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Intravoxel incoherent motion diffusion-weighted MRI, fat quantification, and electromyography: correlation in polymyositis and dermatomyositis

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Introduction

Intravoxel incoherent motion(IVIM) diffusion-weighted imaging(DWI) is a recently introduced MRI technique in which data regarding the incoherent motion of water molecules are acquired using diffusion-encoding gradients. The IVIM model is sensitive not only to the extravascular molecular diffusion of water but also to the intravascular motion of blood flow in capillaries using sufficiently low multiple b-values. The IVIM model can provide information about both molecular diffusion and blood flow, making it an attractive tool for the evaluation of skeletal muscle injury caused by inflammatory conditions. MRI-based fat quantification is advantageous for assessing fat infiltration in skeletal muscle, which is also common in cases of chronic inflammation. We aimed to quantitatively measure various parameters associated with IVIM-DWI and fat quantification in the muscles of patients with inflammatory myositis using magnetic resonance imaging and to investigate the relationship between these parameters and electromyography (EMG) findings.

METHODS

Data were retrospectively evaluated for 12 patients with inflammatory myositis who underwent thigh MRI, including IVIM-DWI and fat quantification. The IVIM-derived parameters included the pure diffusion coefficient (D), pseudodiffusion coefficient (D*), and perfusion fraction (f). The IVIM-derived parameters, ADC values, and Fat fractions were retrospectively measured at three sites in the muscles where EMG was performed, based on records. Fat fraction values were assessed using the six-point Dixon technique. Fat quantification was performed at the same sites in the same muscle, with an ROI using a fat-fraction map. Needle EMG was performed within 9 days of MRI, in accordance with the routine protocol used by our EMG laboratory.

RESULTS

Table 3. Analysis of IVIM-Derived parameters, Fat fraction, and ADC value with or without pathological spontaneous activity

Parameters	Pathologic spontaneous activity	No pathologic spontaneous activity	*P* value
*D** (μm²/s)	19285.18±5615.90	15867.78±7061.79	0.147
D (μm²/s)	1513.44±289.14	1553.02±289.00	0.724
f (%)	19.02±4.87	14.60±5.31	0.027
ADC (μm²/s)	1515.97±255.62	1547.81±250.80	0.747
fat (%)	8.35±10.27	3.37±1.69	0.160

ADC: apparent diffusion coefficient; *D**: pseudodiffusion coefficient; *D*: pure diffusion coefficient; *f*: perfusion fraction; IVIM: intravoxel incoherent motion

The f values (19.02±4.87) in muscles with pathological spontaneous activity on EMG were significantly higher than those (14.60±5.31) in muscles without pathological spontaneous activity ($p < 0.027$). There were no significant differences in D, D*, ADC, or fat fraction between muscles with and without pathologic spontaneous activity.

Figure 2. Correlation of IVIM-Derived parameters, Fat fraction, and ADC value with EMG amplitude

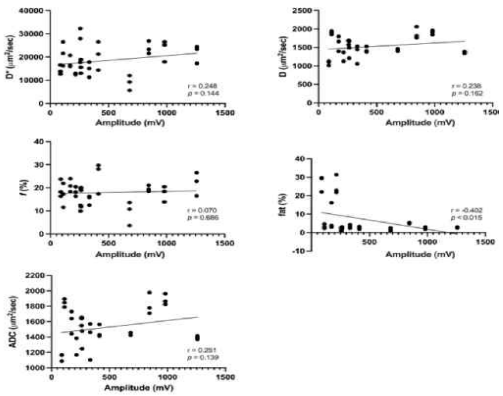

Figure 3. Correlation of IVIM-Derived parameters, Fat fraction, and ADC value with EMG duration

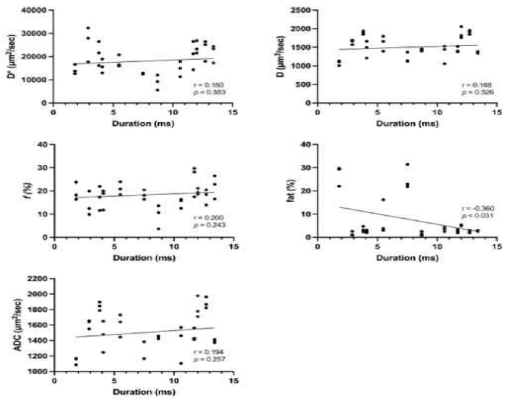

Table 4. Correlations among IVIM-Derived Parameters, Fat Fraction, ADC Value, and EMG parameters

Parameters	Spearman correlation coefficient (r)			
	Amplitude (mV)	*P* value	Duration (ms)	*P* value
*D** (μm²/s)	0.248	0.144	0.150	0.383
D (μm²/s)	0.238	0.162	0.168	0.326
f (%)	0.070	0.686	0.200	0.243
ADC (μm²/s)	0.251	0.139	0.194	0.257
fat (%)	-0.402	0.015	-0.360	0.031

ADC: apparent diffusion coefficient; *D**: pseudodiffusion coefficient; *D*: pure diffusion coefficient; EMG: electromyography; *f*: perfusion fraction; IVIM: intravoxel incoherent motion

Significant negative correlations were observed between fat fraction and amplitude ($r = -0.402$, $p < 0.015$) and between fat fraction and duration ($r = -0.360$, $p < 0.031$).

Conclusion

The current study demonstrates that IVIM-DWI and fat quantification using 3.0 T MRI may aid in predicting EMG findings in patients with inflammatory myopathies and promote the pathophysiological study of inflammatory myopathies.