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INTERNAL AND EXTERNAL OBLIQUE MUSCLES ARE SIMILAR IN THEIR PHASIC ACTIVITY DURING WALKING AND RUNNING

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SUMMARY

Human gait has been extensively investigated, although less is reported about trunk muscle activation during gait. The study aim was to determine internal oblique (IO) and external oblique (EO) muscle activity during walking and running, using a quartile method of analysis. Kinematic data were collected using 10 high speed cameras to identify reflective markers positioned over the left and right lateral malleoli in 12 healthy participants. Surface electromyography (EMG) electrodes were attached to EO and IO (left and right sides). EMG signals were transmitted via telemetry and synchronised with the kinematic data collected during treadmill walk and run (three trials each). Surface EMG data were full-wave rectified and re-sampled to match kinematic data. Data were cut into motion cycles based on the right malleolus. From each motion cycle, the stride parameters of height and length based on the left and right malleoli were calculated. EMG data were expressed as a percentage of the Maximal Observed EMG (%MOE) and the first (Q1), second (Q2), third (Q3) and interquartile range (IQR) were calculated. For Q2 during walk, OI left was significantly greater than OE left (p=0.038), but no statistical significance between any muscles for Q2 was found during running. There were no statistically significant IQR differences found between any of the muscles during walking or running. In conclusion, OI and OE are similar in their phasic activity during walking and running.

INTRODUCTION

Human gait has been extensively investigated, although the activation of trunk musculature during walking and running has received less attention [1]. Surface EMG is commonly used to evaluate trunk muscle activity and various processing methods have been applied which include summative (integrative) functions [1] and linear envelopes [2]. Although commonly used, these methods may not provide adequate information about the spread of muscle activity during a typical motion cycle. One method to provide this information would be to use the quartile distribution. This method has previously been used for limb muscle activity during isometric knee exercises [3]. It may be suggested that during an isometric muscle contraction, the interquartile range, described as the difference between the first and third quartile, would be smaller compared to the interquartile range of a more phasic muscle. Therefore, the aim of this study was to determine IO and EO muscle activity during walking and running, using a quartile method of analysis.

METHODS

Twelve asymptomatic participants (female n=6, male n=6, age 22.4 ± 1.24 years, body mass 67.5 ± 16.6 kg, height 174.9 ± 14.1 cm, and Body Mass Index 21.7 ± 2.2) were recruited as part of another larger study. Exclusion criteria included back pain in the last 12 months, previous spinal surgery or fracture, neurological conditions, abdominal surgery, or a BMI in excess of 25. Normal range of thoracolumbar movement during stance and during 4-point kneeling was assessed in each participant, to ensure that all movements were within normal physiological limits and pain free. All participants except one were right handed and right footed. Ethical approval was granted from the ethics commission at the Medical University of Vienna and all participants signed a consent form.

For this study, reflective markers attached to the skin overlying the bony landmarks of the left and right lateral malleoli were included for data analysis. Three-dimensional kinematic data were collected using 10 high speed cameras (Eagle Digital Real Time System, Motion Analysis Corp., Santa Rosa, USA) recording at 120Hz using kinematic software (Cortex 3.6.1). After skin preparation with sandpaper and alcohol, surface EMG electrodes (Delsys Trigno, Boston, USA) were attached to the left and right sides of the EO and IO muscles and data collected at a sample rate of 1200Hz. EMG signals were transmitted via telemetry and kinematic and EMG data collected synchronously over ten seconds.

Three trials were recorded whilst each participant walked on a treadmill (Kagra, Graber AG, Switzerland) at their own comfortable speed. This was repeated with three trials of running. The order of walk and run data collection was not randomised, and in all participants, walk data was collected first.

EMG data were full-wave rectified and re-sampled to match kinematic data. Data were cut into motion cycles based on kinematics of the right lateral malleolus using scripts written in MATLAB (2008b). From each motion cycle, the stride parameters of height and length based on the left and right lateral malleoli were calculated. For the EMG data, the largest maximal value (mV) of each muscle was identified across all three trials for one gait for each individual participant, and all the values expressed as a percentage of the maximal observed EMG (%MOE). From this data, Q1, Q2, Q3 and IQR were calculated.

Data were statistically analysed using IBM SPSS 19. The normal distribution of data was tested using the Shapiro-Wilk test, and subsequent tests were chosen accordingly. A one-way ANOVA with Bonferroni correction or a Kruskal Wallis test was used to test for significant differences in Q2 and in IQR between the left and right IO and EO during walk and run.

RESULTS AND DISCUSSION

After inspection of the kinematic data, all data sets were included for each participant except the second trial of run for participant 2 due to a hardware error creating non-synchronicity of data. There were no significant differences for stride height and stride length between the left and right limb, therefore mean stride length and height were calculated. For walk, mean stride length was 1195.93 mm (± 192.59) and mean stride height was 167.58 mm (± 23.99). For run, mean stride length was 1563.49 mm (± 328.74) and mean stride height was 257.68 mm (±69.25). Mean speed during walking was 3.72 km/h (± 0.70) and mean speed during running was 6.94 km/h (± 1.59). For the Q2 between muscle comparison at walk, OI left was significantly greater than OE left ($p=0.038$), but there was no statistical significance found for Q2 between any muscles during running. There were no statistically significant differences found between any of the muscles investigated either during walking or running for the IQR.

Based on the concept that muscles with a larger IQR would behave in a more phasic manner and muscles with a smaller IQR in a more static manner, the findings from the present study show that during walking and running, the investigated muscles are no different in their amount of phasic activity. This would indicate that the investigated muscles at this gait provide support and mobility to the trunk with a similar type of activation. A significantly greater Q2 for OI left compared to OE left during walk was found in the present study. Unfortunately, this finding cannot be directly compared to other studies, as studies which investigate these muscles during gait have used alternative evaluation methods or different comparisons. One study however, showed a greater Q1, Q2, Q3 and IQR for OI compared to OE during walk, although the muscles were not directly compared against each other, instead, each muscle was evaluated at different speeds within itself and also between genders [4].

Of interest, the majority of participants included in the present study were right handed and footed (11 out of 12), and future studies should evaluate whether the variability in phasic activity between these trunk muscles during walking or running are related to handedness or footedness.

CONCLUSION

There is no difference between the amount of phasic activity between OI and OE during walking and running in healthy participants.

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