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P3-B-6 Combined study of segmental movements and motion of the centre of mass during adaptation on a split-belt treadmill

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BACKGROUND AND AIM: Walking on a split-belt treadmill (each of the two belts running at different speed) has been proposed as an experimental paradigm to investigate the flexibility of the neural control of gait and as a form of therapeutic exercise for hemi-paretic patients[1]. However the scarcity of dynamic investigations both for segmental aspects and for the entire body system, represented by the Centre of Mass (CoM), challenges the validity of the available findings on split-gait. Thus, the aim of the present study is to describe the dynamic adaptation of healthy subjects in terms of segmental and CoM motion, using Gait Analysis on Force Treadmill [2]. The study intends to clarify the effect of "split-gait", underlining its differences with pathologic claudication. **METHODS:** Ten healthy adults walked on a split-belt treadmill mounted on force sensors, with belts running either at the same speed ('Tied Condition', TC) or at different speeds ('Split Condition', SC, 0.4 vs 0.8 m/s). For the study of segmental motion, the surface Electromyography (sEMG), sagittal power and work provided by ankle, the main engine of body propulsion, were simultaneously recorded. For the study of the CoM motion, the Total Energy

(Etot) and the percentage of Recovery (%R), the index of efficiency of the pendulum-like mechanism, were simultaneously analyzed. Various tied/split walking sequences were requested. The study was approved by the Local Ethic Committee. **RESULTS:** In the SC, the segmental motion analysis revealed a marked asymmetry between the two sides. The work provided by the ankle was 4.8 times higher (in the 0.4 vs 0.8 m/s conditions, respectively) compared with the slower side, and 1.2 times higher compared with the same speed in the TC (0.6 m/s) [3]. Paradoxically, the analysis of the CoM revealed an increased efficiency of the pendulum mechanism, with a higher %R in SC with respect to the TC at the same speed. **CONCLUSIONS:** Split gait entails its own pattern of locomotion, very different from pathologic claudication. The faster leg mimics the paretic limb temporally, but the unimpaired limb from the spatial and dynamic point of view[3]. This must be considered when a therapeutic application is designed. **REFERENCES:**1. Helm et al. Phys Med Rehabil Clin N Am. 2015;26(4):703-13. 2. Tesio et al. Am J Phys Med Rehabil. 2008;87(7):515-26. 3. Tesio et al. Int J Rehabil Res. 2018;41(4):304-315.

Combined study of segmental movements and motion of the Centre of Mass during adaptation on a split-belt treadmill

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Background and aim

Walking on a split-belt treadmill has been proposed as an experimental paradigm to study the flexibility of the neural control of gait and as a form of therapeutic exercise for hemi-paretic patients [1]. However, the scarcity of studies on dynamic adaptations challenges the validity of the available findings, which mostly refer to kinematics. The aim of the present study is to describe the dynamic adaptation of healthy subjects through a combined analysis of segmental motions and the motion of the body Centre of Mass (CoM) using Gait Analysis on Force Treadmill (GAFT) [2].

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 were analyzed with GAFT, a combined analysis based on an integrated optoelectronic system, a wireless EMG from 8 muscles, videos, and a split-belt treadmill mounted on force sensors. The participants walked on belts running either at the same speed ('tied' condition, TC) or at different speeds ('split' condition, SC, 0.4 vs. 0.8 m s⁻¹, dominant leg faster). Plantar-flexors power and work of the ankle were synchronised with the efficiency of the pendulum-like transfer of mechanical energy of the CoM, percent Recovery (%R)[3].

Results

It has already been demonstrated that in the SC healthy adults show a marked asymmetry in the work and peak joint power provided by the trailing ankle at push-off [4]. In the present study, the analysis of the CoM unexpectedly revealed an increased efficiency of the pendulum-like mechanism during the whole stride (hence, per unit distance). The percent Recovery (%R) was 58% in SC and 40% in TC. The reasons still need to be clarified: as a matter of speculation, the faster belt "injects" energy into the walking system, thus decreasing the need for muscle work.

Conclusions

Walking on a split-belt treadmill does not reproduce pathologic claudication but it is an original form of gait instead. %R is higher than that recorded during TC at a velocity intermediate between those of either belts. The step performed on the faster belt mimics the paretic step temporally but neither spatially nor, which is the original finding here, dynamically (it works more than the slower one). 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.

