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MRI quantification of lower limb muscle fatty atrophy: a potential outcome measure in chronic neuromuscular diseases

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Background: Fatty atrophy is a combination of reduced muscle size and the replacement of muscle tissue with fat seen in patients with chronic neuromuscular diseases (NMD). Accurate quantification of fatty atrophy could offer a universal biomarker for trials in chronic NMD. We have assessed its validity as a biomarker by measuring its correlation with muscle strength. Methods: We performed 3T MRI including fat quantification by the three-point Dixon method and detailed computerised myometry (CSMi HUMAC NORM) of lower limbs in 18 patients with Charcot-Marie-Tooth-Disease Type 1A (CMT1A), 16 patients with inclusion body myositis (IBM) and 17 healthy volunteers. Regions of interest encompassing whole muscle cross sections were drawn on transverse images at mid-thigh and mid-calf level. The cross-sectional area and fat percentage were recorded for each region and used to obtain the "remaining muscle area" (RMA), a measure combining both atrophy and fat replacement. Pearson correlation coefficients between RMA and strength were calculated. Results: Excellent correlations were found between RMA and strength for: quadriceps/knee extension ($R=0.87$), hamstrings/knee flexion ($R=0.62$), anterior calf muscles/ankle dorsiflexion ($R=0.75$) and posterior superficial calf muscles/ankle plantarflexion ($R=0.68$). All correlations were significant $p<0.001$, including in analyses of the CMT, IBM and volunteer groups separately. Conclusions: MRI can quantify fatty atrophy by determining "remaining muscle area". The strong correlation with muscle strength in patients with CMT1A, IBM and healthy volunteers makes it an excellent candidate as an outcome measure in clinical trials of chronic NMD.

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