Journal of
Functional Morphology and Kinesiology

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Editorial

The "*Journal of Functional Morphology and Kinesiology*" Journal Club Series: Highlights on Recent Papers in Gait and Posture

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Received: 27 September 2016; Accepted: 27 September 2016; Published: 18 October 2016

Abstract: We are glad to introduce the third Journal Club. The third edition is focused on several relevant studies published in the last years in the field of Gait and Posture, chosen by our Editorial Board members. We hope to stimulate your curiosity in this field and to share with you a passion for sport seen also from the scientific point of view. The Editorial Board members wish you an inspiring lecture.

Keywords: gait; posture; balance; osteoarthritis; gait dysfunction

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1. Introduction

Posture is the position of the human body in the space and the related relationship among its body segments. The correct posture is the most suitable position of the body in the space (antigravity function) with the least energy consumption both in gait and in the stop position. Neurophysiological and biomechanical factors influence the correct posture. Posture is the result of the relationship between individual and environment and, consequently, is influenced by several factors such as stress, physical trauma, wrong professional posture, incorrect breathing, poor nutrition, specific emotional states which, if prolonged, may result in an increase of the state of muscle contraction. This condition, if prolonged, may result in muscle retraction, resolved through muscle stretching programs. The muscle retraction has, in turn, deleterious effects on joint (compression, axial rotation and translation) thus inducing alterations on the skeletal structure such as scoliosis, lordosis, kyphosis, valgus and varus of the knees.

2. Recent Papers Regarding the Gait and Posture

2.1. *The Importance of the Acquisition of a Correct Posture in Early Life*

Highlight by Paola Castrogiovanni

Postural control develops early in life, in fact, in the first year of life, righting and orientation of the head and body provide the infant with the ability to achieve and maintain several postures, such as sitting and standing [1]. After the independent stance is reached, further refinement of postural control continues to develop during childhood [2]. If postural control does not develop adequately, motor development will be influenced [1]. Therefore, it is of great importance that postural deficits are identified early on [1]. The concept of balance has been defined in many different ways [3–5]. Balance has been described as the "foundation for all voluntary motor skills" [3,5]. The concept of balance comprises the control of posture and the control of equilibrium, and the combination of both is necessary to ensure stability of the body during differing motor tasks allowing skilled movement [3]. Postural control can be defined as achieving a desired body position and maintaining this position in any static (maintaining a posture) or dynamic (performing a motor skill) situation [3,4]. Equilibrium control relates to maintaining intersegmental stability of the body and its parts despite the gravitational and inertial forces acting on it [5]. Destabilizing forces could lead to falls, so that adequate reactions to destabilizing forces are necessary to restore balance such as the stepping strategy [3,4]. Depending on their age, children adopt different balance strategies determined not only by the difficulty of the task, but also by the characteristics of each developmental period [5]. In summary, the concept of balance control is the combination of proactive, predictive, and reactive mechanisms that relate to achieving, maintaining, and restoring balance, respectively [3], and the different balance strategies used by children lead towards this purpose.

2.2. Effects of Hip, Knee, and Ankle Osteoarthritis on Walking Kinematics

Highlight by Marta Anna Szychlinska

Osteoarthritis (OA) is a multifactorial, progressive disease of the joints, affecting millions of people around the world [6]. Although OA is often limited to one joint, especially in its early stages, it is well-recognized that this condition leads to function alterations in other joints. Many studies in literature focused on the effects of OA present in a single joint, on lower extremity mechanics during walking [7–9]. In a recent interesting study by Schmitt et al. [10], this topic has been expanded by comparing overall sagittal plane gait mechanics, ground reaction forces, and spatiotemporal parameters between patients with debilitating, isolated ankle, hip, and knee OA. The purpose of this study was to determine in which way the OA in each of the major load-bearing joints of the lower extremity (hip, knee, ankle) affects overall gait disability and the biomechanical changes in the other lower extremity joints. The hypotheses of the study were that all OA subjects would walk at a slower velocity, exhibit a shorter stride length, adopt strategies that moderate ground reaction forces and joint moments allowing in this way to reduce painful limb loading and finally lead to mechanical changes both at the affected joint and the other lower extremity joints during walking, when compared to the control group. For this purpose, 90 subjects between the ages of 40 and 80 years old with severe hip, knee, and ankle OA were enrolled. Stride length, stance and swing times, as well as joint angles and moments at the hip, knee, and ankle were derived from 3-D kinematic and kinetic data collected from seven self-selected speed walking trial. With walking speed controlled, the results indicated a reduction in hip and knee extension and ankle plantar flexion in accordance with the joint affected. In addition, OA in one joint had strong effects on other joints. In both hip OA and knee OA groups the hip never passed into extension, and ankle OA subjects significantly changed hip kinematics to compensate for lack of plantar flexion. Finally, OA in any joint led to lower peak vertical forces as well as extension and plantar flexion moments compared to controls. The presence of end-stage OA at various lower extremity joints resulted in compensatory gait mechanics that cause movement alterations throughout the lower extremity. This study is very useful when considering potential interventions in patients with isolated OA, as it underlines the importance of the effects of the latter on the alterations in the mechanics of the other joints of the same extremity.

