESUMO

A literatura tem mostrado que a Doença de Parkinson (DP) pode afetar negativamente o sistema somatossensorial que está envolvido no controle postural. No entanto, a questão de saber se as deficiências sensoriais podem ou não levar a deficiências motoras permanece sem resposta. Para abordar esta questão, o presente estudo visa comparar a sensibilidade do pé e a mobilidade funcional dos indivíduos com e sem DP. O design do estudo é transversal, onde há 50 indivíduos (36 PD/14 grupo saudável). Para analisar sensibilidade plantar, utilizamos estesiômetros; para analisar mobilidade funcional, teste de Timed Up And Go (TUG) e escalas clínicas; para entender estadiamento, escala de Hoen & Yarh(H&Y), comprometimento motor (UPDRS – III), e escala de congelamento (FOG-q). No presente estudo, encontramos uma diferença na sensibilidade do pé entre os indivíduos com DP e os controles saudáveis emparelhados por idade e sexo. Também encontramos correlações entre a sensibilidade do pé e o tempo TUG, de tal forma que, quanto pior for a sensibilidade do pé, mais longo será o tempo TUG. Contudo, encontramos correlações fracas entre sensibilidade e escala UPDRS- III, escala de (FOG-q); não encontramos correlações entre tempo de diagnóstico e sensibilidade do pé das pessoas com DP, bem como escala de H&Y e sensibilidade do pé das pessoas com DP. O fator inovador do presente estudo foi comparar a sensibilidade do pé DP com o grupo saudável em vários pontos, e não apenas na planta do pé, mas também em regiões como tornozelo, dorso e lateral do pé. Além disso, correlacionou-se com uma avaliação da mobilidade funcional e a escala clínica da doença. Tais descobertas podem ter implicações clínicas relevantes quando percebemos a importância do tornozelo e de todo o pé para o controle postural e as possíveis influências que as alterações de sensibilidade têm sobre as resposta sensoriais obtidas durante a tarefa de mobilidade funcional.

Palavras-chave: Parkinson Disease; Somatosensory Disorders; Functional Mobility; Neurological Rehabilitation.

ABSTRACT

The literature has shown that Parkinson's Disease (PD) can negatively affect the somatosensory system that is involved in postural control. However, the question of whether or not sensory impairments can lead to motor impairments remains unanswered. Addressing this question, the present study aims to compare the foot sensitivity and functional mobility of individuals with and without PD. The study design is cross-sectional, where there are 50 individuals (36 PD/14 healthy group). In order to analyze plantar sensitivity, we used stadiometers; for analyzing functional mobility, Timed Up And Go (TUG) test and clinical scales; to understand staging, Hoen & Yarh(H&Y) scale, motor impairment (UPDRS - III), and freezing scale (FOG-q). In the present study, we found a difference in foot sensitivity between individuals with PD and healthy controls matched for age and sex. We also found correlations between foot sensitivity and TUG time, such that the worse the foot sensitivity, the longer the TUG time. However, we found weak correlations between sensitivity and UPDRS- III scale, scale of (FOG-q); we found no correlations between time of diagnosis and foot sensitivity of people with PD, as well as H&Y scale and foot sensitivity of people with PD. The novel factor of the present study was to compare the sensitivity of the PD foot with the healthy group at various points, and not only on the sole of the foot, but also in regions such as ankle, dorsum and lateral of the foot. Furthermore, it correlated with an assessment of functional mobility and the clinical scale of the disease. These findings may have relevant clinical implications when we realize the importance of the ankle and the whole foot for postural control and the possible influences that sensitivity changes have on sensory responses obtained during the functional mobility task.

Key-words: Parkinson Disease; Somatosensory Disorders; Functional Mobility; Neurological Rehabilitation.

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LISTA DE ABREVIATURAS E SIGLAS

1. PD: Parkinson Disease;
2. SWF: Semmes Weinstein Filament scores;
3. TUG: Timed Up and Go;
4. s: seconds;
5. UPDRS: Unified Parkinson's Disease Rating Scale;
6. MoCA: Montreal Cognitive Assessment;
7. FOG-q: Freezing of Gait Questionnaire;
8. H&Y: Hoen and Yahr staging scale modified;
9. SD: standard deviation,
10. n: number;
11. m: meters;
12. Kg: kilograms;
13. min: minimun;
14. max: maximum;
15. MMSE: Mini-Mental State Examination;
16. UFCSPA: Federal University of Health Sciences of Porto Alegre;
17. V: vertical acceleration (V);
18. ML: mediolateral acceleration (ML);
19. AP: anterior posterior acceleration (AP).

SUMÁRIO

ARTIGO

Somatosensory disruptions in Parkinson's disease and its implications on functional mobility

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Vinícius Horn Vieira Mabilia[3 4], Giulia Palermo Schifino[2 3], Richele Redivo Marchese[2 3], Maira[2 3] Jaqueline da Cunha, Ivan Lima Cortez,[3 4] Francisca dos Santos Pereira[3 4], Luiz Henrique Amodeo Vian[3 4], Aline de Souza Pagnussat[1 3,]

[1]Department of Physiotherapy, Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), Brazil.

[2]Rehabilitation Sciences Graduate Program', Universidade Federal de Ciências da Saúde de Porto Alegre(UFCSPA), Brazil.

[3]Movement Analysis and Rehabilitation Laboratory, Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), Brazil.

[4]Physical Therapy undergraduate program, Universidade Federal de Ciências da Saúde de Porto Alegre(UFCSPA), Brazil.

Correspondent Author: viniciusvm@ufcspa.edu.br

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Somatosensory disruptions in Parkinson's disease and its implications on functional mobility

Introduction

Parkinson's disease (PD) is a neurodegenerative disorder characterized by motor and non-motor symptoms. Among them, Bradykinesia, muscle rigidity, and tremor stands out as PD motor symptoms that could potentially lead to, postural instability and gait alterations, tending to increase as the disease progress. [Teive et al., 2005;]. Gait in PD is characterized by a reduction in stride length leading to an enhanced double support time and increased cadence [Monteiro et al., 2017]. Additionally, postural stability may also be affected as the disease progress, once approximately 62 -68% of PD patients report a previous episode of fall. [Williams D. R. et al. (2006); Wood B. H. (2002)].

PD related gait and postural control alterations may directly impact quality of life, once they are strongly associated with risk of falls, daily life limitations and functional mobility impairments. [Cho C., 2010].

