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THE RELATIONSHIP BETWEEN CROSS SECTIONAL AREAS OF TRUNK AND THIGH MUSCLES AND CROSS-DIRECTIONAL DIFFERENCE OF SPRINT TIME ALONG A CURVE

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INTRODUCTION

Morphological characteristics of muscles were affected by the specific and continuous training programs of competitive sports. Track and field athletes repetitively exercise on counter-clockwise curvilinear running in their daily training. These training would cause the morphological characteristics of the muscles of track and field athletes to adapt for the specific purpose. Therefore, sprint along a counter-clockwise curve would be preferable than clockwise for these athletes. The purpose of this study was to investigate whether bilateral difference of cross sectional area (CSA) of trunk and thigh muscles related to the curvilinear sprint time in track and field athletes.

METHODS

Thirteen collegiate students volunteered to participate in the study (10 male, 3 female; age 20.4 ± 1.7 years; body height 167.6 ± 8.9 cm; body mass 57.4 ± 5.4 kg). All subjects had at least 4 years of training experience and were regularly running 4 days per week. Their dominant leg was determined by the previous report [1]; then confirmed that all the subjects preferred right leg as dominant.

Subjects were instructed to sprint along the circular track twice in each of counter-clockwise or clockwise directions. The track of 23 m radius circle (circumference 144 m) was drawn on flat dirt ground. We measured the sprint time for one-round of the circular track. Subjects were given 15 minutes to rest between the trials.

The CSA of the psoas major (PM), quadriceps femoris (QF), and hamstrings (Ham) muscles were measured by magnetic resonance imaging (MRI). Transverse T1-weighted MR images were obtained at the midlevel of L2-L3, L3-L4, L4-L5, and L5-S1 (L: Lumbar spine, S: Sacral spine) and at the nearest to 30, 50 and 70% of the femur's length.

Descriptive data are presented as means ± standard deviations (S.D.). Cross-directional difference of sprint time was calculated as the subtraction of the time of clockwise direction from that of counter-clockwise direction:

cross-directional difference of sprint time (sec) = [sprint time of counter-clockwise direction (sec)] – [sprint time of clockwise direction (sec)]

The bilateral differences of the muscle sizes were evaluated as the symmetry index [2] by following equation:

symmetry index (%) = {2 × (right side - left side) / (right side + left side)} × 100.

Paired t-test was used for comparison of the parameters between sides. Pearson's correlation coefficient was used to assess the relationship between cross-directional difference of sprint time and symmetry indices. The level of significance was set at $p < 0.05$.

