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EFFECT OF GENDER AND WALKING SPEED ON GAIT VARIABILITY IN HEALTHY YOUNG SUBJECTS

[1]Rita M. Kiss, [2]Mátyás O. Magyar
[1]Budapest University of Technology and Economics, Department of Structures; email: kiss@vbt.bme.hu
[2]Pain Ambulance

SUMMARY

Repetition in walking may vary from trial to trial: gait parameters are not constant but they rather fluctuate in the course of time and change from one stride to the next, even if environmental and external conditions are fixed. The aim of this study was to specify the effect of gait speed and gender on the variability of gait. The variability of spatial-temporal parameters was characterized by a coefficient of variance (CV), the percentage ratio of standard deviation and mean; on the other hand, the variability of angular parameters was characterized by a mean coefficient of variance (MeanCV), which is the average coefficient variance over all integer percents of normalized gait cycles. The spatial positions of the anatomical points for calculating gait parameters were determined in 33 young healthy controls. Walking speed influences the variability of gait: gait analysis must be peformed at each self-selected walking speed of the group investigated. Gender influences significantly the variability gait. This means that the values of gait variability should be compared by taking gender into account.

INTRODUCTION

Repetition in walking may vary from trial to trial: gait parameters are not constant but they rather fluctuate in the course of time and change from one stride to the next, even if environmental and external conditions are fixed [1]. The variability of spatial-temporal parameters represents the consistency of the motion of the lower limbs from stride to stride [1,2], while the variability of joint motions may reflect the flexibility of movement patterns and joints [1,3]. The variability of spatial-temporal parameters and the variability of angular parameters together represent the complexity of gait [3], which is an index of the stability of gait [2,1]. If the variability of spatial-temporal parameters increases and the variability of angular parameters decreases parallelly, complexity and stability may deteriorate [2,3].

The aim of this study was to specify the effect of gait speed and gender on the variability of gait.

METHODS

The investigated group consisted of 20 women (age 21.6 ± 8.7, body mass 66.3 ± 9.7, body height 161.2 ± 13.5) and 13 men (age 23.2 ± 1.6, body mass 79.9 ± 11.3, body height 177.4 ± 9.8). Nine subjects required correction to normal vision, and the maximum diopters were +2.0 and –4.5.

Gait analysis was performed using a zebris CMS-HS (zebris, Medizintechnik GmbH, Germany) d ultrasound-based motion analysis system. The basics of this measurement method have been described in detail [17]. A biomechanical model applying 19 anatomical points [18] was selected, enabling an accurate and reproducible analysis of lower limb motion. A frequency of 100 Hz was used to determine the spatial coordinates of the designated anatomical points. Gait analysis was performed on a 500 mm x 1500 mm treadmill driven by an electric motor (Kistler Holding AG, Germany). Subjects walked barefoot on the treadmill for 10 minutes. Two different controlled walking speeds (1.0 m/s, and 1.2 m/s) were used for gait analysis. There was a 5-minute rest between trials. The measurement control software recorded the spatial coordinates of the designated anatomical points for at least 400 cycles.

The spatial coordinates of the designated anatomical points were used to calculate spatial-temporal and angular parameters such as step length, walking base, duration of double support phase, duration of support phase, cadence, knee and hip angles, pelvic flexion-extension, obliquity, and rotation. The variability of spatial-temporal parameters was characterized by a coefficient of variance (CV), which is a percentage ratio of standard deviation and mean. The variability of angular parameters of the hip and knee joints at both limbs and the pelvis was represented by the mean coefficient of variance (MeanCV), which is the average CV over all integer percents.

In order to compare results, a one-sample t-test was used, applying a symmetrical critical range.

RESULTS AND DISCUSSION

All healthy subjects and patients involved in the investigation were able to complete the tests at both walking speeds. Figure 1 shows the CV (%) of spatial-temporal parameters, and Figure 2 the MeanCV (%) of angular parameters.