Timed Up & Go (TUG) test is a widely used functional mobility assessment tool, consisting in the time (in seconds) that the subject takes to stand from a sitting position, walk into a obstacle placed 3 meters apart, circle it, walk back to the chair and sit again. In this sense, TUG test is a reliable measure of dynamic balance [Steffens, 2008] and is also related to risk of falls [Robsion, 2005], being directly impacted by PD related gait and postural control disruptions.

The role of PD upon postural control is not fully comprehended, but it is known that postural instability in PD is less responsive to dopaminergic treatment, indicating that other neuropathologic process in non-dopaminergic neurons may be playing a more important role on it. [Curtze, 2015 ; Giardini, 2018] The central nervous system relies on three major components to maintain balance; (1) the sensorial input (sensorial information received from somatosensorial, vestibular and visual systems), (2) the central integration of those information and (3) the motor output that deals with possible postural perturbations. In fact, PD could leads to sensory deficits, once there is a reduced sensitivity of the plantar foot in PD subjects. [Prätorius, 2003] So, those plantar foot sensitivity disruptions could influence postural instability in PD patients by negatively affecting sensorial input. [Prätorius, 2003] [Perry, 2000] [Quiu, 2012]

Additionally, PD plantar foot sensitivity deficits could affect not only static stability but also dynamic balance and gait, once while walking the plantar cuttaneuos afferents are responsible for (1) sensing posterior stability limits during initiation of backward steps, (2) sensing and controlling heel-contact and subsequent weight transfer during termination of forward steps, and (3) maintaining stability during the prolonged swing phase of lateral crossover steps. [Perry, 2000]

The literature has shown that Parkinson disease may negatively affects the somatosensory system that is involved in postural control. However, a question of whether sensory

impairments may or not lead to motor disorders remains unanswered. Aiming to address that question, the present study intends to compare the foot sensibility and functional mobility of PD and non-PD individuals.

Methods

Study Design

This cross-sectional study was approved by the Ethics and Research Committee of the Universidade federal de Ciências da Saúde de Porto Alegre (3.285.141) and was conducted according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [Von Elm E,et al. 2014]

Participants

Volunteers were recruited through a Santa Casa de Misericórdia Neurology service database in Porto Alegre, Brazil, institutional sites, and social media. Those individuals who met the following criteria wereincluded as convenience sample: aged between 18 and 90 years; with a Diagnosis of idiopathic PD based on clinical criteria [Jankovic et al., 2008], according to London Brain Bank Criteria (2006); ability to walk at least 5 meters without assistive devices; minimum score of 20/30 points (illiterate) or > 24/30 points (literate) in the Mini-Mental State Examination (MMSE) [Trzepacz et al., 2015];. Individuals with a clinical diagnosis of musculoskeletal diseases, significant visual deficit that may compromise the physical assessment were excluded. The study also included a reference group of healthy individuals, paired by age and sex. Exclusion criteria for the reference group were: a previous history of neurological or musculoskeletal disorders that induced visible gait abnormalities. All participants signed the informed consent after an explanation about the objectives and possible complications of the study. According to the MMSE score, all participants were presumed competent for decision-making and, for this reason, signed the informed consent (Table 1).

Procedures

This study was conducted at the Federal University of Health Sciences of Porto Alegre (UFCSPA) between February 2021 to October 2022. Each participant performed a clinical and documentedevaluation session. The same researcher applied all clinical assessments.

Clinical Measures

Functional Mobility

Functional mobility was assessed by means of the instrumented TUG using an inertial sensor device *(G- Walk from BTS Bioengineering) attached to subjects*'waist with a semi-elastic belt, covering the L5 S1 segments [Pinto et al., 2019;]. Individuals were instructed to walk as fast as they could, in a safe way, without running and turn towards their most affected side (reference group subjects were asked to turn towards their dominant side). Test latency and acceleration data were recorded using the inertial sensor attached to the

subjects' waists with a semi-elastic belt covering the L2 segment. Time to complete the TUG was subdivided into five phases: 1) lift from the chair; 2) walk 3 meters (going phase); 3) turn around; 4) walk 3 meters back to the chair (returning phase); 5) sit down. Additionally, subjects were asked to undertake the same test procedure while performing a dual task of solving simple math calculus (sum and subtractions) [Johansson, et al., 2021]. Each participant performed this test three times for each situation (with and without dual task) and the average of three trials was used in the analysis [Gall et al., 2015].

The inertial sensor wore during the evaluation measured the acceleration along three accelerations axes: vertical acceleration (V), mediolateral acceleration (ML), anterior posterior acceleration (AP); Acceleration data with pulse width 4 to 1000Hz were then transmitted via Bluetooth to a PC and processed using dedicated software (BTS G-STUDIO, version: 2.6.12.0) that filtered the raw data and calculated the spatiotemporal parameter during TUG phases.

Foot Sensitivity

Somatosensory deficit were evaluated trough foot plantar sensitivity evaluation. By that means the Semmes-Weinstein Monofilaments esthesiometer were used to quantify skin sensitivity thresholds. The nonlinear bending forces of the 20 filaments ranged from 0.08 mN (filament number 1) to 3 N (filament number 20).Sensitivity thresholds were recorded at 12 anatomical sites of the foot at the plantar (P), dorsal(D), medial (M), and lateral (L) foot regions (figure 1). During the assessment subjects were required to lie blindfolded on a massage bed in a quiet room. Room temperature was kept constant. The filament was positioned at a 90º angle in respect to skin surface. The evaluator then applied a sufficient pressure to bend the filament and gently removed it, preventing it to slide over the skin. After this procedure subjects were asked if their felt or not felt the stimulus. The order of measurements at the 12 anatomical sites was randomized. The *4, 2, and 1 stepping* algorithm were used for threshold detection. [Dyck et al., 1993] Additionally five repetitive stimuli, including null stimuli, were given with the same filament. If subjects gave right answers in four out of the five trials, the filament was considered recognized. [Muller et al., 1996]

Freezing of Gait – Questionnaire

The freezing of gait questionnaire (FOG-Q) has 6 questions and the total score ranges from 0 to 24; higher scores correspond to more severe FOG. It is a useful tool for history taking of clinical data suggesting the presence of freezing. The item 3 of the scale directly assesses the presence of freezing. This scale proved to be reliable to screen and measure the severity of FOG in patients with PD, and also to assess treatment interventions [Baggio et al., 2012]

Montreal Congnitive Assement (MoCA)

It is a 30-point test that can be administered in about 10 minutes, but unlike the MMSE, the MoCA also covers a range of executive functions. It has 6 orientation questions, and a 5 word memory recall task. A clock drawing task and a cube copy test assess visuospatial function. Attention/concentration is assessed using serial 7's, target tapping, and digit span

forward and backward. Confrontation naming and repetition tasks assess language. Executive functions are evaluated using a shortened version of the Trail Making B test, phonemic fluency, and a verbal abstraction task. The cut-off scores on the MOCA-BR scale for diagnosing PD-MCI and PD-D were 22.50 and 17.50, respectively. The prevalence of PD-MCI was 41.6% and of PD-D was 28.1%.

