Neuromechanical adjustments in human walking with bent posture

M. Nunez-Lisboa [a], A.H. Dewolf [b]

[a] *Exercise Science Laboratory, School of Kinesiology, Faculty of Medicine, Santiago, Chile*
[b] *Laboratoire de biomécanique et physiologie et la locomotion, Institute of Neuroscience, UCLouvain Louvain-la-Neuve, Belgium*

Introduction

Evolutionary and functional adaptations of the spine and trunk are inherently related to an important role of gravity for the mechanisms determining a specific postural tone and body segment configurations, when comparing bipedalism and quadrupedalism [1]. But other than this, gravity has a major impact on specific rules of motion in the gravity field, and foot-support interactions in particular. Here, we looked at the neuromechanical adjustments made by people walking with bent posture that may help us understand the physiological mechanisms and biomechanical regulations underlying our tendency toward upright posture, as well as possible motor control disturbances in some diseases associated with trunk orientation problems.

Methods

Ten healthy young men walked at 1.1 m s^{-1} on an instrumental treadmill. They walked with a natural trunk position, and with an imposed 10°, 20°, 30° and 40° of trunk flexion. The angles were controlled on the sagittal plane by OnForm app. For each condition, participants walked 3 minutes and the last 10 seconds of each session were recorded. The vertical ground reaction force (Fv) under each foot were recorded,as well as the EMG activity of 4 lower-limb muscles (vastus medialis, vasto lateral, tibial anterior, medial gastrocnemius and lateral gastrocnemius). The ratio between the maximal force of the front and the back leg (Ff/Fb) during the step-to-step transition was measured. From Fv, we computed the vertical velocity of the CoM, to determine the begin (Vv,min) of the transition. A one-way ANOVA and Bonferroni post hoc was used to compare our variables. For each condition and each stride, the mean activation and the center of activity (CoA) were calculated. The CoA is the vector's angle that points to the center mass of the circular distribution.

Results

No differences of step length were observed between conditions ($p = 0.532$). The timing of $V_{v,min}$ relative to the foot contact and F_f/F_b were different between conditions ($p < 0.001$): the greater the increase in trunk flexion, the later $V_{v,min}$ occurred relative to FC ($p < 0.05$). Also, as compared to natural walking, F_f/F_b was higher in the 20°, 30°, and 40° trunk flexion conditions ($p < 0.05$). No differences were founded in F_f/F_b between 10° and normal ($p = 1.00$).

The angle of trunk inclination significantly influences in the muscle mean activation of muscles, especially the extensors. Specifically, the GL's mean activation was higher at 20°, 30° and 40° than during normal walking ($p < 0.004$). The mean VL and VM muscle activity was higher at 10°, 20°, 30°, and 40° compared to normal conditions ($p < 0.001$). The trunk inclination also influences the timing of extensor muscle activation but not of flexor muscle ($p = 0.054$). Also, small change was observed at proximal extensors whereas at distal extensors, the changes were much larger ($p = 0.0017$).

Discussion

Surprisingly, attenuating extensor muscle activity at the end of stance was one of the main impacts of trunk inclination. During step-to-step transitions, in each step the velocity of the center of mass must be redirected upwards. When walking upright, this redirection was initiated in an anticipatory manner by the trailing leg, propulsing forward and upward the body before foot contact. However, with increasing trunk inclinations, there was a lack of these anticipatory adjustments and the redirection was performed later by the loading limb after the collision with ground. The results are discussed in the context of the biomechanical principles underlying foot-support interactions during step-to-step transitions in bipedal upright walking.

REFERENCES

[1] Crompton RH, et al. *Journal of Human Evolution* 1998; 35:55–74
[2] Ruina A, et al. *Journal of Theoretical Biology* 2005; 237:170–192

https://doi.org/10.1016/j.gaitpost.2023.07.323

Identifying the best discriminative gait features to characterize disease progression in Multiple Sclerosis

A.S. Orejel Bustos [a,b], M. Tramontano [b], R. Montemurro [a], V. Belluscio [a,b], E. Bergamini [a,b], O. Argento [a], M. Bossa [a], U. Nocentini [a,c], G. Vannozzi [a,b]

[a] *IRCCS Santa Lucia Foundation, Rome, Italy*
[b] *University of Rome "Foro Italico", Rome, Italy*
[c] *Tor Vergata University of Rome, Rome, Italy*

Introduction

Digital outcomes identifying gait features through inertial measurement units (IMUs) have been proposed to investigate balance and locomotion disorders in people with Multiple Sclerosis (PwMS) and other neurological disorders [1,2]. Their application has been a beneficial tool to monitor the progress of the disease and for decision-making to enhance clinical outcomes [1-3]. In this perspective, identifying key indicators that could be able to discriminate between PwMS with different levels of walking impairment, could be employed as a tool to characterize walking dysfunction in PwMS. The aim of this study is to explore what specific gait features extracted from IMUs during different walking modalities, best discriminate for disease progression in two grouped classes based on the Expanded Disability Status Scale (EDSS) [4].

Methods

Fifty-seven patients with MS (*Class 1*– greater degree of ambulatory ability, $n = 32$, 21 F, 50.4 ± 9.8 y, EDSS 0–4; *Class 2*– impaired ambulatory ability, $n = 25$, 17 F, 52 ± 10.2, EDSS 4.5–6.5) participated in this study. All participants performed a 10-meter Walk Test (10mWT) and a Figure-of-8 Walk Test (F8WT) [5] while wearing five IMUs (APDM, Opal, 128 Hz) on both lateral malleoli, pelvis, sternum, and head. Stride segmentation was performed from leg IMUs. Spatio-temporal (ST) parameters (stride frequency-SF, stride duration-SD and