TACSM Abstract

Manual Versus Semi-Automated Detection of Muscle Fascicle Pennation Angle of the Vastus Lateralis

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ABSTRACT

Muscle pennation angle (PA) is a key characteristic in muscle function. However, current methodologies are tedious, time consuming, and usually only include a few representative fascicles for the PA measures. Leveraging image processing methods could improve the efficiency of PA measurements while still providing valuable insight into architectural changes during specific tasks. **PURPOSE:** To compare manual (MAN) versus semi-automated (SA) analyses for muscle PA within the vastus lateralis (VL) utilizing ultrasound images taken during isometric knee extensions at different intensities relative to maximum volitional effort. **METHODS:** Sixteen lower-body resistance trained males (n =7, mean ± SD; 21±7 yrs; 77.7 ± 30.1 kg; 157.3 ± 53.8cm) and females (n = 9; 23 ± 4yrs; 64.6 ± 4.0 kg, 166.5 ± 5.7 cm) were included in the study. Subjects were seated upright with the knee joint fixed at 110° of extension and an S-beam load cell attached to the ankle. Ultrasound images were collected from the VL of the right limb while relaxed (REST) and during 3 separate isometric contractions of the knee extension exercise at 30, 70, and 100% of maximal voluntary contraction (MVC). Images were analyzed offline using ImageJ (MAN). The SA method used feature detection techniques to identify fascicles in MATLAB. PA was measured from the deep aponeurosis manually (3 representative fascicles) and calculated relative to the horizontal (SA). A two-way mixed factorial analysis of variance (ANOVA) (analysis [MAN vs. SA] x intensity [REST vs $30\%_{MVC}$ vs $70\%_{MVC}$ vs $100\%_{MVC}$]) was used to determine differences in PA measures. Post hoc analysis with Bonferroni adjustments were made as deemed appropriate by the ANOVA. **RESULTS:** An average of 25 representative fascicles were identified in each image using SA procedures. There was no interaction between analysis method and intensity ($p = 0.117$). SA underestimated PA compared to the MAN technique (-1.7 ± 0.5°, $p = 0.014$). There was a main effect of intensity ($p = 0.002$; $100\%_{MVC}$ > REST and $30\%_{MVC}$). **CONCLUSION:** The SA method underestimated PA compared to MAN measures, perhaps due the fact that the SA measures did not account for any changes in the angle of the deep aponeurosis. Significant differences in PA were only noted at $100\%_{MVC}$ and not at other intensities, which is consistent with previous findings in the VL. Architectural PA changes of the VL with increasing force production may indicate fascicle rotation or muscle bulging, and, may be more noticeable at maximum MVC compared to submaximal contractions.