The contribution of this study is that the cut-off scores obtained on the MOCA-BR, both to distinguish PD-N from PD-MCI and PD-MCI from PD-D, have high sensitivity and specificity. [Chou et al., 2010; Almeida, 2019]

Unified Parkinson's Disease Rating Scale (UPDRS) - Part III

This scale evaluates the signs, symptoms and certain activities of patients through self-report and clinical observation. It consists of 42 items, divided into four parts: mental activity, behavior and mood; activities of daily living (ADLs), motor exploration and complications of drug therapy. The score on each item ranges from 0 to 4, with the maximum value indicating greater impairment by the disease and the minimum, normality. The 14 items of the motor exploration section (numbered 18 to 31) were based on the original version of the Columbia scale. The UPDRS is a reliable and valid scale (convergent and criterion-related validity), which qualifies it as a suitable method for the assessment of PD. [Tsanas et al., 2005]

Hoehn and Yahr (H&Y)

This scale is quick and practical in indicating the general condition of the patient. In its original form, it comprises five classification stages for assessing the severity of PD and essentially comprises global measures of signs and symptoms which allow the individual to be classified in terms of the level of disability. Patients classified in stages I, II and III have mild to moderate disability, while those in stages IV and V have more severe disability. Signs and symptoms include postural instability, rigidity, tremor, and bradykinesia. A modified version of the H&Y has been developed more recently and includes intermediate stages. In stage 1.5 the involvement is considered unilateral and axial, while in stage 2.5 the disease is considered bilateral and mild, with recovery on the "push test". [Tsanas et al., 2005]

Statistical Analysis

The sample size was determined by G-Power 3.0 software based on previous studies [Rinón et al., 2020] adopting 90% power and the alpha value of 0.05 to detect the minimum effect size of 0.78% in foot sensitivity comparation beteewn PD and healthy controls[Prätorius et al., 2003] (). A total of 27 participants in each group (PD and healthy controls) were estimated as necessary to this study.

Data were expressed as median or mean, standard deviation (SD) or 95% confidence intervals (continuous variables) and frequency distribution (categorical variables). Shapiro-Wilk tests were used to evaluate the normality of the continuous variables. Parametric Student t-tests, nonparametric Mann–Whitney, were used to compare PD and Healthy control groups and a spearman correlation was used to verify correlations between foot sensitivity, functional mobility and clinical measures.

Results

Participants were recruited from February 2021 to October 2022. Finally, 50 subjects were included, 36 inPD group and 14 healthy controls paired by age and gender. The baseline demographic and clinical characteristics of participants are depicted in Table 1.

Table 2 presents the comparisons among PD subjects and healthy controls. We found statistical differences among groups in TUG ($p<0.01$; effect size=0.078) and foot sensitivity in all sites tested withan exception of hallux and lateral maleolus (see Table 2).

We also found weak to moderate positive correlations between TUG and foot sensitivity in some sites tested (ankle – dorsal – articulation talocruralis area p=0.460, r=0.280; dorsal - metatarsal head III area p=0.031 r=0.300; Foot sole – Heel area p=0.700 r= -0.054; arch intermedius area p= 0.060 r=0.262; metatarsal head III area p= 0.200 r=0.182; hallux area p= 0.140 r= 0.260; Foot Lateral – lateral mallolus area p=0.060 r=0.260; calcaneus lateral area p= 0.004 r= 0,391; forefoot lateral p= 0.146 r=0.208; Foot Medial – medial malleolus area p= 0.181; r= 0.19; medial calcaneus p= 0,002 r=0.42; forefoot medial p=0.011 r=0.356). We found correlations between foot sensitivity in two sites evaluated and UPDRS andFOG-Q (Table 3).

Discussion

This study aimed to compare the foot sensibility and functional mobility of PD and healthy control. We found differences in foot sensitivity between Parkinson's subjects and healthy controls paired by age and gender. We also found that foot sensitive is positively correlated to functional mobility, once the worse is the foot sensitivity, the longer was the time required to perform TUG test. However, we found only minor correlations between foot sensitivity of people with PD and clinical measures such as UPDRS III, freezing scale; and no correlation at all with time since PD diagnosis and staging of PD.

In our study we found differences between foot sensitivity among PD group and healthy subjects. Indeed, it is known that PD leads to somatosensory deficits and PD subjects tent to present lower foot sole sensitivity as the disease progress. [Prätorius et al., 2003] However, in our study we found differences not only in the foot sole, as previously showed, but also in the ankle and forefoot regions (on dorsal and foot laterals). The central nervous system relies on sensory input not only to maintain the upright position but also to correct internal and external perturbations.[Burgess et al., 1974] Given that, foot sensibility integrity not only in the sole but in other foot sites is crucial to control postural strategies that maintain and restore balance. So, cutaneous mechanoreceptors in foot areas such ankle and forefoot (dorsal and laterals) could provide important information regarding ankle and foot position, allowing the brain to predict and program compensatory foot stepping, hence avoiding falls.[Perry et al., 2000]

Functional mobility measured by TUG test is a reliable tool to assess postural control and predict falls inelderly and PD populations [Nocera et al., 2013]. TUG test require several

directions and posture changes resulting in a high balance demand aiming to correct postural perturbations. Our findings suggest that TUG test positively correlates with foot sensibility (hence, the higher was the sensitivity threshold, higherwas the time required to complete TUG test). In fact, while we are reacting to postural perturbations, our plantar cutaneous afferences provide distinct types of information that the visual input alone is not able to replace. [perry2000] So, those findings may indicate that sensory afferences could play a higher role in functional mobility of PD subjects that was expected before. However, those findings should be interpreted carefully once we only find weak to moderate correlations.

