Changes in Skeletal Muscle Fractional Anisotropy and Apparent Diffusion Coefficient in Juvenile Dermatomyositis

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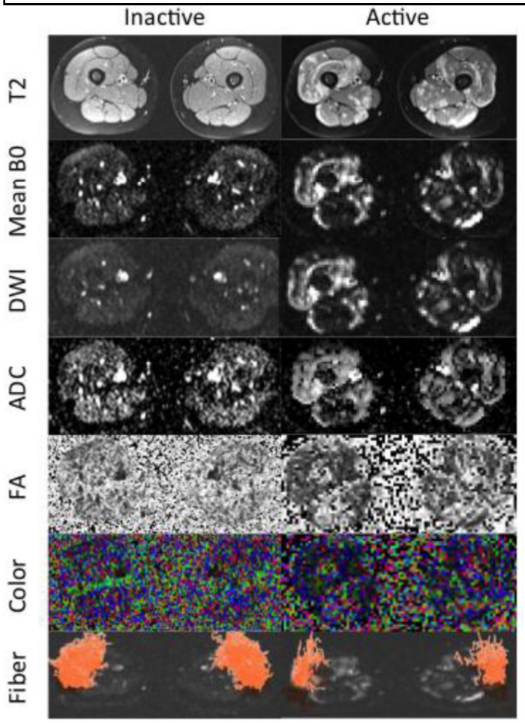
Target Audience: Musculoskeletal Radiologists, Medical Physicists, Neurologists, and Rheumatologists involved in the care and management of patients with Juvenile Dermatomyositis and the application of DTI to this disease process.

Purpose: MRI is currently the gold standard for evaluating inflammatory skeletal muscle disease. Juvenile Dermatomyositis (JDMS) is a childhood inflammatory muscle disease characterized by an acute inflammatory state, chronic fatty infiltration of diseased muscle, and recurrent episodes of inflammation. These features are characterized by focal contrast enhancement, subcutaneous signal abnormalities, and muscle edema on conventional MRI. There is ongoing research into the use of advanced MRI techniques including quantitative T2 mapping and MR spectroscopy. To date, there is no data on the use of diffusion tensor imaging (DTI) to analyze patterns of inflammation, monitor disease status, and predict outcomes in JDMS. The aim of this study is to analyze the muscles of the thighs in patients with both active and inactive JDMS by comparing fractional anisotropy (FA) and mean apparent diffusion coefficient (ADC) values.

Figure 1—T2-MRI and DTI images during active and inactive disease.



Methods: Non-contrast bilateral thigh MRIs were collected from 5 patients with active and inactive JDMS involving the muscles of the thigh using a 1.5T Siemens scanner. These images were obtained as part of routine care and their analysis in this study was approved by the local institutional review board. Skeletal muscle was classified as having active or inactive inflammation based on clinical data and T2-MRI. DTI was collected using echo-planar-SE sequence with diffusion weightings: b = 0, 800 s/mm^2 along 6 directions. Data was collected from regions of interest (ROI) drawn around each muscle of the anterior and posterior compartment of the thigh. Tensors, ADC maps, and fibertracking were performed using DTI-studio software. FA and mean ADC were determined from both DTI and fibertracking data. Values obtained from active diesease were compared to inactive disease using paired t-test with significance based on p-value less than or equal to 0.05.

Results: Both active and inactive JDMS caused skeletal muscle abnormalities on T2 and DTI images. In Figure 1, areas of T2 hyperintensity representing active inflammation correlate with decreased FA and increased ADC. The average FA value for inactive JDMS was 0.63 and the average ADC was 0.99 mm^2/s. The average FA value for active JDMS was 0.51 and the average ADC was 1.37 mm^2/s. Active JDMS is characterized by significant decrease in FA ($p < 0.01$) and significant increase in ADC ($p < 0.01$).

Discussion: This study analyzes changes in FA and ADC in the muscles of patients with JDMS during remission and active disease. To our knowledge, this is the first such study to use DTI to analyze physiologic and structural changes in skeletal muscle affected by JDMS. Compared to remission, active JDMS causes significant decrease in FA and significant increase in ADC in all muscles and compartments of the thigh. These findings are likely a result of muscle inflammation and edema that increase the freedom of water diffusion (ADC). Inflammation also compromises cell membrane integrity and changes in surrounding vascular and connective tissues resulting in decreased restriction of water motion along the muscle long axis (FA).

Conclusion: Previous studies have used T2 relaxation time to predict outcomes for JDMS. DTI offers a unique opportunity to visualize muscle abnormalities during inactive and active JDMS. In the future, changes in DTI parameters may be used to predict outcomes and recurrence in patients with JDMS.

References:

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