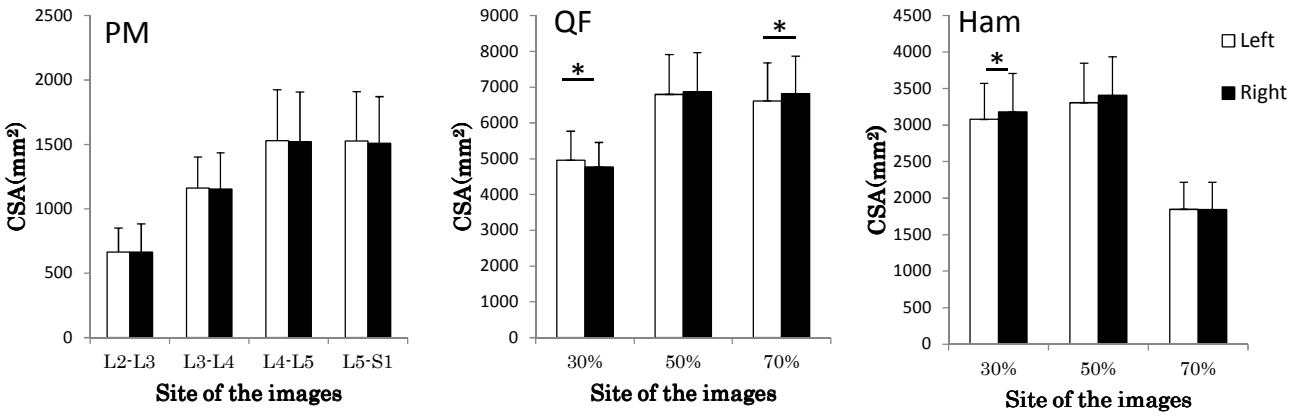

Figure 1: Cross sectional areas (CSA) of psoas major, quadriceps femoris and hamstrings in both sides of each measurement site. *: $p < 0.05$, significantly difference between sides. L = Lumbar spine, S = Sacral spine, 30, 50 and 70% = nearest to 30, 50 and 70% of the femur's length, PM = psoas major; QF = quadriceps femoris; Ham = hamstrings. The difference in CSA of quadriceps femoris at 30% was significantly greater in the left than right, but vice versa at 70% and hamstrings at 30% ($p<0.05$). No significant side difference on CSA of psoas major was seen.

RESULTS

No significant difference was found in sprint time between counter-clockwise (22.15 ± 2.27 sec) and clockwise (22.13 ± 2.32 sec) directions. CSA of left QF at 30% was significantly greater than right, but vice versa at 70%. CSA of right Ham at 30% was significantly greater than left. There were no significant bilateral differences of PM at all levels (Figure 1).

No significant correlations were found between the symmetry indices of thigh muscles and cross-directional difference of sprint time ($r = -0.226$, $p = 0.45$ and $r = 0.140$, $p = 0.64$ for QF and Ham, respectively). However, the symmetry index of PM (-0.94 ± 7.45%) was significantly correlated with cross-directional difference of sprint time (Figure 2, $r = -0.599$, $p < 0.05$).

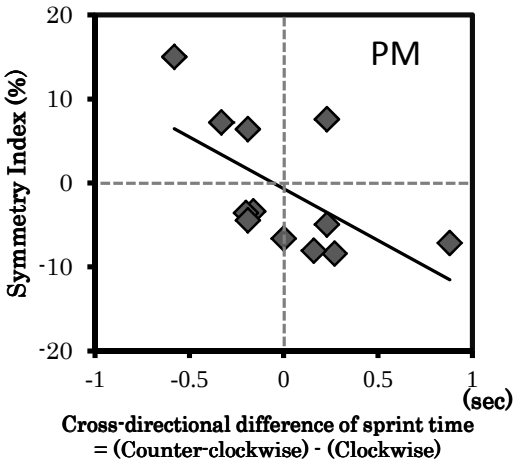

Figure 2: The relationship between cross-directional difference of sprint time and the symmetry index of psoas major ($y = -12.308x - 0.676$, $r = -0.599$, $p < 0.05$)

DISCUSSION

Major finding of this study was that bilateral difference of PM size was significantly correlated with cross-directional difference of sprint time along a curve.

From the kinematical analysis of the previous study [3], step length of outside leg was larger in curved sprint than that in straight lane running, which requires larger hip joint flexor angle of outside leg at the swing phase. In a curve sprinting, the outside leg produced larger magnitude of forces onto the ground than the inside leg [4]. These findings suggest that running along a curve is related to the hip flexor kinematics and/or kinetics of outside leg. Therefore, subjects who have larger CSA of outside PM than that of inside could run faster than the reverse sprint curve direction. However, the symmetry indices of QF and Ham were not significantly correlated with cross-directional difference of sprint time. No significant difference of the knee extension angle between sides was found in curved line running [3]; consequently there were no significant correlations between symmetry indices of thigh muscles and cross-directional difference of sprint time.

There were significant bilateral differences in CSA of QF and Ham, but not in CSA of PM. These results were disagreed with the previous studies on bilateral differences in CSA of these muscles on soccer or tennis players [5,6]. It is suggested that the bilateral differences in thigh muscle sizes are characteristics of track and field athletes, who exercised on counter-clockwise direction of curvilinear running. Also, these results were accountable by the dominance leg of the subjects. However, the causal relationships between them were yet confirmed, and future studies are needed.

CONCLUSIONS

The results of this study suggest that cross-directional difference of sprint time is related to the bilateral difference of psoas major. In a curve sprinting, the outside psoas major is more necessary than inside.

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