During forward and backward perturbations, foot sole mechanoreceptors are responsible for sensing and controlling center of mass position in relation to stability limits of support base [Perry et al., 2000].

However, it is important to highlight that the TUG/ foot sensitivity correlations we found in our study were related to other foot sites (such as ankle and dorsal region) rather that sole sites (see Table 3). Those findings may be related to the ankle's strategy to maintaining balance during a functional activity that involves various changes in posture and direction of motion such as TUG test. The ankle strategy consistsin the correction of the gravity center by rotating the body around the ankle joint. [Breniere et al., 1982] So, a disrupted sensory input in areas around ankle and foot dorsal may lead to a less effective ankle strategy during a high postural demand functional task, hence worsening functional mobility.

In our study, we found merely minor correlations (in only two foot sites) between foot sensitivity and UPDRS III and freezing scale. Additionally we found no correlations regarding time since PD diagnosis and staging of PD. As well as other non-motor symptoms, foot sensitivity decrease as the disease progress. [Chaudhuri et al., 2006] Thus, given that our sample was manly of subjects with mild to moderate PD (see Table 1), the lack of severe compromised PD subjects could explain no correlations regarding clinical measures time since PD diagnosis and foot sensitivity.

Foot sensitivity loss in PD is an important matter in postural control rehabilitation. As far as our knowledge this is the first study that evaluated not only foot sole sensitivity of PD subjects but other foot sites that are crucial to maintain balance. Regarding this study's limitations, some points should be considered. Firstling, there is an imbalance between PD group and healthy controls that could lead do a statistic bias. Additionally, our sample lacks of severe compromise PD subjects what may hinder the extrapolation of these results for this population.

Given the above findings, there is a difference between PD and healthy control foot sensitivity not only in foot sole but in other foot areas around ankle, foot dorsal and laterals. Additionally, the lack of sensitivity in those foot areas not located in foot sole appears to play an important role in postural control and functional mobility. However, further studies with higher samples that include severe compromised PD subjects are still needed.

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ANEXOS

ANEXO A

NORMAS DA REVISTA ESCOLHIDA PARA SUBMISSÃO DO ARTIGO

https://www.utpjournals.press/pb-assets/utoronto/PTC/documents/PTC_Submission-Guidelines-1630726280150.pdf

Physiotherapy Canada

Subject Matter and Scope

Physiotherapy Canada is the official, scholarly, refereed journal of the Canadian Physiotherapy Association (CPA), giving direction to excellence in clinical science and reasoning, knowledge translation, therapeutic skills and patient-centred care.

Physiotherapy Canada publishes the results of qualitative and quantitative research including systematic reviews, meta analyses, meta syntheses, public/health policy research, clinical practice guidelines, and case reports. Key messages, clinical commentaries, brief reports and book reviews support knowledge translation to clinicalpractice.

Each volume of *Physiotherapy Canada* comprises four issues to meet the diverse needs ofnational and international readers and serve as a key repository of inquiries, evidence and advances in the practice of physiotherapy.

Peer Review Process

Physiotherapy Canada uses a double-blind peer review process. Blinding a manuscript entails removing all identifying information (i.e., references to authors, specific research facilities, acknowledgements, names of ethics review boards, or any other information that could identify the authors, including references to previous work). To blind your manuscript, substitute your name (and any coauthors' names) in the text in any reference that would identify you with Xs. For example, if
you are referring to one of your previously published articles, change the citation "(Jones, 2003)" to "(Author, XXXX)." In the reference list of your manuscript, do not list the title of thearticle, the journal, or any other identifying information. For example, if you refer to three of your own publications in the text, list them as follows in the references:

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"Author" is then inserted into the reference list with the other "A" references.

When blinding the context of your research, use pseudonyms for the names of institutions or participants, and do not identify the city or town in which the research took place if it could serve to identify the participants and/or the institution. For example, “a bilingual university in Ottawa” is inadequate blinding because there is only one such university. Try to avoid including any other characteristics that might lead to the identification of the individuals or institutions involved.

Please also remove any information that would identify you from the “properties” section of your Word file. To do this go to the document and click on “file,” scroll down to “properties” and delete any identifying information. If you are sending a PDF please remove yourinformation before you create the PDF version of the article.

Manuscripts that have not been blinded will be returned to the authors for blinding beforethey are sent out to the reviewers.

Manuscript Submission Process

Prior to submitting your article, you will have to register through *Physiotherapy Canada*’s online peer review system where you will be uploading your final manuscript.

All articles must be the author’s original work, previously unpublished, and not beingconsidered for publication with another journal.

After you submit your article, it will be evaluated. Based on this evaluation, you will receive one of the following responses: accepted, rejected, or returned for further revisions. If your article is accepted either as is or following revisions, it will be edited, copy-edited, and published ahead of print.

Upon initial submission, all supporting files including figures and illustrations, tables, and images must be submitted within the main file. They are to appear at the end of the file. Oncethe article is accepted for publication, you will be required to resubmit supporting images as either their source files (e.g., Excel, PowerPoint) or as high resolution JPEG or TIFFs.

Please apply Microsoft Word’s continuous line-numbering feature to the blindeddocument (see section on Peer Review Process for details on blinding).

Reporting Guidelines

To improve the quality of research reports in the journal, *Physiotherapy Canada* now requires a completed reporting checklist as a condition of article submission. A table listing the study types and corresponding checklists can be found here or at http://www.utpjournals.press/pb-assets/utoronto/PTC/documents/PTC_Reporting- Guidelines.pdf.

The checklist must be uploaded as a Reporting Checklist on the file upload page on the submission platform along with your manuscript. We urge you, when completing this form, toconsider amending your manuscript to ensure that it addresses all issues raised by the reporting checklist, where appropriate. As well as improving the accuracy and completeness of your manuscript, taking the time to ensure that it meets these basic reporting requirementsmay enhance its chances of eventual publication.

Author DisclosureForm

At the time of submission all co-authors must complete the Disclosure of Interest Form andhave anyone acknowledged in the article sign the Permission to Acknowledge Form and upload it to the electronic submission system.

This form allows authors to disclose their contributions to the manuscript as well as anycompeting interest they may have.

