Reduced diffusion in acute cervical cord multiple sclerosis lesions

Philipp Eisele, MD; Angelika Alonso, MD; Kristina Szabo, MD; Achim Gass, MD

Several studies have reported reduced water diffusion in acute inflammatory-demyelinating lesions in multiple sclerosis (MS) on brain MRI.¹⁻⁴ Spinal cord (SC) MRI represents an important part of diagnostic examinations in MS as 80% to 90% of patients with MS show focal and/or diffuse signal abnormalities.⁵ Acute SC lesions frequently show contrast enhancement because of an increased vascular permeability.⁵ We report 2 patients with acute relapses who showed symptomatic SC lesions with reduced diffusion.

Case 1

A 19-year-old man diagnosed with relapsing-remitting MS in 2011 presented with hypoesthesia including the trunk and all 4 limbs below dermatome C3-4 that had started 2 days earlier. From February 2012 until March 2014, he had been on immunomodulatory treatment with interferon- β . During this time, he developed 2 clinical relapses and treatment had been switched to dimethyl fumarate 8 weeks before the current new symptoms. On clinical examination, there was decreased sensory sensation of light touch, vibration, and 2-point discrimination of all 4 limbs more so on the left with preserved pain and temperature sensation, as well as an ataxic gait (Expanded Disability Status Scale score 3.0). Sagittal and transverse SC MRI revealed a new lesion at the level of the C2 vertebral body located in the dorsal columns that was hyperintense on T2-weighted and diffusion-weighted MRI (DWI) and showed matching hypointensity on apparent diffusion coefficient (ADC) maps (reduced diffusion; figure, A–D) without contrast enhancement on postcontrast T1-weighted MRI (not shown). There were no new brain lesions. Somatosensory evoked potentials showed normal responses after median nerve stimulation but bilaterally delayed P40 latencies after tibial nerve stimulation (44.7 milliseconds left, 45.5 milliseconds right). Motor evoked potentials showed normal latencies and potentials. The patient was treated with IV methylprednisolone (500 mg for 5 days) leading to full recovery over 8 weeks.

Case 2

A 27-year-old woman with a 10-year history of relapsing-remitting MS reported new-onset hypoesthesia and dysesthesia of the right arm and leg since 4 days (Expanded Disability Status Scale score 2.0). She was on natalizumab treatment for almost 5 years and had been clinically stable without relapses, progression, or newly developing lesions on MRI. The current brain MRI was unchanged but SC MRI demonstrated a new T2 hyperintense lesion at the level of C3 vertebral body, mainly involving the dorsal columns, with a hyperintense signal on DWI and reduced ADC values (figure, E–H). No contrast enhancement was detectable (not shown). Somatosensory evoked potentials demonstrated bilaterally normal latencies but slightly asymmetric smaller amplitudes of right median N20 and tibial P40 responses.

Practical Implications

Diffusion-weighted MRI of the spinal cord has the potential to visualize acute demyelinating lesions in multiple sclerosis presenting with reduced diffusion in the absence of contrast-enhancement and might be therefore an useful additional MRI technique for the detection of new focal inflammatory disease activity.

Department of Neurology, Universitätsmedizin Mannheim, University of Heidelberg, Mannheim, Germany.

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Correspondence to: achim.gass@medma.uni-heidelberg.de

Figure Spinal cord MRI demonstrating multiple sclerosis lesions with reduced diffusion

Conventional and diffusion-weighted MRI of case 1 (A-D) and case 2 (E-H). From left to right: proton density-weighted MRI (A, E), diffusion-weighted images (B, F), map of the apparent diffusion coefficient (C, G), and transverse T2-weighted images (D, H). In both patients, spinal cord MRI demonstrates a cervical lesion that appears hyperintense on proton density-weighted (green arrow and arrowhead) and diffusion-weighted images (yellow arrow and arrowhead) with reduced apparent diffusion coefficient values (red arrow and arrowhead), mainly located in the dorsal columns (D, H). No contrast enhancement was detectable in either of the lesions (not shown).

Motor evoked potentials were unremarkable. She was treated with IV methylprednisolone (500 mg for 5 days) resulting in partial recovery and residual hypoesthesia.

DISCUSSION

In the last decade and a half, several studies have reported reduced diffusion in the very early phase of acute MS brain lesion development.¹⁻⁴ While previously described in case studies only,¹ more recent publications demonstrated in more detail that a transient reduction of the ADC can delineate a short and very early phase of MS lesion evolution.² We now report this finding also in 2 patients with symptomatic cervical cord MS lesions.

Reduced diffusion is characterized on MRI by hyperintense DWI signal and reduced ADC values, delineating a very early phase of lesion development when contrast enhancement may be absent and which can be accompanied by CSF pleocytosis.³ This is considered to be a transient phenomenon only present for a brief period of a few days before pseudonormalization of the ADC and increased diffusion occurs parallel to the development of vasogenic edema and blood-brain barrier breakdown.² It is likely that the reduced water molecule mobility is a result of mitochondrial dysfunction due to cytotoxic cell swelling as a result of an aggressive inflammatory milieu induced by proinflammatory cytokines including tumor necrosis factor α and nitric oxide.⁶

However, to date, it remains unclear whether acute MS lesions presenting with reduced diffusion represent a general phenomenon of lesion development or a subgroup of active lesions.

Reduced water mobility is commonly seen in developing acute stroke and early phases of SC infarction, which have been visualized by DWI.⁷ In the 2 cases presented here, acute ischemia can be ruled out as the underlying cause of the MRI changes seen because of the clinical presentations (painless and rather mild and improving symptoms) and the typical lesion location.

Our study demonstrates focal acute MS lesions with reduced diffusion in the absence of contrast enhancement on SC MRI. Although this is a rare finding, DWI has the potential

to visualize acute demyelinating lesions and can therefore be a useful additional MRI technique for the detection of new focal inflammatory-demyelinating disease activity.

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AUTHOR CONTRIBUTIONS

P. Eisele: conceptualization of the study, data acquisition, analysis and interpretation of the data, drafting and revising the manuscript. A. Alonso: analysis and interpretation of the data, revising the manuscript. K. Szabo: analysis and interpretation of the data, revising the manuscript. A. Gass: conceptualization of the study, data acquisition, analysis and interpretation of the data, drafting and revising the manuscript.

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Practical Implications

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