Water T2 Values Are Elevated in Duchenne Muscular Dystrophy Independent of Fat Infiltration

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Introduction: Duchenne muscular dystrophy (DMD) is characterized by sarcocellular fragility, myofiber degeneration, inflammation, increased synthesis and deposition of extracellular matrix proteins and the replacement of contractile tissue with fatty infiltrate and connective tissue.\(^3\) Quantitative transverse relaxography \((qT_2)\) of \(^1\)H MR signals has shown excellent sensitivity for the detection of muscle pathology associated with DMD\(^D\) and strongly correlates with clinical assessments.\(^3\) Muscle lipid content increases with DMD disease progression\(^-6\) and is readily quantified using MRS techniques. MRI determined \(qT_2\) values are known to increase markedly with DMD disease progression and this behavior may in part or in whole be due to increased lipid contribution to the observed \(^1\)H MRI signal. The purpose of this study was to investigate the influence of muscle lipid content on MRI \(qT_2\) values and independently assess the behavior of MRS determined \(^1\)H/O T2 values in DMD as a function of muscle lipid content.

Methods: Data were acquired from 30 DMD boys (ages 5-13 y, mean 8.9 y (2.1)) and 8 healthy controls (HC; 9.7 y (2.1)) on 3T MRI inst

Table 1. Significant between group differences were found for all measures. \(^1\)H/O T2 values determined using non-fat suppressed MRI acquisitions and there was a strong correlation with lipid fraction measured by MRS and MRI T2 values (Figure 2A). This supports the notion that fat infiltration is largely responsible for increasing MRI T2 values observed with age in DMD boys.\(^2\) However, even in the absence of increased lipid fraction (primarily young DMD boys), soleus \(^1\)H/O T2 values are elevated (Figure 2B); perhaps "pattern 2" using the schema of Marden et al.\(^1\) Interestingly, we find a significant negative association between soleus \(^1\)H/O T2 and lipid fraction in DMD (Figure 2A), perhaps indicating increased fibrotic changes with advanced disease. Thus, increasing T2 values with DMD progression observed from non-fat suppressed MRI measurements likely reflect increased water early in disease (at low lipid fraction), and increasing contributions from fat signals late in disease. Elevated \(^1\)H/O T2 values early in the disease process likely reflect underlying pathology including inflammation, increased sarcocellular water permeability, and myofiber degeneration.

Figure 2. (A) Soleus MRI T2 (non-fat suppressed) in DMD (red triangles) and HC (blue triangles) as function of lipid content determined from \(^1\)H MRS. The DMD MRI T2 values show a strong quadratic dependence on muscle lipid \((r=0.84; p< 0.001\); T2=50 ms at lipid fraction =1). \(^1\)H/O T2 values were determined from MRS and are displayed as a function of lipid fraction for DMD (red squares) and HC (blue circles). DMD \(^1\)H/O T2 values decrease linearly with lipid fraction \((r=0.48, p < 0.01\). (B) This panel focuses on the \(^1\)H/O T2 values with lipid fraction to illustrate that even in the absence of increased lipid, soleus \(^1\)H/O T2 values are elevated strongly in most DMD boys – red squares within red oval. The red dotted lines represent 95% confidence intervals based on the healthy control data.

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