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SPLIT-BELT WALKING DOES NOT REPRODUCE HEMIPARETIC CLAUDICATION: A STUDY ON THE POWER OUTPUT AT THE ANKLE AND AT THE BODY CENTRE OF MASS

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INTRODUCTION

Walking on a split-belt treadmill (with each of two belts running at a different velocity) has been claimed, based on kinematic findings, to mimic pathologic claudication by imposing a shorter stance ("escape" limp) on the faster belt. However, the anterior step decreases, contrary to what is usually observed in hemiparesis. This paradigm has been claimed to be a useful therapeutic exercise. Nevertheless, it leads to contradictory findings: spatial symmetry can be forced by placing the hemiparetic lower limb on the faster belt, but this entails exaggeration of the temporal asymmetry (vice-versa if belts are exchanged). Some light can be shed onto this contradiction if one considers the dynamics of gait. In the present study, the muscle power subtending the sagittal rotation of the joints of the lower limbs and the translation of the body Centre of Mass (CoM) were analyzed.

METHODS

Ten healthy adults (5 women), mean age (SD) 26 (2.81) years, height (SD) 1.71 (0.12) m, body mass (SD) 63.67 (11.13) kg walked on a split-belt treadmill mounted on force sensors providing 3D ground reaction forces. The belts ran either at the same ('tied' condition, TC) or at different velocities ('split' condition, SC) [2]. Lower limb joint rotations were recorded through a wireless optoelectronic system. The spatiotemporal synchronization of sagittal ground reactions and joint rotations allowed measuring the muscle power in the sagittal plane at the ankle, which provides about 70% of the muscle power needed to keep the body in motion during normal waking [3]. Subjects walked in TC at 0.6 m s^{-1} and in SC at 0.4 vs. 0.8 m s^{-1}, with the dominant lower limb placed on the faster belt. By summing vectorially the ground reactions from both belts, the 3D mechanical energy changes of the body CoM could be computed, according to the "double integration" method (Cavagna's algorithms, [3]). The total mechanical energy (E_{tot}) and the efficiency of its pendulum-like transfer (saving of muscle work, percentage of energy Recovery, %R), were analyzed. A 30-180-30 s tied/split/tied walking sequence was requested.

RESULTS

In the SC, it has already been demonstrated that healthy adults show a marked asymmetry in the peak joint power provided by the trailing ankle at push-off: this was 2.5 times higher compared with the slower side, and 1.2 times higher compared to the one observed at the intermediate speed in TC [4]. In the present study, the analysis of the CoM unexpectedly revealed an increased efficiency of the pendulum mechanism during the whole stride (hence, per unit distance). %R was 58% in SC and 40% in TC. The reasons still need to be clarified.

DISCUSSION

Walking on a split-belt does not reproduce pathologic claudication but is an original form of gait instead. %R is higher than that recorded during TC at intermediate velocity. The step performed on the faster belt mimics the paretic step temporally but neither spatially nor, which is the original finding here, dynamically. Split-belt walking cannot be proposed as an established therapeutic paradigm until the choice for forcing dynamic (at joint and/or CoM level) vs. temporal vs. spatial symmetry is motivated.

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