References

- Helm et al. Phys Med Rehabil Clin N Am 2015; 26(4): 703-13.
- Tesio et al. Am J Phys Med Rehabil 2008; 87(7):515-26.
- Cavagna et al. J Appl Physiol 1983; 55(2): 607-13
- Tesio et al. Int J Rehabil Res 2018; 41(4):304-315

Results

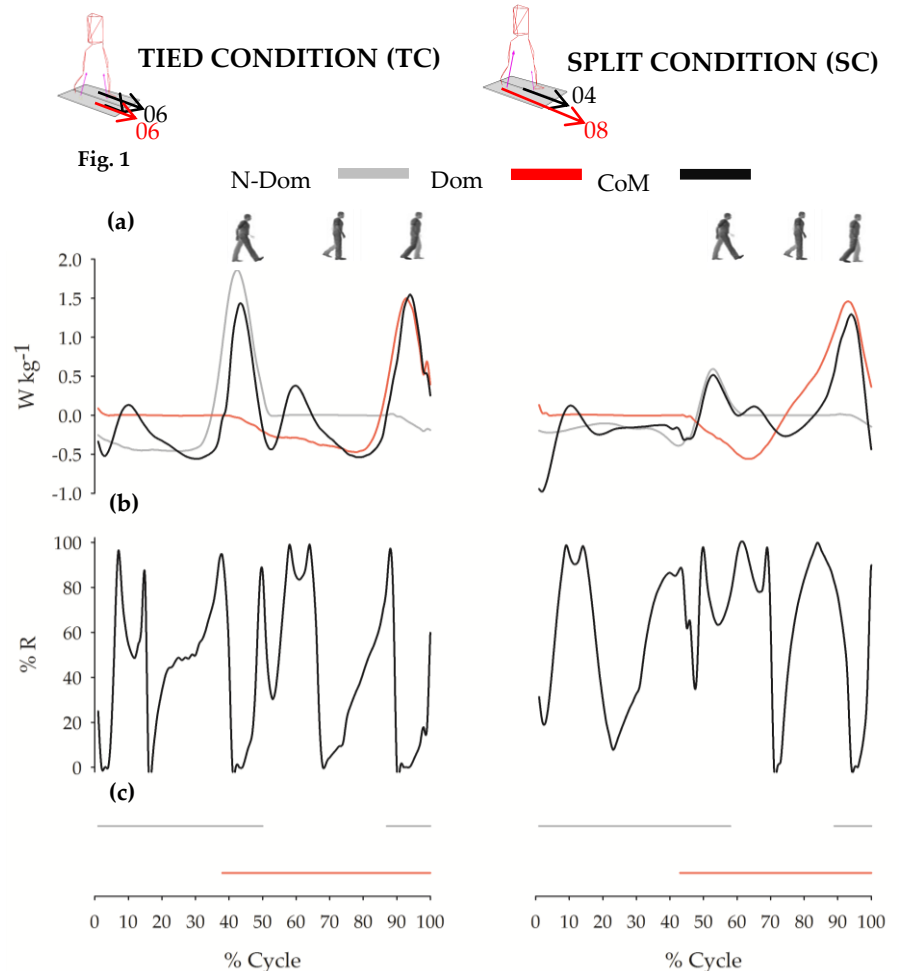


Fig.1. From top to bottom, synchronized traces of Ankle plantar flexion and CoM Power [W kg⁻¹] (panel a) and instantaneous percentage of energy Recovery [%R] (panel b) during a stride: horizontal segments refer to stance on the non dominant (grey) and dominant (red) limb (panel c). Mean of 6 strides from 1 representative healthy subject walking in TC (both belts ran at 0.6 m s⁻¹) and SC (one belt ran at 0.4 m s⁻¹ and the other at 0.8 m s⁻¹).

Tab. 1

(a)	ANKLE			(b)	CoM	
	TC 0606	SC 04	SC 08		TC 0606	SC 0408
Peak Power [W kg ⁻¹]	1.21 (0.24)	0.60 (0.28)	1.49 (0.24)	Recovery (%)	40 (4.83)	58 (4.81)
Work [J kg ⁻¹]	12.89 (1.89)	4.43 (2.13)	21.34 (4.22)			

Ankle peak plantar-flexors power, work (panel a)[3] and percent Recovery (panel b). Grand-mean (SD) across 6 strides performed by 10 healthy adults.



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