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CONTRIBUTION OF ILIOPSOAS AND QUADRATUS LUMBORUM MUSCLE SIZE ON LONG DISTANCE RUNNERS

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INTRODUCTION

Long distance running performance presumably depends on the interaction of various physiological and biomechanical factors. Some of the studies indicated that the concurrent training on endurance and leg strength developed the long distance running performance [1]. Nevertheless, the effects of trunk muscle strength on long distance running performance were undetermined.

A hypertrophy of psoas muscle (PM) is assigned to be one of the major determinants for sprint running [2]. Moreover, the erector spinae and quadratus lumborum muscles related to the sprint performance [3]. These results suggest that higher sprint performance require the stabilization of the trunk lateral movement. The main function of PM is to flex the thigh on the pelvis, but also counteract as lateral flexion of the lower vertebral column. The functions of quadratus lumborum (QL) was considered as lateral flexion of lumbar spine. Therefore, activating unilateral PM with complementary activating contra-lateral QL can stabilize the lumbar spine during running.

In the present study, muscle volumes of PM and QL in top-level young female long distance runners were determined. The purpose of this study was to investigate how the muscle volumes of these muscles are related to the endurance running performance in top-level endurance athletes.

METHODS

Twenty-three well-trained female young runners (Age 19.7 \pm 1.0 yrs, body height 160.0 \pm 4.6 cm, body mass 48.9 \pm 4.9 kg) were recruited from collegiate track and field team. All subjects were at least 3 years of competitive long distance running (800 m ~ 10,000 m). The best times in an official 5,000-m race were 980.04 \pm 35.67 sec. Written informed consent was acquired from all the subjects.

A 1.5T whole-body magnet (Signa HDxt, GE Healthcare, USA) was used to acquire magnetic resonance imaging of the iliopsoas and quadratus lumborum muscles. Subjects were relaxed and lying supine with the hip and knee joints fully extended. The scanning region was extended from twelfth-rib to lesser trochanter of the femur. Images were acquired in contiguous 10mm thickness axial slices. The entire region was acquired in two or three blocks of 20 slices each.

All analyses were carried out by the specially designed image analysis software (SliceOmatic 4.3, Tomovision Inc., Montreal, Canada). QL, PM and iliopsoas muscle (IL) were separately measured. The CSA data for the each muscle were then summed to derive the respective muscle volumes (Figure 1). The volume of both sides of the QL, PM, IL, and the sum of PM and IL (PM+IL) were assessed in each subject. The dominant side was defined as the same side of the dominant arm. The ratio of PM and IL to QL (PM/QL and IL/QL) for contra-lateral side were also assessed. Descriptive data are presented as means \pm standard deviations (S.D.). Side-to-side comparisons were carried out using paired student's t-test method. A simple linear regression analysis was used to calculate the correlation coefficient between the absolute values of muscle volume, the ratio of each muscle volumes and the best official record of 5000-m race. Significant levels for the results of the simple linear regression analysis were set at 0.05.

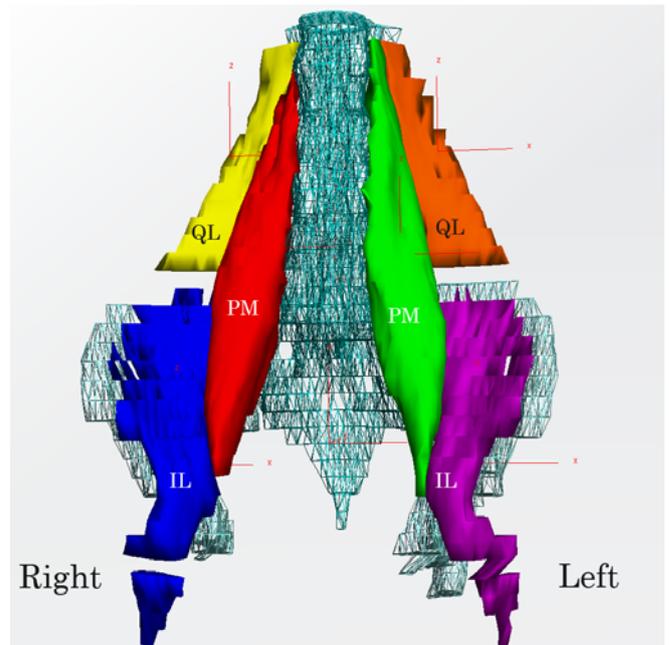


Figure 1: Typical example of anterior view of surface renderings of the psoas muscle (PM), Iliacus muscle (IL), and quadratus lumborum muscle (QL). PM, IL, and QL from manual segmentation of axial MR images. Note: In the surface renderings of the iliac bone and spines have been shown for better visualization.

RESULTS AND DISCUSSION

Table 1 summarized the both sides of volumes of psoas, iliacus and quadratus lumborum muscles. No significant difference between dominant and non-dominant sides was observed in all the muscles.

