

CHANGE OF SYMMETRY BETWEEN OVER GROUND AND TREADMILL RUNNING WITH A CHRONIC KNEE INJURY

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Introduction

Injured runners are known to show high variability [Hein, 2011], but it remains unclear if running behaviour is altered when performed over ground (OG) or on a treadmill (TM). The first aim of this study is to analyse the running asymmetry between affected (AF) and not affected (NA) leg. The second aim is to investigate the change in asymmetry between OG and TM locomotion.

Methods

Fourteen subjects suffering from chronic knee osteoarthritis (8 women, 6 men) ran OG at self-selected velocity which was subsequently used on the TM.

We measured the lower body segment kinematics (Vicon, modified Plug-in-Gait marker set). Based on foot markers we estimated contact phase and step duration (step begin at touchdown and end at the next touchdown). The average of the four pelvis markers was used to estimate the centre of pelvis (COP). The fluctuation of COP position and velocity in sagittal plane was calculated for each step [cf. Cavagna, 1976]. We measured the reductions of COP height (vertical compression) and of COP forward velocity occurring after landing. For each kinematic parameter the average over all AF and NA steps was retained. The difference between the kinematic parameters for AF and NA legs was analysed for OG and TM locomotion.

Two additional parameters were defined: the heavy-support duration (HS) with vertical force (F) > bodyweight and the extended-fly duration (EF) with F < bodyweight. HS and EF were defined from the derivative of the vertical COP velocity. Based on HS and EF an asymmetry parameter (AP) was defined for AF and NA steps:

$$AP = 1 - \frac{EF_{NA} / HS_{NA}}{EF_{AF} / HS_{AF}}, \text{ that describes the}$$

degree of change for EF/HS between NA and AF steps.

Results

A significant reduction on AF leg was observed for the step (-3.0%, p<0.001), contact (-2.7%, p=0.031), and heavy-support duration (-7.7%, p=0.044). We found a significant increase of the extended-fly duration (+4.4%, p=0.027) and a significant decrease of the vertical compression during contact (-17%, p=0.042) for AF steps. The forward velocity reduction at landing was significantly larger on AF leg (+8.2%, p=0.008).

The asymmetry parameter AP showed a significant reduction from 12.9% OG to 8.6% on TM (p=0.004).

Discussion

A clear asymmetry between NA and AF steps was found for the investigated running parameters. Measurements showed significant time asymmetry for the contact, step, heavy-support and extended-fly durations with differences between AF and NA lower than 8%. The movement in sagittal plane during the absorption phase (first part of the contact phase) is at the origin of a larger significant asymmetry (> 8%) for the vertical compression and for the reduction of the forward velocity.

The symmetry is dependent on the OG or TM locomotion conditions. This is illustrated by the significant decrease of AP on the TM.

We can conclude that subjects with chronic knee injury showed a clear asymmetrical running behaviour OG. On the TM, however, a significant increase in running symmetry was found. This finding indicates that running on a TM could be beneficial to train a symmetrical running behaviour for runners with chronically injured knees.

References

Hein *et al*, Hum Mov Sci, 31:683-694, 2011
Cavagna *et al*, J Physiol, 262:639-657, 1976