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Validity and reliability of a novel 3D ultrasound approach to assess static lengths and the lengthening behavior of the gastrocnemius medialis muscle and the Achilles tendon in vivo

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Human muscle tendon units (MTUs) are highly plastic and undergo changes in response to specific diseases and disorders. To investigate the pathological changes and the effects of therapeutic treatments, the use of valid and reliable examination methods is of crucial importance. Therefore, in this study, a simple 3D ultrasound approach was developed and evaluated with regard to: (1) its validity in comparison to magnetic resonance imaging (MRI) for the assessment of the gastrocnemius medialis (GM) MTU, muscle belly, and Achilles tendon lengths; and (2) its reliability for static and dynamic length measurements. Sixteen participants were included in the study. To evaluate the validity and reliability of the novel 3D ultrasound approach, two ultrasound measurement sessions and one MRI assessment were performed. By combining 2D ultrasound and 3D motion capture, the tissue lengths were assessed at a fixed ankle joint position and compared to the MRI measurements using Bland Altman plots. The intra-rater and inter-rater reliability for the static and dynamic length assessments was determined using the coefficient of variation, standard error of measurement (SEM), minimal detectable change (MDC95), and intraclass correlation coefficient (ICC). The 3D ultrasound approach slightly underestimated the length when compared with MRI by 0.7%, 1.5%, and 1.1% for the GM muscle belly, Achilles tendon, and MTU, respectively. The approach showed excellent intra-rater as well as inter-rater reliability, with high ICC (? 0.94), small SEM (? 1.3 mm), and good MDC 95 (? 3.6 mm) values, with even better reliability found for the static length measurements. The proposed 3D ultrasound approach was found to be valid and reliable for the assessment of the GM MTU, muscle belly, and Achilles tendon lengths, as well as the tissue lengthening behavior, confirming its potential as a useful tool for investigating the effects of training interventions or therapeutic treatments (e.g. orthotics).