SEMINAR SERIES

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The Midfoot Passive Mechanical Properties Affect the Lower Limb Biomechanics in Weight-Bearing Activities

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PRESENTATION ABSTRACT

The midfoot joint complex (MFJC), composed of all joints connecting the rearfoot and forefoot, plays an important role in the mechanical efficiency of the lower limb in weight-bearing activities. When the forefoot is on the ground, rearfoot eversion is accompanied by motions at the midfoot joints, which permit the metatarsal heads, as a unit, to invert relative to the rearfoot and stay horizontally supported. Thus, the soft tissues that resist this collective inversion of the midfoot joints may also resist weight-bearing rearfoot eversion. This reasoning was called “torsion spring theory” by Souza et al. (2014). Therefore, it is important to have an instrument to accurately measure the passive mechanical properties of the MFJC, and then to investigate their effects on the functionality of the lower limbs. The first step was to design, build and test the Foot Torsimeter, an instrument to measure the passive torque and angle of the forefoot motion over the rearfoot. Through these measures, other variables can be calculated, as passive stiffness. Magalhaes et al. (2020) showed good to excellent reliability with low measurement error in healthy adult individuals for the variables angle, passive torques and stiffnesses during inversion and eversion. Hence, clinicians and researchers may benefit from the reliable and stable measures provided by the Foot Torsimeter when assessing patients and planning interventions. The next step was to verify the association between these measures and clinical tests. Then, other studies were conducted to investigate whether hip passive stiffness, midfoot passive stiffness and forefoot-shank alignment are related to each other. The results showed that individuals with reduced MFJC passive stiffness also have reduced hip passive stiffness (Fajardo et al., 2021) and increased forefoot-shank alignment (Paes et al., 2019). In sequence, further investigations were conducted during functional tasks. Gomes et al. (2019) demonstrated that the smaller the midfoot resistance torque, the greater the forefoot-rearfoot inversion and dorsiflexion peaks and the rearfoot-shank eversion peak during gait, and Cardoso et al. (2020) found that reduced hip and midfoot stiffness have higher hip and knee internal rotation and higher ankle eversion during the stance phase of gait, and individuals with increased midfoot torque and stiffness have higher knee external rotation. Finally, a more recent study showed that foot and ankle joint moments are possible strategies to reduce pronation and improve propulsion, but not sufficient to prevent the altered kinematics related to low midfoot stiffness (Magalhaes et al., 2021). Therefore, midfoot passive stiffness seems to be critical for foot and ankle kinematics and kinetics during walking propulsive phase as well as it is a potential target of interventions.

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