Gait Function is Related to Muscle Fat Infiltration Quantified via Magnetic Resonance Spectroscopy in Children with Duchenne Muscular Dystrophy


Introduction

The purpose of this study was to compare gait parameters/function in children with Duchenne muscular dystrophy (DMD) to controls and to examine the relationship between gait function and measures of muscle fat infiltration.

Experimental

Twenty-three ambulatory boys ages 5.3-14.9 years (mean 8.9±2.8 years) diagnosed with DMD and 11 healthy control (CON) boys ages 5.8-14.7 years (mean 10.0±2.9 years) participated in this study.

Spatiotemporal parameters of gait were assessed using the GaitMat II system with subjects walking at a self-selected speed (DMD n=21, CON n=6). Gait function was determined for all subjects with the timed 30’ walk test. Muscle fat infiltration was quantified from the soleus muscle via proton magnetic resonance spectroscopy (1H-MRS) on either a 1.5T or 3.0T whole-body scanner (DMD n=19, CON n=11). For 1H-MRS measurements, a voxel (volume of ~5,800 mm³) was selected using transaxial, fat suppressed T1 weighted images of the lower leg and was placed inside of the soleus muscle with care to avoid visible vasculature, subcutaneous fat, and myofascial layers. The following acquisition parameters were used: TR=3,000 ms, TE=108 ms, 64 scans, 2,084 data points, and spectral width=2,500 Hz. Concentrations of creatine, choline, total lipid, and water were determined using jMRUI software. Two sample t-tests were used to assess differences between groups for gait parameters, time to walk 30’ and Total Lipid:Total Proton ratios from 1H-MRS. A Pearson correlation coefficient was used to examine the relationship between time to walk 30’ and Total Lipid:Total Proton ratio.

Results and Discussion

DMD subjects demonstrated smaller step and stride lengths relative to CON subjects (0.5±0.1 vs 0.6±0.1 m for step, p<0.02, and 1.0±0.2 vs 1.3±0.2 m for stride, p<0.02). A trend was noted for DMD subjects having a greater base of support (p<0.06) and a slower gait velocity (p<0.08). Boys with DMD demonstrated slower times for the 30’ walk than CON subjects (7.9±3.3 vs 5.0±0.6 s, p<0.001) and had a greater amount of soleus lipid infiltration (0.077±0.11 vs 0.027±0.02, p<0.03). A positive correlation was noted between time to walk 30’ and lipid via 1H-MRS in boys with DMD (r=0.84, p<0.001) but not in CON boys (r=0.05).

Conclusions

Children with DMD exhibit smaller steps/strides relative to healthy children and have impaired gait function as evidenced by a longer time to walk 30’. We also observed greater muscle fat infiltration in the soleus of boys with DMD, and this increased fat content may influence gait ability in this population, as it is associated with a slower time on the 30’ walk test.

1H-MRS provides a non-invasive quantification of muscle composition in children with DMD and may be an important physiological correlate to gait and functional abilities in this patient population. Further studies on the prognostic use of 1H-MRS in predicting functional abilities in boys with DMD are warranted.

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