Contributions are based on the authorship standards established by the International Committee of Medical Journal Editors (available at www.icmje.org).

Authors must disclose any competing interests that do, or may, influence or bias their research or findings. A conflict of interest occurs when the interpretation of data or presentation of research findings are influenced by financial or personal relationships.

Conflicts of interest may occur in many areas. For example, if authors:

- Receive research support provided by a manufacturer
- Are employed by the manufacturer of a product under study
- Have equity or stock ownership in the company of a product or method being studied
- Are paid as consultants or ghost authors for a study
- Have public or foundation funding
- Are provided equipment for research
- Have grants or patents received or pending related to research reports

Authors must also disclose all sources of funding, regardless of amount or source (e.g.,commercial firms, foundations, institutions, government, etc.).

Authors who are unsure of what constitutes a competing interest and want guidance on what to report may contact the Editorial Coordinator at ptc@utpress.utoronto.ca.

Ethics Review

Where applicable, a statement should be included indicating that a study has been approved by the appropriate ethics review board(s) and that informed consent has been obtained for all

participants.

Informed Consent

When appropriate, all authors must include proof of informed consent as per the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals. This must be documented in your paper.

Protection of Human Subjects and Animals in Research

When reporting experiments on human subjects, authors must indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). If doubt exists whether the research was conducted in accordance with the Helsinki Declaration, the authors must explain the rationale for their approach, and demonstrate that the institutional review body explicitly approved the doubtful aspects of the study. When reporting experiments on animals, authors should be asked to indicate whether the institutional and national guide for the care and use of laboratory animals was followed.

- International Committee of Medical Journal Editors ("Uniform Requirements for Manuscripts Submitted to Biomedical Journals") -- February 2006

Transparency Declaration

The lead author (the manuscript's guarantor) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Copyright Agreement

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Manuscripts accepted for publication or published in *Physiotherapy Canada* become the property of the CPA and may not be published elsewhere, in whole or in part, without the written permission of the CPA.

Manuscript Guidelines

The final revised manuscript in digital format should be in 12-point Times New Roman font, double- spaced, with 1-inch margins, submitted as a Microsoft Word file and must have a complete reference list of all sources cited.

Word limits are as follows:

- Manuscripts should be a maximum of 5,000 words, which

includes title, abstract, keywords, body content, references (75 or fewer), and tables and figures (no more than 6 tables and figures in total). Additional tables, figures and appendices may be published as online-only content.

- Case Reports are a maximum of 1,250 words, which includes title, abstract, keywords, body content, references (20 or fewer), and no more than 3 tables/figures in total. Additional tables, figures and appendices may be published as online-only content.
- Evidence-Based Practice articles are a maximum of 1,250 words, which includes title, abstract, keywords, body content, and references (20 or fewer).
- Brief Reports are a maximum of 2,500 words, which includes title, abstract, keywords, body content, references (20 or fewer), and 1 table or figure. Additional tables, figures and appendices may be published as online-only content.

The text should be aligned flush left and ragged right; do not justify or centre.

Use hard returns at the end of paragraphs only. Let your software make line breaks (word wrap), and do not add extra line spaces between paragraphs.

Headings should follow the following format: First-order headings should be in **BOLD ALL CAPS;** second-order headings should be in **bold title case**; third-order headings should be in *italic title case*. If there are more than three subheadings, indicate the level as appropriate.

- Headings for research articles must include: Introduction, Methods, Results, Discussion, Limitations, and Conclusion. Up to three levels of subheadings maybe used.

Use only one space after a period, colon, semicolon, and comma. Use an en-dash for date and page ranges, and an em-dash (without spaces on either side of it) as an interrupter. Refer to the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals for further grammatical guidance on style.

Refer to the *AMA Manual of Style (10th edition)*, for guidance on formatting andpresentation of statistics.

With a few exceptions, spelling follows the *Concise Oxford Dictionary, 12th Edition*. Please do not include any running headers or footers.

Focus on patients as people. Avoid using labels. For example, “people with arthritis” ispreferred over “arthritis patients.”

Please use generic names for drugs and only list the brand name if also listed with thegeneric name. For example, use the generic name acetaminophen and follow with parenthesis listing the brand name Tylenol if necessary.

You must provide all information on all mentioned equipment and/or product manufacturers including a full address with the postal code as footnotes. Footnotes in the manuscript and in tables must include company name, address, city, province/state, postal code/zip code.

Please use the International Metric System of Units (Imperial or standard units may besupplied in parentheses if desired).

At the end of the manuscript but before the references, please add the following sub- sections under the heading “Key Messages”: (1) *What is already known on this topic* and (2)*What this study adds*. In these sections, please summarize the relevant literature on your topic and state what your study, in particular, has added to the knowledge base.

A notation should be included if the work was adapted from a conference presentationor other speech.

Statistical Reporting

Ensure coherence among the study purpose, sample size calculation, statistical methods, and presentation of results. State the statistical software applied in the analysis. When more than one statistical software package is applied, link each analysis to the appropriate software. Include a statement concerning the extent to which the requisite assumptions associated with the statistical test were evaluated and met.

When applied in a statistical context use statistical terminology appropriately, especially theterms range and inter-quartile range. Include 95% CI even when the goal is hypothesis testing. When reporting the results from reliability studies, ensure that a 95% CI is applied to the standard error of measurement as well as the intraclass correlation coefficient.

- Range is a single value.
- Inter-quartile range is a single value.
- Minimum and Maximum are two values.
- 1st and 3rd quartiles are two values.

For inferential statistical analysis, ensure the study purpose indicates whether the goal is parameter estimation or hypothesis testing. When hypothesis testing is applied, ensure the null value is clearly stated and whether the alternate hypothesis is directional or non- directional. This sets the stage for a 1- or 2-tailed test of statistical significance. When hypothesis testing is applied, state the critical *p*- value (i.e. alpha) and whether the test was 1-or 2-tailed. In addition, include the test statistic, degrees of freedom and *p*-value (for example:$F_{1,46} = 5.84$, $p=0.020$). Report exact *p*-values when possible, if they are not exact, report *p*-values ≥0.05 to 2-decimal places and *p*-values <0.05 to 3-decimal places. If *p*-values are lessthan 0.001, it should read as $p<0.001$. In hypothesis testing studies that report correlation coefficients,

ensure the reported *p*-value tests the investigator's declared null value and not the software package's default value (typically zero).