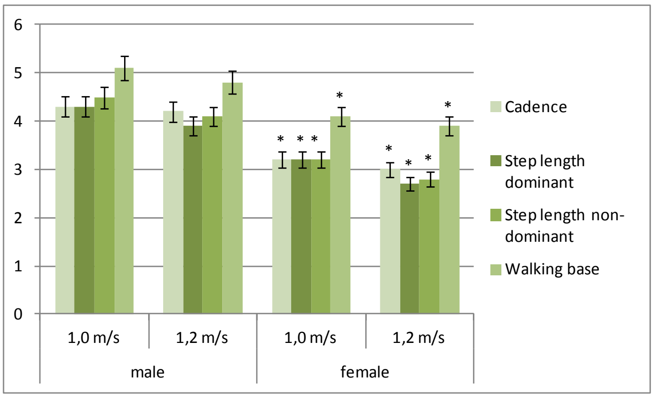

Figure 1: CV values of spatial and temporal parameters (*: significant differences in comparing the values of males and females)

The CV values of spatial-temporal parameters were the lowest (Figure 1), the Mean CV of angular parameters was the highest (Figure 2) at 1.2 m/s in the healthy group, which is the self-selected walking speed of the group. The CV values increased and the Mean CV values decreased (though not significantly) if the walking speed differed from the self-selected walking speed (Figures 1 and 2). Based on our results, the tendency for changes in the variability of spatial-temporal parameters and the variability of angular parameters appear controversial because the variability of spatial-temporal parameters increased and the variability of angular parameters usually decreased at the different walking speeds. Our results demonstrated the theoretical establishment by Beauchted et al [4]. The walking speed influenced the variability of gait parameters and the most comparable limb movement was found when the analysis was done at speeds near the self-selected walking speeds.

At female subjects the CV values of spatial parameters were significantly lower (Figure 1), and the Mean CV values of angular parameters (Figure 2) were significantly higher than the values of male subjects. The tendency for changes in the variability of spatial-temporal parameters and the variability of angular parameters appear controversial, similarly to the tendency at the change of walking speeds. On the basis of the results it can be established that the capability of responding to different perturbations and adapting to changes in the environment is better at females than at males. This can be caused by the better flexibility of female joints [1].

CONCLUSIONS

On the basis of our results it can be established that walking speed influences the variability of gait; gait analysis must be performed at each self-selected walking speed of the group investigated. Gender significantly influences the variability of gait. This means that the values of gait variability should be compared by taking gender into account.

ACKNOWLEDGEMENTS

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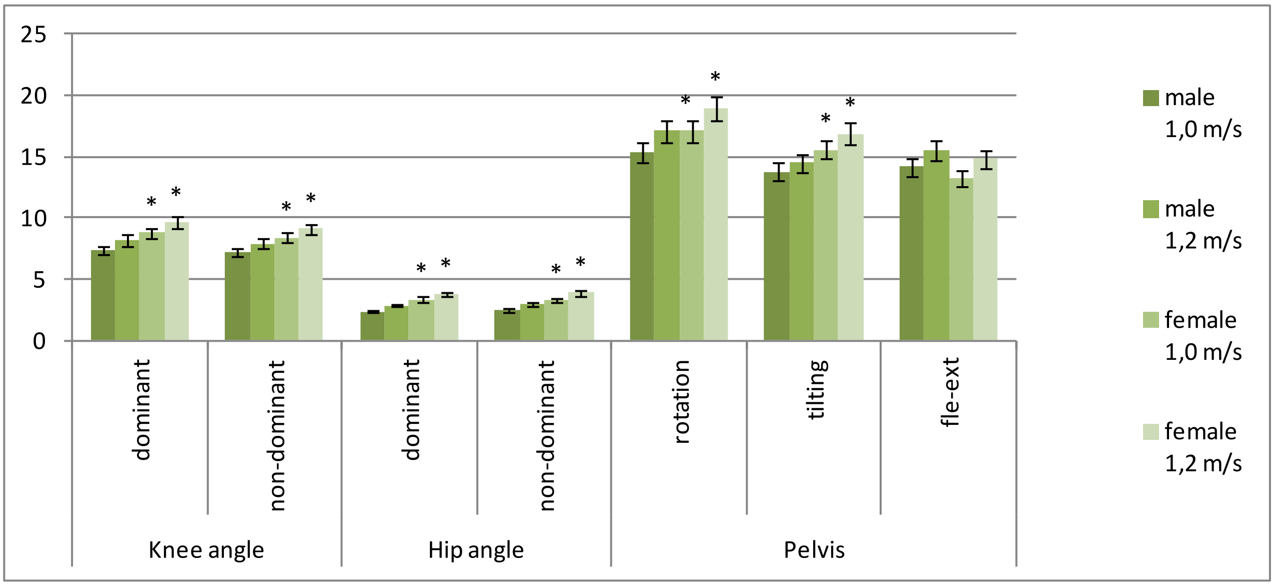

Figure 2: MeanCV values of angular parameters (*: significant differences in comparing the values of males and females)