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The Influence of Different Testing Conditions in running on Gender Specific EMG Activity and Kinematics of the Lower Extremity

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THE INFLUENCE OF DIFFERENT TESTING CONDITIONS IN RUNNING ON GENDER-SPECIFIC EMG ACTIVITY AND KINEMATICS OF THE LOWER EXTREMITY – A WAVELET-BASED ANALYSIS

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INTRODUCTION

Running mechanics are considered to be different between male and female runners (Ferber et al., 2003). To investigate running mechanics, different testing conditions, such as treadmill or over ground running on laboratory tracks with different path lengths, can be used. Kinematics are found to differ between over ground and treadmill running, but there is little information about changes in EMG activity depending on testing condition (Nigg et al., 1995, Wank et al., 1998). Therefore, the purpose of this study was to investigate a) if kinematics and EMG signals in running vary depending on testing condition, b) if there are gender dependent differences in muscle activity or kinematics and c) if the muscular / kinematic response to changes in testing condition is gender specific.

METHODS

Six female and six male volunteers were tested running at 3.0 m/s on a treadmill (TM), on a 10 m laboratory track (LT) and during continuous over ground running (CR). Surface EMG was recorded (3000 Hz) with unaltered electrode placement from mm. tibialis anterior, peroneus longus, gastrocnemius medialis and lateralis, soleus, vastus medialis and lateralis, semitendinosus and biceps femoris. Kinematic data of the knee and ankle joint was obtained by a high-speed camera (125 Hz) in the sagittal plane and a custom-designed rear foot goniometer in the frontal plane. For each testing condition, three sets of data were recorded to test intra-condition variability. Selected EMG-variables were computed based on a wavelet analysis of the signals.

RESULTS

For all subjects there are differences in EMG signals as well as in kinematics while running in different testing conditions (example of changes in rear foot angle depending on running condition in Fig. 1). These muscular and kinematic responses to changes in testing condition are highly individual and deviate between the tested subjects.

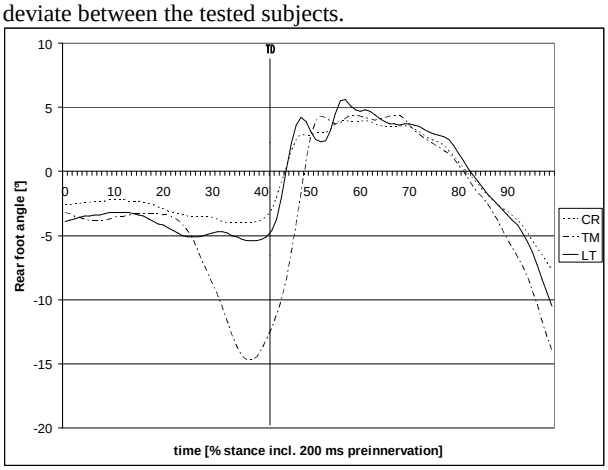
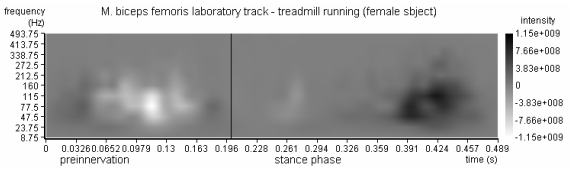


Fig. 1: Mean values of rear foot angle of one male subject while running in the three investigated testing conditions (nine steps per condition; TD = touch down).

Several mean values of male and female runners differ in EMG signals and kinematics ($p<0.05$).
In addition, the muscular and kinematic responses to changes in the testing condition are gender-specific (example of diverging muscular responses of one male and one female subject to the change from LT to TM running in Fig. 2).

a)



b)

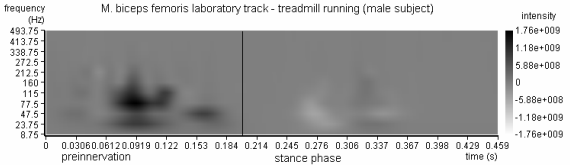


Fig. 2: Gender dependent EMG responses to varying testing conditions (example of a wavelet-based EMG analysis: difference patterns of activity patterns of LT and TM for two subjects: a) female, b) male. Light zones indicate higher intensity in EMG-signals during running on TM, dark zones indicate higher intensity in EMG-signals during running on LT).

DISCUSSION

Measured muscular and kinematic responses to changes in testing conditions are highly individual. This corresponds to the results of Nigg et al. (1995), who found kinematic differences between over ground and treadmill running to be individual. Wank et al. (1998) found little differences in EMG signals between over ground and treadmill running, which may be due to investigating mean data and not examining individual data.
Although data are highly individual, statistically significant differences in gender specific EMG responses and kinematics exist. While interpreting these findings, however, it has to be considered that the procedure of averaging data results in smoothing individual responses. These responses have to be taken into account as well.

CONCLUSION

In this study differences in EMG signals and kinematics depending on running condition and gender have been found. Since calculated values are highly individual, care has to be taken when obtaining and interpreting mean values.

REFERENCES

1. Ferber et al. Clin Biomech 18: 350-357, 2003.
2. Nigg et al. Med Sci Sports Exerc 27: 98-105, 1995.
3. Wank et al. Int J Sports Med 19: 455-461, 1998.