

MUSCLE ARCHITECTURE AND THE RATIO OF JOINT TORQUE TO MUSCLE VOLUME OF TRICEPS SURAE MUSCLES IN YOUNG MEN AND WOMEN

N. Mitsukawa, J. Sakuma, T. Fukunaga*, and Y. Kawakami*

Graduate School of Sport Sciences, Waseda University, Saitama, Japan

* Faculty of Sport Sciences, Waseda University, Saitama, Japan

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INTRODUCTION: Muscle volume is a major determinant of joint torque (Fukunaga et al., 2001). However, it is not clear whether there are gender-differences in a relationship between joint torque and muscle volume. It is not clear also about muscle architecture, e.g., physiological cross-sectional area (PCSA) and fascicle length. We aim to compare 1) muscle architecture under the maximal voluntary contraction condition and muscle volume (MV_{TS}) of the triceps surae muscles (TS), and 2) the relationship between MVC and MV_{TS} , for young men and women.

METHODS: The maximal voluntary plantar flexion torque (MVC) was measured for 15 men and 14 women aged 21 to 36 years. Magnetic resonance images were taken to determine anatomical cross-sectional areas (ACSA) of the TS, and the muscle volumes of individual muscles. Each muscle volume relative to whole TS and the MVC/MV_{TS} ratio were calculated. The fascicle length and pennation angle of each TS during MVC at anatomical position, and -10 and -20 deg dorsiflexion were measured using ultrasonography for 11 men and 9 women. PCSA was calculated from muscle volume divided by fascicle length during MVC at the ankle position with the largest tendon force.

RESULTS and DISCUSSION: Gender-differences were observed for PCSA of gastrocnemius muscles, while the fascicle length during MVC was similar in men and women (Table 1). These results indicate that men have higher force-generating potential relative to a given muscle volume than women. The MV_{TS} was significantly correlated with the MVC both in men and women, while MVC/MV_{TS} in women was lower than that in men. The differences in PCSA and each muscle volume ratio between men and women tended to be larger for the gastrocnemii (28%) than for SOL (18%). This may be one of the factors affecting the gender-difference in MVC/MV_{TS} ratio.

Table 1. Muscle architectural characteristics and volume of TS, MVC in men and women.

		Fascicle length (cm)	PCSA (cm ²)	Muscle volume (cm ³)	Plantar flexion torque (Nm)	MVC/MV_{TS} (Nm/cm ³)
Medial gastrocnemius	men	3.7 \pm 0.4	47.6 \pm 7.7	229.5 \pm 43.6	men: 207.9 \pm 41.5 women: 137.5 \pm 26.7 **	men: 0.284 \pm 0.026 women: 0.245 \pm 0.041 **
	women	3.9 \pm 1.0	34.8 \pm 6.9 **	160.5 \pm 29.2 **		
Lateral gastrocnemius	men	4.7 \pm 1.2	26.3 \pm 7.3	139.9 \pm 13.5		
	women	4.4 \pm 0.7	17.7 \pm 3.7 **	96.3 \pm 16.2 **		
Soleus	men	2.8 \pm 0.5	122.7 \pm 28.6	398.7 \pm 44.2		
	women	2.7 \pm 0.6	97.2 \pm 24.8	324.1 \pm 57.5 **		

Values are mean \pm SD. * $P < 0.05$, ** < 0.01 compared with men

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Fukunaga et al. (2001). *Acta Physiol Scand*, 172, 249-255.