

# Diffusion-Weighted Imaging Provides a Detailed Evaluation of Polymyositis: Inflammation, Fat Infiltration and Replacement of Muscle

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## Introduction

Polymyositis is an inflammatory myopathy characterized by severe weakness, elevated serum CPK, muscle inflammation in the early stages, but with time progressive fat infiltration can completely replace essential muscle groups. T1- and T2-weighted images, as well as STIR images, have been used for quantitative evaluation of inflammatory myopathies and therapeutic evaluation (1,2). As described in this report, DWI studies provide additional information which may relate to the pathophysiology of muscle disease.

## Methods

Imaging of the thigh muscles of 7 PM patients and 5 normal controls was performed using a 1.5 T Signa LX clinical scanner and an extremity coil. Axial T1- and T2-weighted images were acquired for calculation of T1 and T2 relaxation times, and STIR images were quantified by signal intensities. DW images were obtained using a DW-EPI pulse sequence with acquisition parameters: TR/TE 6300/112 ms, FOV 26, 128 X128 matrix, slice thickness 10 mm with 10 mm spacing, and 17 diffusion gradients (b values) ranging from 0 to 1000 s/mm<sup>2</sup> (3,4). Images were acquired in x, y, z, and combined directions independently. Signal intensities were plotted as S/S<sub>0</sub> versus b values and fitted with a biexponential equation for determination of D and D\*. Patients with early or severe chronic disease were compared in order to characterize disease progression.

## Results

Four patients were selected for presentation. Patient 1: Early stage PM with inflammation in selected quadriceps and hamstring muscles (Fig. 1A). Patient 2: Advanced PM with fat infiltration in the quadriceps and sartorius muscles (Fig. 1B). Patient 3: Chronic PM showing total fat replacement of the vastus muscles (Fig. 1C). Patient 4: Chronic PM with fat replacement of the semimembranosus muscle and extensive infiltration in the quadriceps muscles. T2 relaxation times confirmed the visual analyses of normal muscle (31 msec), inflammation (56 msec), and fat replacement (46 msec).

DWI data for inflammation in the muscles of Patient 1 showed about 25% increase in D values as compared to control muscles. In PM and control muscles, the D values along the Z direction were higher than those of the X, Y, and combined directions, which demonstrated diffusion anisotropy along the direction of the muscle fibers (Table 1, shaded values). Fat infiltration in Patient 2 reduced the D values as compared to the control values, and anisotropic motion was preserved in the Z direction. In Patient 3, with complete fat replacement of the vastus muscles, further reduction of the D values was observed, and anisotropy was still present in the Z direction. By contrast, fat replacement in Patient 4 showed no anisotropic motion, indicating more advanced degeneration.

## Discussion

In PM muscles with inflammation, elevated D values reflect the increased fluid observed on T2-weighted and STIR images. With advanced or chronic PM, low D values and anisotropy suggest that fat replacement occurs within the fascial structure of muscles. By contrast, superficial fat shows random motion. Slow, progressive fat infiltration with low D values can restrict delivery of metabolites and thereby contribute to weakness and progressive muscle atrophy. Although T2 values for replacement fat in Patient 3 and 4 were the same as those for superficial fat, the D values and directional motion were different. DWI characterized the muscle disease at a pathological level whereas T2 values were morphological indicators. DWI provides unique information regarding molecular motion of fluid which may relate to the pathogenesis of inflammatory muscle diseases.

References 1. Park JH, et al. Radiology 1990; 177:473-479. 2. Fraser DD, et al. J Rheum 1991; 18:1693-1699. 3. Le Bihan D, 1988; 168:497-505. 4. Morvan D, et al. Magn Reson Imaging 1995; 13:943-948.

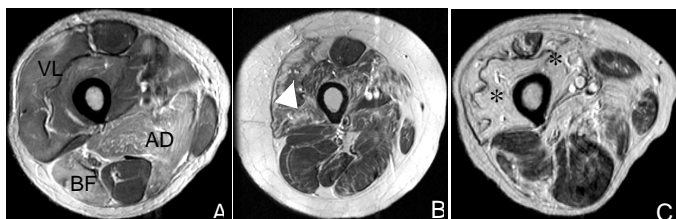


Figure 1: T2-weighted images of the thigh of three PM patients. (A) Inflammation in selected muscles; (B) Fat infiltration (†) and (C) fat replacement (\*) in the quadricep muscless.

Table 1: Diffusion coefficients (D ×10<sup>-3</sup>mm<sup>2</sup>/sec) in 4 directions for a control and 4 PM patients.

SUBJECTS	Z	Combined	Y	X
Control	1.58	1.45	1.22	1.33
Patient 1	2.07	1.83	1.52	1.86
Patient 2	1.41	1.08	0.71	0.92
Patient 3	0.92	0.77	0.77	0.49
Patient 4	0.89	0.91	0.70	0.85
Superficial fat	0.69	0.72	0.65	0.35