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Original article

Variability and repeatability analysis of plantar pressure during gait in older people

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ABSTRACT

Introduction: Repeatability and variability of the plantar pressure during walking are important components in the clinical assessment of the elderly. However, there is a lack of information on the uniformity of plantar pressure patterns in the elderly.
Objective: To analyze the repeatability and variability in plantar pressure considering mean, peak and asymmetries during aged gait.
Methods: Plantar pressure was monitored in four different days for ten elderly subjects (5 female), with mean ± standard-deviation age of 73 ± 6 years, walking barefoot at preferred speed. Data were compared between steps for each day and between different days.
Results: Mean and peak plantar pressure values were similar between the different days of evaluation. Asymmetry indexes were similar between the different days evaluated.
Conclusion: Plantar pressure presented a consistent pattern in the elderly. However, the asymmetry indexes observed suggest that the elderly are exposed to repetitive asymmetric loading during locomotion. Such result requires further investigation, especially concerning the role of these asymmetries for development of articular injuries.

Análise da variabilidade e repetibilidade da pressão plantar durante a marcha de idosos

Palavras-chave:
Marcha
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RESUMO

Introdução: A repetibilidade e a variabilidade da pressão plantar em avaliações da marcha são componentes importantes na avaliação clínica do idoso. Contudo, pouco é conhecido sobre a consistência dos padrões de pressão plantar em idosos.
Objetivo: Analisar a variabilidade e repetibilidade da pressão plantar durante da marcha de idosos, considerando valores médios, picos e assimetrias.

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Métodos: A pressão plantar foi avaliada em quatro diferentes dias em dez idosos (5 mulheres), com idade média ± desvio-padrão de 73 ± 6 anos, durante o andar descalço em velocidade preferida. Os dados de pressão plantar foram comparados entre as pisadas em cada dia, e entre os diferentes dias de avaliação.
Resultados: Dados de pressão média e pico foram similares entre os diferentes dias de avaliação. Os índices de assimetria observados foram similares entre os diferentes dias avaliados.
Conclusão: A pressão plantar (média e pico) apresentou um padrão consistente nos idosos. Contudo, os índices de assimetria observados sugerem que idosos estejam sistematicamente expostos a cargas assimétricas durante a locomoção. Esta observação requer futuras investigações, especialmente em relação ao impacto destas assimetrias na origem de doenças articulares.

Introduction

Gait is vital for older people in order to maintain independence, as it allows carrying out daily activities and contributes to the functioning of various body systems. Since biped walking is a common ability to humans, it serves both as a means of locomotion as an exercise modality. During the gait, every contact of the feet to the ground generates an impact due to the action of the ground reaction forces.[1,2]

Based on force measurements and area of foot contact with the surface, it is possible to quantify the plantar pressure during walking. Thus, we can access important information for the investigation of the stress generated in the different regions of the plantar surface.[3] The published data suggests that older people experience higher plantar pressure on the regions of the 2nd, 3rd and 5th metatarsophalangeal joints and hallux when walking.[4] This increase of plantar load on soft tissues, which have stiffened due to the aging process, often progresses to metatarsalgia in the elderly.[5]

Additionally, excessive exposure to loads on the soft tissues of the feet may lead to problems commonly known as pressure ulcers.[6] These injuries can arise from repetitive microtrauma, causing a decrease in the elastic fibrous tissue water content and a gradual loss of collagen in the fat pad of the heel, contributing to the decrease in elasticity and the ability of fat pad to absorb impact.[7,8] The changes in mechanical properties of heel fat cushion also lead to impact-induced injuries, and to heel pain.[9] These conditions have been assumed to be similar between lower limbs. However, evidence suggests that functional lateralization is a dynamic component of human motor development, and can influence differences between the lower limbs during gait.[10]

In the context of human locomotion, the subject of our study, asymmetries can be seen as deviations on the similarity of performance among right and left hemibody. These deviations are considered significant, based on statistical tests or from the application of symmetry indexes.[11] Many studies have discussed the effects of asymmetries in locomotion parameters, suggesting that asymmetry may influence performance characteristics and also the risk of injury to the lower limbs.[11,12]

Chavet et al.[13] assessed asymmetries in a scenario of impact and shock transmission in lower limbs and suggested that the repetition of asymmetries can be more damaging than its own magnitude. That is, even low rates of asymmetry, if experienced in a repetitive manner, can be a risk factor for injuries.[13] In this sense, the asymmetry index quantification can provide important parameters for the evaluation of asymmetric loads in locomotion. Considering the above observations on the ability of impact absorption during gait in the elderly,[14] repeatability of asymmetries in the gait in this population can be a risk factor for the onset of foot injuries. The popularization of the use of baropodometry systems boosts the discussion of the clinical applications of plantar pressure measurement in the evaluation of human movement, especially in relation to variability and consistency of the measures.[15] Previous studies have suggested that a minimum of three measurements in each test would be necessary to obtain a good level of consistency in measures.[16,17]

However, little is known about the repeatability of plantar pressure parameters in the elderly. In addition, most clinical evaluations are carried out in only one day, not considering possible variations that may occur when more evaluations are performed. From the point of view of the asymmetries, the repetitive load can result in a greater risk than its own magnitude, and there are few studies that investigate these issues in the gait of the elderly. Thus, this study aimed to analyze repeated measures of plantar pressure during the gait of elderly people, in order to discuss the consistency of mean and peak pressure measurements, as well as the asymmetry indexes on different days.

Material and methods

Participants

Initially, a group of 50 senior citizens was invited to participate in the study. Many participants failed to attend the study visits. Since this is a study that involves repeated measurements, participants who were not assessed in the given period were excluded. After the evaluation period, 10 senior citizens were included in this study (5 men and 5 women). All were recruited from a local Community Center for the Elderly, where they took part in recreational activities, as a group, three times a