2.3. Assessment of the Trunk Motion during Gait

Highlighted by Silvio Lorenzetti

Almost 20 years ago, it was suggested by Crosbie et al. [11] that the spinal movements during gait are linked to the primary motions of the pelvis and the lower limbs. Nowadays, the evaluation of the trunk during gait has become important in different areas which include patients suffering strokes, idiopathic scoliosis, and cerebral paresis, in showing the effect of retraining gait or other interventions. From a technical point of view, studies with either bone bins, accelerometers or a video-based system with skin markers have been conducted. A study using bone bins resulted in less than 4 degrees of lumbar intersegmental motion in all planes [12]. These authors state that the lumbar spine mainly contributes to coronal plane motion, while the thoracic spine contributes to the majority of the transverse plane motion.

With the evaluation of the trajectories of the skin markers, a more global description of the motion of the spine with either a segmental or a curvature/cobb angle based approach can be performed. Recently, Alberto Leardini et al. [13] presented the motion around the three anatomical axes of the trunk during gait, using a multi segment approach [14]. Alberto Leardini et al. [12] concluded that their results support the potential of using gait retraining for walking with a straighter back for forward trunk inclination in the elderly or people with poor balance control and a risk of falling. Schmid et al. [15] were using a curvature based approach with skin markers to quantify curvature angles during gait and suggested that the dynamic functionality of the scoliotic spine can so be assessed and that such procedures should become standard in clinical gait analysis. In the future, curvature angle data could be useful to drive whole body models in order to gain insights into the loading of the healthy and pathologic spine during gait.

2.4. Gait and Posture in Older Adults

Highlight by Milos Ljubisavljevic

The examination of gait and posture in older adults has gained momentum over the last decade, highlighting their importance for the overall well-being of this vulnerable population. Considerable efforts were focused on improving assessment of gait and balance in relation to the risk of falling, and its prevention also through training. Classically, gait performance in older adults is assessed by measuring pace, rhythm, and variability of gait. A recent study identified five primary domains of spatiotemporal gait parameters including rhythm, phase, variability, pace, and a base of support, each incorporating a set of measurements [16]. The results showed that domains vary between men and woman across age groups. Importantly, the study presented reference values for these domains, enabling future comprehensive assessment and interpretation of gait dysfunction in elderly adults. A systematic literature review that examined which spatiotemporal parameters of gait can distinguish an elderly faller from a non-faller showed that the variability of step length, gait speed, stride length, and stance time better distinguish faller from non-faller [17]. Variability of gait was also shown to be associated with variability local dynamic stability (LDS) of gait, a non-linear gait stability index, which correlated with fall history [18]. Improvement of the assessment and training by use of widely available interfaces like 'Nintendo Wii' and Microsoft Kinetics also gained momentum. An interface for 'Nintendo's Wii Balance Board' was developed allowing accurate calculation of a participant's center of pressure [19]. The use of real-time visual feedback of present centre of pressure (COP) position would allow development of virtual environment applications, providing safe, home-based, adaptable, subject-friendly and low-cost diagnostics and training tool for balance in older adults. Variability of gait and stability and the risk of fall is also associated with a decline in cognitive function, and in particular with executive functions. Using a single and dual task walking paradigm, Ijmker and Lamoth [20] showed that gait pattern becomes increasingly unstable during dual tasking, suggesting that increased gait variability in dementia patients may be directly related to decreased executive function [20]. This finding is significant as it suggests that measures of gait variability and stability should be taken into consideration when designing fall risk interventions for this population, and interestingly that gait variability may be useful in supporting the diagnosis of dementia.

Acknowledgments: The special thanks goes to the Editorial Board members who wanted to commit to this new initiative of the journal with much enthusiasm and interest.

Conflicts of Interest: The authors declare no conflict of interest.

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