

Reliability and Validity of Ultrasound Cross Sectional Area Measurements for Long-Duration Spaceflight

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Limb muscle atrophy and the accompanying decline in function can adversely affect the performance of astronauts during mission-related activities and upon re-ambulation in a gravitational environment. Previous characterization of space flight-induced muscle atrophy has been performed using pre and post flight magnetic resonance imaging (MRI). In addition to being costly and time consuming, MRI is an impractical methodology for assessing in-flight changes in muscle size. Given the mobility of ultrasound (US) equipment, it may be more feasible to evaluate changes in muscle size using this technique. **PURPOSE:** To examine the reliability and validity of using a customized template to acquire panoramic ultrasound (US) images for determining quadriceps and gastrocnemius anatomical cross sectional area (CSA). **METHODS:** Vastus lateralis (VL), rectus femoris (RF), medial gastrocnemius (MG), and lateral gastrocnemius (LG) CSA were assessed in 10 healthy individuals (36 ± 2 yrs) using US and MRI. Panoramic US images were acquired by 2 sonographers using a customized template placed on the thigh and calf and analyzed by the same 2 sonographers (CX50 Philips). MRI images of the leg were acquired while subjects were supine in a 1.5T scanner (Signa Horizon LX, General Electric) and were analyzed by 3 trained investigators. The average of the 2 US and 3 MRI values were used for validity analysis. **RESULTS:** High inter-experimenter reliability was found for both the US template and MRI analysis as coefficients of variation across muscles ranged from 2.4 to 4.1% and 2.8 to 3.8%, respectively. Significant correlations were found between US and MRI CSA measures (VL, $r = 0.85$; RF, $r = 0.60$; MG, $r = 0.86$; LG, $r = 0.73$; $p < 0.05$). Furthermore, the standard error of measurement between US and MRI ranged from 0.91 to 2.09 cm^2 with high limits of agreement analyzed by Bland-Altman plots. However, there were significant differences between absolute values of MRI and US for all muscles. **CONCLUSION:** The present results indicate that utilizing a customized US template provides reliable measures of leg muscle CSA, and thus could be used to characterize changes in muscle CSA both in flight and on the ground.