- Parameter estimation example: Our purpose was to estimate…
- Hypothesis testing example: Our purpose was to determine whether a difference…
- Non-directional example: Our purpose was to determine whether a difference exists between Treatment A and Treatment B.
- Directional example: Our purpose was to determine whether patients treated with Treatment A had better outcomes than patients treated with Treatment B.

References

All articles must include a list of references.

List the bibliographic entries under the heading "References" at the end of the text. With some exceptions (note format for websites/web pages below), references should follow the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals. In-text references should be cited by superscript Arabic numbers consecutively in order of appearance. Superscript numbers should appear after a comma or period.

Only references cited in the text should be included in the list.

For each reference, up to three authors may be listed. For more than three authors, list thefirst three and then use et al.

Samples of references cited in this style are available at www.nlm.nih.gov/bsd/uniform_requirements.html and, briefly, below.

Journal article:

Malouin F, Prefontaine J, Richards CL. Quantitative evaluation of head posture and movements with a triaxial electrogoniometer: a reproducibility study. Physiother Can.1989;40:294–301.

Website or webpage:

American Medical Association. AMA Office of Group Practice Liaison [Internet]. Chicago: TheAssociation; c1995-2002 [updated 2001 Aug 23; cited 2002 Aug 12]. Available from: http://www.ama-assn.org/ama/pub/category/1736.html

Book:

McArdleWD, Kath FL, Katch VL. Exercise physiology: Energy, nutrition, and human performances. 2nd ed. Philadelphia: Lea & Febiger; 1986.

Chapter in edited book:

Guccione AA, Cullen KE, O'Sullivan SB. Functional assessment. In: O'Sullivan SB, Schmitz TJ, editors. Physical rehabilitation: assessment and treatment. Philadelphia: FA Davis Co; 1988. p. 219–35.

Conference paper published in proceedings:

Bengtsson S, Solheim BG. Enforcement of data protection, privacy and security in medical informatics. In: Lun KC, Degoulet P, Piemme TE, et al., editors. MEDINFO 92: Proceedings of the 7th World Congress on Medical Informatics; 1992 Sep 6–10; Geneva, Switzerland.
Amsterdam: North-Holland; 1992. p. 1561–5.

Additional Elements for Submission

Contact Information

Please complete all sections of the ScholarOne Manuscripts registration section.

Abstract, Keywords and Acknowledgements

Abstract

Your abstract must be fewer than 200 words and written in the language of the paper. Please use the following headings: Purpose, Method (subjects, design, and procedure), Results, and Conclusions (including clinical implications). If you are writing an abstract for an evidence-based practice article, it must include the following headings: Clinical Case, Clinical Question, Evidence, Limitation of the Evidence and Future Research, and Recommendation for Clinical Question. If you are writing an abstract for a case report, it must include the following headings: Purpose, Client Description, Intervention, Measures and Outcome, and Implications. It must be a brief summary of
the key points of the article, without the use of phrases such as "In this article…"; "The author…"; "The article is about…." For good examples of abstracts, please visit the *Physiotherapy Canada* website: http://www.utpjournals.press/loi/ptc

Keywords

Following your abstract, include a maximum of 5 keywords, which will enhance discoverability through *Physiotherapy Canada Online*, search engines, and databases. These keywords must be MeSH terms. Please visit the National Library of Medicine online to obtain these terms.

Acknowledgements

Major contributors to the work should be identified in the Acknowledgments section.

Reviewer List

As part of the submission process, authors are asked to suggest five potential reviewers for the manuscript. Potential reviewers should be considered experts, have published in the area of research, and not be in a position of conflict. Authors must not suggest individuals from thesame institutions or individuals whom they have collaborated or published with in the past. If necessary, authors can find potential reviewers by reviewing the reference list to their manuscript.

Tables and Figures

Tables and figures must be included at the end of the manuscript. Tables must be double- spaced using the Tables function in Microsoft Word and include a title. Do not duplicate data in results and tables. Ensure that each table and figure has been mentioned in the text.

Tables

Use the Tables function in Microsoft Word to avoid formatting problems.

The title should be typed above the top horizontal line. The source and any notes should appear below the bottom horizontal line. Do not use the spacebar to align columns; please use appropriate tab settings.

Please include all tables within the manuscript.

Figures

The font used for figures should be Arial/Helvetica.

Physiotherapy Canada requires a figure caption to be provided in themanuscript, on a separate page following the tables.

Final figure files must be submitted to the following specifications:

- Line drawings are scanned at 1200 dpi at a minimum of 12.5 cm (5 inches) in width and saved as a TIF, EPS or JPEG file (flow charts must not exceed 7 inches[18 cm] in width).
- Colour photographs must be saved in an RGB colour space, and black and white photographs saved in a greyscale colour space. Either file must be saved as a TIF at 1200 dpi at 5 inches (12.5 cm) in width.

For previously published figures, written permission from the copyright holder must uploaded during the submission process, please fill out andupload the Copyright Permission Form.

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While images appear in black and white in the print journal, the

online version can accommodate colour images, video, and audio. If you have material such as this that is relevant to your article, please submit for inclusion in the online version of the journal.

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Please note that colour images and video illustrating your thesis can also be presented in the online version of *Physiotherapy Canada Online* at no cost to the author.

Videos

The video guidelines are posted online at the *Physiotherapy Canada* website with instructions on how to complete a video submission fromstart to finish.

If you are using video material, please refer to each video separately (i.e., Video 1, Video 2, etc.) within the manuscript. You must ensure that you havesecured permissions for the video(s) to appear in *Physiotherapy Canada Online*.

Case Report Review Guidelines

The main focus of a case report should be to highlight an intervention, either a new intervention or an amendment of an existing management approach or strategy, as it pertains to the clinical concerns of a specific patient or client.

Please adhere to the 1,250 word limit, which includes 20 or fewer references.

Title

The title will indicate that it is a case report and will highlight the intervention ofinterest.

Abstract

The abstract will be no more than 200 words and will include the following subheadings: Purpose, Client Description, Intervention, Measures and Outcome, and Implications.

Body of the Review

Purpose

In this section, the underlying theoretical basis for the development of a new intervention or for the modification of an existing intervention will be stated. Appropriate evidence should be presented and discussed. The purpose statement will clearly indicate the focus of the case as it relates to the intervention (e.g., "The purpose of this case report is to describe the development and demonstrate the use of a new intervention for ….").

