16th annual ECSS Congress Liverpool/UK, July 6-9 2011

MUSCLE SHAPE AND DISTRIBUTION OF MUSCLE VOLUME WITHIN THE TRICEPS SURAE MUSCLE GROUP IS INDEPENDENT ON MUSCLE SIZE

Albracht, K., Arampatzis, A.
German Sport University Cologne; Humboldt University Berlin

The assessment of muscle volume is essential, when evaluating muscle-tendon unit performance. Muscle volume affects directly the maximum mechanical power that can be generated by a muscle. Furthermore, muscles with a smaller ratio of muscle volume to physiological cross-sectional area generate a given force more economical than a muscle with a higher ratio [2]. However, direct measurement of muscle volume is laborious. In general, muscle volume is a fraction of the product of the maximum anatomical cross-sectional area (ACSA) and muscle length (lm). The size of the fraction (shape factor) depends on muscle shape. It was recently shown for the three triceps surae (TS) muscles that the shape factor showed a low inter-subject variability and that an approximation of muscle volume based on this theoretical consideration was possible with an accuracy of 4 to 7% for people who are exposed to normal daily activities [1]. The aim of the present study was to investigate, whether the shape factor and therefore the possibility to approximate muscle volume from ACSAmax and lm is affected by muscle size.

According to their muscle activation level 32 subjects were divided into a low (LA), moderate (MA) and high (HA) activation group. The LA group consisted of 13 subjects that were at least active in recreational sports, the MA group consisted of nine endurance runners (training volume of 14±4 hours/week), the HA group consisted of ten elite track & field athletes (sprint, long jump, triple jump) with an average training volume of 18±3 hours/week. Transversal MR Images were acquired from the calf of the dominant leg. Each muscle was reconstructed to determine muscle volume, lm, ACSAmax, the shape factor and the relative contribution of each muscle to the entire TS muscle volume.

The HA group had significant ($p<0.05$) longer muscles, a greater ACSAmax and a greater muscle volume in comparison to the other groups. The scaling factor and the relative contribution of each muscle to the entire TS muscle volume showed significant ($p<0.05$) differences across the three muscles but no significant ($p>0.05$) differences across the three groups. In addition, the coefficient of variance for the scaling factor was similar across the groups (LA 4.3 - 6.7%, MA 4.3 - 7.4%, HA 4.3 - 6.7%).

Thus, despite considerable differences in muscle size (length, thickness, volume) the shape factor and the relative contribution of each muscle to the entire TS muscle volume is not affected. The fact, that the shape factor is specific for each muscle but similar across the groups indicates that the shape of each muscle is similar within the population and thus independent of muscle size. Therefore, the theoretical consideration can be used to approximate muscle volume from ACSAmax and lm, which are both easily accessible in comparison to a muscle reconstruction.

[1] Albracht et al (2008) J Biomech,41,2211-8
[2] Biewener et al (2000) Exerc Sport Sci Rev 28,99-107

Keywords:
triceps surae, muscle volume, MRI

TOPIC: BIOMECHANICS
PRESENTATION FORM: POSTER
SESSION ART: POSTER