Quantitative assessment of muscle degeneration in DM1 patients using MRI

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Introduction: MRI is a very promising technique for muscle degeneration exploration, even though only some descriptive or qualitative results were reported in the literature. We propose a quantitative exploration of muscle degeneration in Steiner's myotonic dystrophy using MRI (particularly in Tibialis Anterior muscles).

Materials and methods: Lower limb MRI examination was performed on a 1.5T whole body MR-system. 3D high spatial anatomical images were acquired in the transversal orientation, covering the legs from knee to ankle. The same geometric parameters were used to acquire MR images using the following pulse sequences: T1 weighted Turbo Spin Echo (TSE); DP/T2 weighted TSE; 3-point Dixon. TA muscular relative isometric strength (i.e. muscle torque) was also assessed for left and right legs using a hand-held dynamometer [1].

The TA muscle borders were manually delineated in each of the T1 weighted slices in order to define the whole TA volume for both limbs. An intensity nonuniformity correction was applied inside the TA muscle using the N3 algorithm [2]. Delineation between normal and diseased tissues was performed using a home-built segmentation program. This program provides a three class image segmentation (into tendon, normal tissue and diseased tissue classes (fig. 1)) using a Hidden Markov Random Field model and the Expectation Maximum algorithm for model parameters estimation [3]. Similarly, the oedematous area volume was assessed from T2 weighted images. Finally, the fat to water ratio in TA muscles was measured from fat and water images of the 3-point Dixon acquisition.

Results: Normal and fat-infiltrated tissue volumes were measured for all patients and a good correlation was found between TA strength and normal tissue volume (fig. 2). Thanks to the use of an automatic segmentation program, a lower inter observer variability (±6.5%) was obtained for muscle volume assessment compared to isometric strength measurement (±9.3%). Oedematous area volumes were calculated for more severely affected patients, who present oedema in TA muscles. TA fat to water ratio was also measured for all subjects and lower values were observed in control subjects compared to less severely affected patients who did not present any visible fat infiltration in TA muscle.

Conclusion: The proposed method could be very interesting for muscle disease follow up and for the evaluation of emerging gene therapy efficiency.

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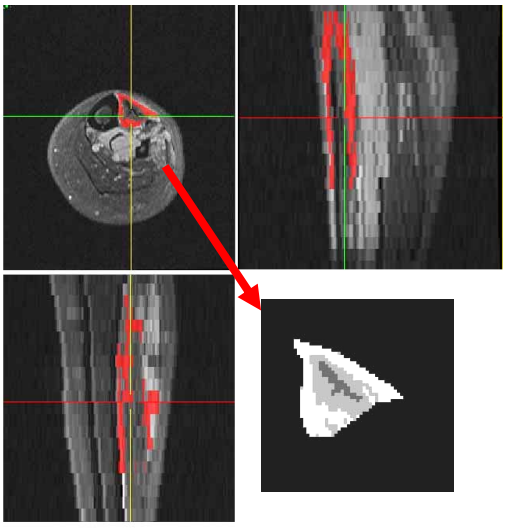

Figure 1. 3D T1 image, with tissues identified as normal shown in red, and one slice of the TA tissue segmentation into 3 classes: healthy tissue (white), fat-infiltrated tissue (gray) and tendon (dark gray).

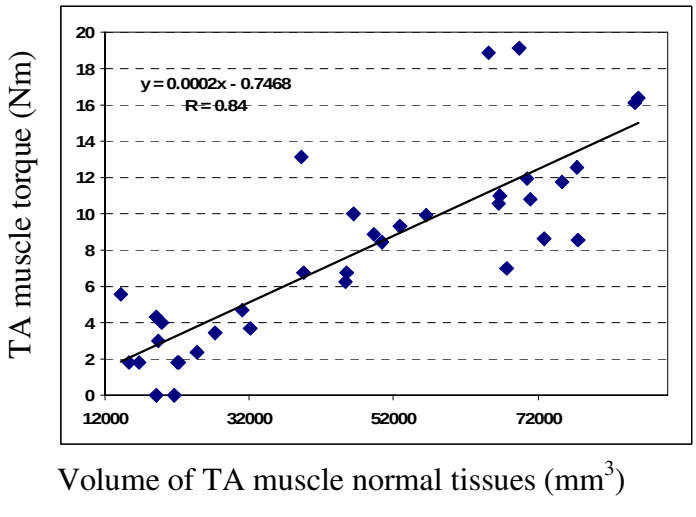

Figure 2. Correlation between torque and volume of normal TA tissue in DM1 patients.

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