Client Description

Describe patient history and relevant findings, demographic characteristics, diagnosis, patient's primary concerns related to physiotherapy, other relevant health history, prior or current services related to the current episode, and co-morbidities. The patient history and assessment should indicate why the patient is appropriate for the new or modified intervention.

Intervention

Describe the intervention in detail. Details of how the intervention was developed and how it is applied to the patient should be thorough so that others can replicate the procedure. Tables, figures, references and appendices can be used to enhance the detailed description. Provide the parameters of the intervention (i.e., intensity, frequency, and duration) and rules for progression. State the changes/progression in treatment over time as well as the rationale for such changes/progression.
List any co-interventions that the patient may have received but that arenot directly related to the purpose of the case.

Measures and Outcome

Describe the plan for follow-up assessments (e.g., measures to be used, follow-up time points) to determine the outcome of the intervention. Cite evidence for responsiveness, reliability and validity of outcome measures. Present the outcomes over the time points indicated in the follow-up plan. Compare follow-up outcomes to baseline. Tables and figures can be usedto enhance the description.

Implications

Review purpose of case report and the patient's response to the intervention; relate approach and findings to existing literature; comment on what this case adds to the literature. Provide a succinct statement of what the findings imply and what research should follow.

Evidence-Based Practice Article Guidelines

This type of article applies the concept of case-based learning to the assessment and management of a particular disease or condition. Evidence-based practice articles will be reviewed by a blinded Associate Editor and a peer reviewer.

Please adhere to the 1,250 word limit, which includes title, abstract,keywords and 20 or fewer references.

Title

The title will indicate that it is an evidence-based practice article.

Abstract

The abstract will be no more than 200 words and will include the following subheadings: Clinical Case, Clinical Question, Evidence, Limitation of the Evidence and Future Research, and Recommendation for Clinical Question.

Body of Manuscript

Clinical Case

In this section, the author(s) describe the patient's history and relevantfindings, demographic
characteristics, diagnosis, patient's primary concerns related to physiotherapy, other relevant health history, prior or current services related to the current episode, and co-morbidities.

Clinical Question

The clinical question must be explicitly stated; for example, "Is there evidence to support the use of (this intervention) in (this patient/client)?" Thisstatement will be followed by the rationale for considering this clinical question.

Evidence

In this section, the underlying theoretical basis for the posed clinical question will be provided. In addition, appropriate evidence must be presented and critically discussed. Authors should also critically review any available qualitative and survey evidence that considers the patient's viewsand preferences.

Limitation of the Evidence and Future Research

This section will discuss where the evidence is lacking and make specific and clear recommendations for future studies. These sections could be combined or kept separate.

Recommendation for Clinical Question

A 'definitive statement' of the quality of the evidence available to support (or not) some aspect of practice should be made. Based on this evidence,there should be a succinct statement of what the findings imply for this clinical case.

Additional Information

CrossCheck – Plagiarism Detection Software

Physiotherapy Canada is now using Crossref's Similarity Check, a plagiarism screening tool designed for academic content, to ensure the originality of written work before publication. We will run a random selection of articles through this program; any manuscript in which plagiarism is detected will be assessed further and may be rejected outright.

Writing a Scholarly Article

"*How to Alienate Your Editor: A Practical Guide for Established Authors*", written by Stephen K. Donovan and published in the *Journal of Scholarly Publishing*, is an excellent article on classic mistakes made during the submission process. Also useful is "*Surviving Referees' Reports*" written by Brian Martin and also published in *Journal of Scholarly Publishing*.

Queries

Questions relating to any of the above details may be directed to the
Physiotherapy Canada Scientific Editor at the address below:Dina Brooks, PhD, MSc, BSc (PT)
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1400 Main Street West, Hamilton, Ontario, L8S 1C7 Scientific Editor, Physiotherapy
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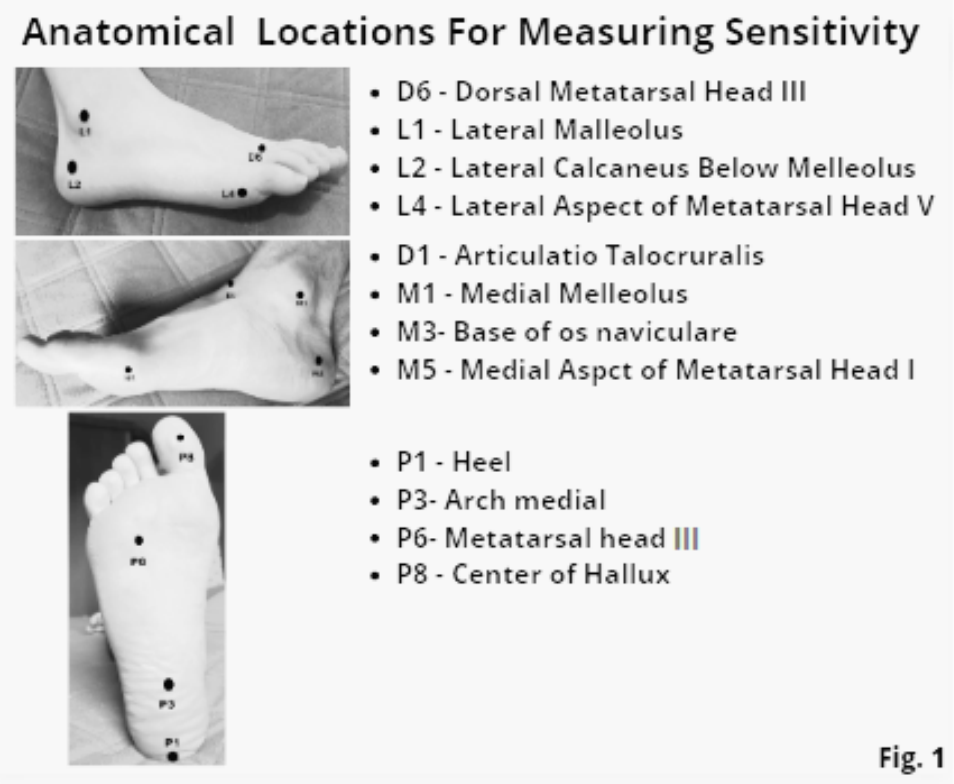
ANEXO B

Figura 1



ANEXO C

Tabela 1.