Table 1: Descriptive data on the measured muscle volumes (values expressed in cm³, mean ± S.D.).

Muscles	Dominant	Non-dominant
PM	166.8 ± 25.4	167.9 ± 28.0
IL	117.9 ± 14.4	114.2 ± 16.7
PM+IL	284.7 ± 30.2	282.1 ± 36.3
QL	34.7 ± 6.5	36.3 ± 8.3

PM, Psoas muscle; IL, Iliacus muscle; PM+IL, Iliopsoas muscle; QL, Quadratus lumborum.

No significant correlations were found between the best official record of 5000-m race and these muscle volumes (PM-D, $r = 0.35$, $p = 0.10$; PM-ND, $r = 0.20$, $p = 0.37$; IL-D, $r = -0.26$, $p = 0.24$; IL-ND, $r = -0.21$, $p = 0.33$; PM+IL-D, $r = 0.18$, $p = 0.42$; PM+IL-ND, $r = 0.05$, $p = 0.81$; QL-D, $r = -0.39$, $p = 0.07$; and QL-ND, $r = -0.29$, $p = 0.18$: D = dominant side, ND = non-dominant side). However, the best official record of 5000-m race was significantly correlated to the ratio of muscle volume of psoas muscle to quadratus lumborum muscle (PM/QL) ($r = 0.577$, $p < 0.05$ for PM-ND/QL-D; $r = 0.534$, $p < 0.05$ for PM-D/QL-ND) (Figure 2). No significant correlation was found between the ratio of muscle volume of iliacus muscle to quadratus lumborum muscle (IL/QL) and race time ($r = 0.16$, $p = 0.45$ for IL-ND/QL-D; $r = 0.20$, $p = 0.35$ for IL-D/QL-ND).

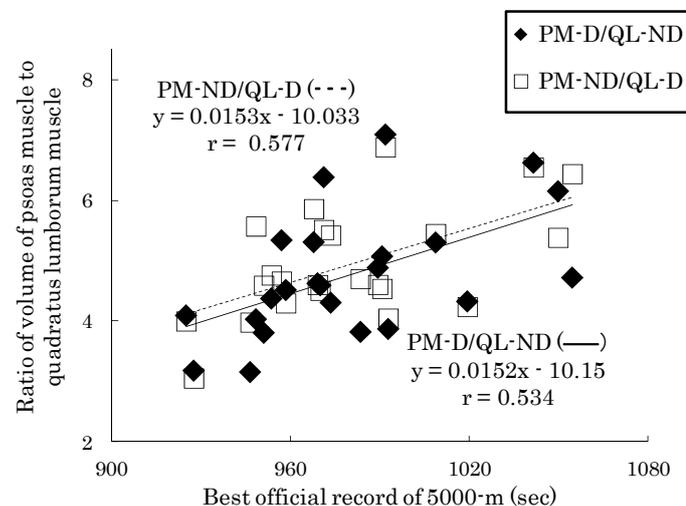


Figure 2: Relationships between the best official record of 5000-m race and the ratio of muscle volume of psoas muscle to quadratus lumborum muscle (PM/QL) in contra lateral sides (PM-ND/QL-D(□) and PM-D/QL-ND(♦)).

This results implies that not larger PM, IL or QL, but the combination of these muscles can be significant contributor for the long distance running performance. In short, the counterbalance of larger QL compared to PM is requisite. To our knowledge, this is the first study concerning the balance of muscle sizes within contra-lateral sides. The previous studies merely attempted to clarify the correlation

between the absolute value of muscle size and sprint performance [2,3].

The three-dimensional angular kinematics of the lumbar spine and pelvic during running showed that there were considerable magnitude of changes in lateral bending angle and axial rotational angle rather than that in flexion-extension angle during stance phase [4]. Heise and Martin [5] indicated that the vertical motion during stance phase may be potential wastes of energy. The lateral side oscillation, which was ignored in these studies, could be also potential energy loss. If co-activation of the psoas muscle and contra-lateral quadratus lumborum may minimize the oscillation of the lumbar spine, it will diminish the energy loss, which could enhance the distance running performance.

The present study suggests that the development of quadratus lumborum muscle interrelated to psoas muscle is an effective to improve the distance running performance. Top-level endurance athletes typically intend to avoid gains in muscle mass, as elevated muscle mass is thought to be detrimental for an optimal endurance capacity within endurance sports. However, from the functional role of the muscles, it is recommended that the athletes who stabilize their trunk in erect posture should develop their quadratus lumborum and psoas muscles.

CONCLUSIONS

For top-level female long distance runners, the ratio of muscle volumes of PM and contra-lateral QL (PM/QL) is related to a better performance in long distance running. Not the absolute value of the muscle size but the balance of these muscles may be important.

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