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WALKING ON A SPLIT-BELT TREADMILL INDUCES A HIGHER POWER OUTPUT AND A SHORTER STEP LENGTH FROM THE FASTER LEG IN HEALTHY SUBJECTS, WITH OPPOSITE (AFTER)-EFFECT LASTING LESS THAN 5 MINUTES AFTER EXERCISE

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INTRODUCTION

Walking on a split-belt treadmill has been claimed as a possible treatment of pathologic step asymmetries: in particular, the step lengthening on the affected side [1]. Placing the paretic limb on the slower belt would increase this asymmetry, reverting to long-lasting symmetry after exposure (after-effect). These studies neglected the underlying dynamics. Recently, it has been demonstrated that this paradigm entails an opposite spatial and dynamic asymmetry in healthy subjects. The stance on the faster belt is shortened, thus mimicking the paretic step temporally. On the contrary, the step is shorter and more muscle power is produced [2]. This challenges the rationale of the previous researches. The present study aims at extending these findings by investigating the after-effect both on spatiotemporal step parameters and power output from the plantar flexors on either belt.

METHODS

Ten healthy adults (21-34 years, 1.61-1.91 m tall, 5 women) participated in the study. After a brief familiarization, participants walked on a force-sensorized split-belt treadmill with one belt running at 0.4 m s^{-1} and the other belt running at 1.2 m s^{-1} (split condition) for 15 minutes and then, with no interruption, with the belts running at the same velocity (0.4 m s^{-1}, tied condition) for other 5 minutes. The dominant lower limb was assigned to the faster belt. Kinematic data were recorded through an optoelectronic system as per the Davis anthropometric model. Joint sagittal power was computed by multiplying the moment generated by the ground reaction forces at the joints, times the rotation speed. All signals were simultaneously recorded [2]. The study was approved by the Local Ethics Committee.

RESULTS

Consistently with previous studies [3], during the split condition, the step length on the slower belt was longer, reaching gradually about 130% of the opposite step length. Ankle peak power attained about 15% of that observed on the opposite side. During the following tied condition, the step length on the formerly slower belt initially shortened by about 65% (after-effect), compared to the opposite step, and returned to values similar to that of the opposite side within 5 minutes. During this transition phase, ankle peak power gradually increased by up to 50% compared to baseline. On the formerly faster belt, step length did not change, while ankle peak power suddenly dropped to the contralateral level (Figure 1).

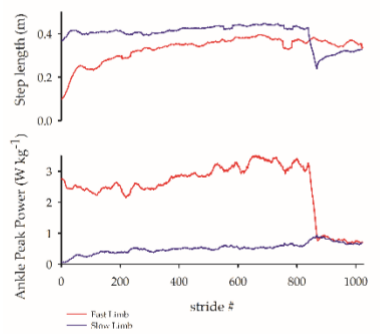

Figure 1 Stride by stride plots (moving average, time-window 30 strides) of step length (upper panel) and ankle power (lower panel) from one representative subject (woman, 21 years, 1.65 m tall, body mass 60 kg) walking on a split-belt treadmill with the dominant lower limb on the faster belt (red) and the non-dominant lower limb on the slower belt (blue). Strides from 1 to 867 refer to the split condition, and stride from 868 to 1025 refer to the following tied condition.

DISCUSSION

The increase in plantar flexor power on the faster belt, despite the shorter stance period and length, may reflect the priority need to counteract the backward drag from the faster belt, with respect to the slower one. This adaptation does not seem to lead to substantial learning, given that an after-effect, both on step length and ankle peak power, is only seen during the 5 minutes following split walking.

In pathologic claudication, placing the affected lower limb on the faster belt might represent an effective form of “forced-use” [4], as far as enhanced power is requested. Long term effects remain questionable.

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