Table 1. Demografic characteristics

	PD (n=36)	**Control** (n=14)	*p values*
Gender, n (%) ¥			
Male	38.9%	42.8%	*0.797*
Age, years, mean ±SD #	65. 588	59. 714	*0.840*
Height , mean ±SD (m) #	166. 176	167. 500	*0.434*
Body Mass (kg) #	72. 338	75. 280	*0.481*
Time since diagnose; months, median (min-max)	72(6- 372)		
UPDRS, median (min-max)	8(1- 25)	-	-
MoCA, median (min-max)	27 (16- 30)	-	-
FOG-Q, median (min-max)	0 (0 -20)	-	-
H & Y modfied (frequencies)		-	-
1	20 (55.5%)	-	-
1.5	7 (19.4%)	-	-
2	2(5.5%)	-	-
2,5	4(11%)	-	-
3	3(8%)	-	-
4	0	-	-
5	0	-	-

Note: PD: Parkinson Disease; SD: standard deviation, n: Number, m: meters, Kg: kilograms,min: minimun; max: maximum; UPDRS: Unified Parkinson's Disease Rating Scale, MoCA: Montreal Cognitive Assessment, FOG-q: Freezing of Gait Questionnaire, H&Y: Hoen and Yahr staging scale modified;

U-Mann-Whitney

¥ Likelihood Ratio Chi-Square analysis

ANEXO D

Table 2. Foot Sensistivity comparasions- PD group and Control group

	PD	Control		
			p-value	*Effect size*
TUG (s)				
	10.997 (8.729 -13.264)	7.497*(6.890- 8.105)	0.002	0.785
Foot Sensitivity (SWF scores)				
Foot Sole				
heel	4.740 (4.308-4.796)	4.195 (2.55 - 4.39)	0.360	3.613
arch intermedius	3,61 (3,122 -3,717)	2,635 (2.053 - 3.368)	0.450	3.032
metatarsal head III	3.61#(3.298 - 4.035)	2.635 (1.951 - 3.232)	0.040	6.096
hallux	3.960 (3.581 - 4.086)	3.610 (2. 276 - 3.917)	0.800	
Dorsal				
articulatio talocruralis	3.960 (3.673 - 4.166)	3.220 (2. 276 - 3.686)	0.070	4.464
dorsal metatarsal head III	3. 22#(2. ,899 - 3. 3619)	2. 360 (1. 659 - 2.546)	0.000	6.381
Foot Lateral				
lateral malleolus	4.125 (3. 519 - 4. 300)	2. 830 (1. 968 - 3.610)	0.17	3.994
calcaneus lateral	3. 22# (3. 102 - 3.736)	2. 360 (1.668 -2.735)	0.00	5. 996
forefoot lateral Φ	3.61#(3,229 - 3,904)	2.635 (1.977 - 3.165)	0.020	4.506
Foot Medial				
medial malleolus	3.61 (3.353 - 4.046)	3.22 (2.166 -3.730)	0.910	
medial calcaneus	3.61# (3.369 -3.,800)	2.595 (1.8172 - 3.118)	0.010	5.008
forefoot medial ¤	3.61# (3.273 -3.934)	2.635 (1.844- 3.236)	0.040	4.190

¤ medial aspect of metatarsal head I

Φ lateral aspect of metatarsal head V

* t-Student

U-Mann-Whitney

Data are mean (TUG) or median (foot sensitivity) and 95% confidence intervals; SWF scores: Semmes Weinstein Filament scores; TUG: Timed Up and Go, s: seconds; PD: Parkinson Disease; * = TUG, # = foot sensiibility

ANEXO E.

Table 3. Correlation Foot Sensitivity and Clinical Scales

	TUG (s)		H&Y		UPDRS III		FOG-Q		MoCA		Time since diagnose	
	r value	p value	r value	p value	r value	p value	r value	p value	r value	p value	r value	p value
Foot Sensitivity (SWF scores)												
Foot Sole												
heel	-0.054	0.706*	0.102	0.551	0.202	0.235	0.035	0.837	0.074	0.666	0.057	0.739
arch intermedius	0.262*	0.065*	0.229	0.178	0.210	0.217	0.132	0.439	-0.095	0.580	0.163	0.341
metatarsal head III	0.182*	0.204*	0.209	0.22	0.262	0.121	0.085	0.618	-0.108	0.529	0.089	0.604
hallux	0.265*	0.146*	0.147	0.389	0.352*	0.035 *	0.102	0.551	-0.028	0.868	0.039	0.818
Dorsal												
articulatio talocruralis	0.284*	0.046 *	0.228	0.179	0.153	0.370	-0.042	0.805	-0.031	0.855	0.173	0.310
dorsal metatarsal head III	0.304*	0.031 *	-0.061	0.720	-0.106	0.537	0.047	0.784	0.183	0.284	0.028	0.870
Foot Lateral												
lateral malleolus	0.261*	0.066*	-0.174	0.309	-0.029	0.863	-0.056	0.742	0.023	0.892	0.059	0.731
calcaneus lateral	0.391*	0.004 *	-0.158	0.355	0.083	0.627	-0.098	0.568	-0.156	0.362	0.171	0.316
forefoot lateral Φ	0.208*	0.146*	-0.434	0.008	-0.105	0.541	-0.406*	0.014 *	-0.035	0.835	-0.023	0.890
Foot Medial												
medial malleolus	0.192*	0.181*	-0.119	0.485	0.020	0.903	0.031	0.855	0.117	0.494	-0.143	0.402
medial calcaneus	0.426*	0.002 *	0.008	0.961	0.204	0.231	0.010	0.949	-0.106	0.536	0.217	0.202
forefoot medial ¤	0.356*	0.011 *	-0.196	0.250	0.026	0.878	0.047	0.781	-0.016	0.924	-0.071	0.680

¤ medial aspect of metatarsal head I

Φ lateral aspect of metatarsal head V

*Significative Correlation - Spearman Correlation

Note: SWF scores: Semmes Weinstein Filament scores;TUG: Timed Up and Go, s: seconds; PD: Parkinson Disease; UPDRS: Unified Parkinson's Disease Rating Scale,MoCA: Montreal Cognitive Assessment,FOG-q: Freezing of Gait Questionnaire, H&Y: Hoen and Yahr staging scale modified;