INTRA SUBJECT RELIABILITY OF KINEMATIC DATA IN PREFERRED AND SPECIFIED RUNNING SPEEDS

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INTRODUCTION

Standardization attempts in biomechanical measurement protocols mostly consist of recording a series of trials at a pre-specified running speed to ensure comparability of the results between the subjects. However, a fixed running speed (e.g. 3.3m/s for all subjects) does not account for anatomical differences and subject-specific preferences which could be critical for many kinds of biomechanical variables including kinematic measures. A new measurement protocol was used in a study primarily designed to assess biomechanical differences between female runners suffering from patella tendon syndrome (PTS) and healthy controls (CO, both male and female). It incorporated a total of up to 40 trials per subject, featuring two different running speeds (individual "preferred" vs. specified 3.3m/s).
In order to compare results of the different groups (e.g. by creating average files) variability of the gait curves had to be assessed. The main goal was to investigate a possible effect of running speed on kinematic data. The results should influence future decisions on the choice of measurement conditions in similar laboratory settings.

METHODS

A total of 51 subjects (19 COmale, 17 COfemale, 15 PTSfemale) were included in the study. Subjects ran barefoot along a runway consisting of shore18 EVA foam material to ensure comfortable and natural barefoot running. To obtain 3D kinematic data, 21 reflective markers were applied to the pelvis, thigh, shank and foot. Left and right lower limbs were recorded separately and in randomized order using a 6-camera motion analysis system (Vicon, Oxford) at a frame rate of 250 Hz. Subjects started their sessions by performing 10 trials at their preferred running/training speed followed by 10 trials at the pre-specified 3.3m/s (+/- 5%). All speed situations were recorded by photo cells. Subsequently the same protocol was conducted for the other side as well. Angular joint motion was calculated using a rigid body assumption and joint coordinate systems in accordance to Grood & Suntay Conventions (Grood/Suntay 1983). Reliability of the unfiltered kinematic angular displacement data was assessed using Intraclass Correlation Coefficients (ICC) (Duhamel et al. 2004). Calculated measures were the mean and standard deviation of the preferred and specified speeds for each individual set of up to 10 trials, variability of the kinematic data for each individual set of up to 10 trials and finally the difference in variability of kinematic data between preferred and specified speed series expressed by the percentage ratio of the corresponding ICCs. Calculations were accomplished using the SPSS 11.5 software package.

RESULTS

First of all, the distributions of the preferred running speeds as well as the standard deviations for each set of trials seem to be similar throughout all gender/pathology groups, whereas they differ in mean level of the preferred speeds. Both female groups chose approximately the same speed and were slower than the male group by up to 0.2m/s. However, these results show no statistical significance. Additionally, neither absolute ICC values nor change of ICC between the two speeds differ between the gender/pathology groups.

Subjects and their individual speed changes between preferred speeds and 3.3m/s-speeds were then re-categorized into three "speed-groups": unchanged, increased or decreased mean of their preferred speed compared to their 3.3m/s mean value. Based on this new subject grouping, a new analysis of preferred speed variability, ICC values and ICC change between preferred and specified speeds again does not reveal differences between the groups. However, substantial differences can be found between the different rotation components of the joints, where sagittal plane movements (e.g. hip flexion, knee flexion) show ICC group mean values of up to 0.97 and frontal plane movement values as low as 0.75.

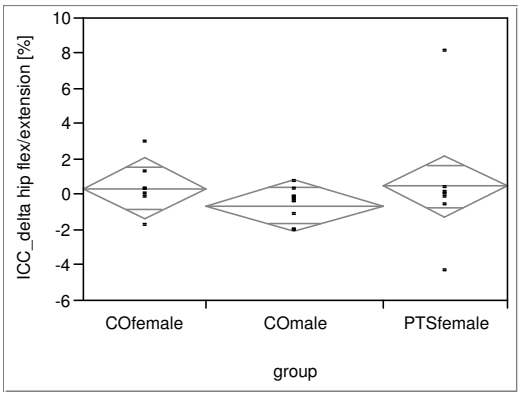

Figure 1: Change in ICC between preferred and specified running speed for hip flexion movement. Mean diamonds show group means and 95% confidence intervals. ICC change is expressed in percentage of difference between ICC at preferred speed and ICC at 3.3m/s. All three groups show neither statistical nor relevant changes as group means are located around zero.

DISCUSSION

Generally, between trial reliability of the recorded data was considered to be good (many results at 0.8 or better). Results indicate that running barefoot at individually preferred speeds does not affect the variability of recorded 3D-kinematic data systematically, or to an extent that would be considered relevant in a clinical research setting. However, reliability differences between different rotation components are much more evident than the effect of speed changes on those measures, with sagittal plane movements being the least affected. On the one hand, this is in accordance to recent research which revealed similar results for treadmill running (Karamanidis et al. 2003). On the other hand, these results indicate the possibility of using measurement protocols with subjects running barefoot in a spatially limited laboratory setting. Finally, the difference in preferred speeds between the two genders is obvious (though small). Based on these findings, future studies could forgo pre-specified running speeds, as variability in kinematic data seems to be almost unaffected. Subsequently, measurement economy could be improved if subjects were not forced to run at specified speeds which would result in fewer trials needed to complete the measurement series.

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