Simplified triceps surae muscle volume assessment in the elderly

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Introduction

Muscle volume is an important determinant of the muscle's mechanical power, which is a crucial predictor of functional performance in the elderly population. Based on previous reports from Albracht et al. (2008, J Biomech, 41: 2211–2218) and Mersmann et al. (2014, J Biomech, 47: 1348–1352), it is possible to assess the individual muscle volume within the triceps surae (TS) muscle group in younger adults by only using the maximal anatomical cross-sectional area ($ACSA_{max}$), the length of the muscle and a muscle-specific shape factor. The purpose of the present study was to investigate if the previously proposed simplified muscle volume assessment for the TS muscle group is also applicable in the elderly and if muscle-specific shape factors may change with ageing.

Methods

The TS morphological properties of twenty-three older (66 ± 7 years) female adults were determined by using magnetic resonance imaging. The boundaries of all three TS muscles (SOL, soleus; GM, gastrocnemius medialis; GL, gastrocnemius lateralis) were manually outlined in transversal and sagittal image sequences and the resulting muscle contours were used to calculate the volume for each investigated muscle, as the integral of the obtained cross-sectional areas of the contours along the whole length of the muscle. The shape factor for each individual muscle was obtained by dividing the measured muscle volume by the product of $ACSA_{max}$ and the muscle length, as proposed in Albracht et al. (2008). Paired t-tests were used to investigate possible differences between the measured and both estimated muscle volumes (using newly calculated shape factors from older adults and the reported factors from young adults in Mersmann et al. 2014). The accuracy and conformity between the measured and both estimated muscle volumes were further investigated by using the root mean squares (RMS) differences and the coefficients of determination (R^2).

Results

The average measured muscle volume of the older female adults was 361.7 ± 64.6 cm^3, 178.7 ± 31.5 cm^3 and 91.0 ± 15.5 cm^3 for SOL, GM and GL respectively, which were not significantly different from the estimated muscle volumes (SOL: 364.0 ± 72.1 cm^3; GM: 179.7 ± 34.1 cm^3; GL: 91.1± 13.5 cm^3). The relative RMS difference between the measured and estimated muscle volumes using the newly calculated shape factors was 6.1%, 8.4% and 9.8% and the R^2 was 0.91, 0.80 and 0.65 for the SOL, GM and GL respectively. However, when using the reported muscle shape factors from the young adults, there was a significant ($p<0.05$) overestimation of the muscle volume for all the compartments of the TS (RMS values of 12-14%).

Discussion

The current findings suggest that the previously proposed simplified method for assessing muscle volume by using the maximal cross-sectional area, muscle length and a muscle-specific shape factor in the TS muscle group is applicable for scientific or clinical use in the older population. However, the results also indicate that using the muscle-specific shape factor from younger adults significantly overestimates the muscle volume in the TS muscles in the elderly. This indicates that ageing may not only be accompanied with muscle atrophy, but also changes in the shape of skeletal muscle.