Acute disseminated encephalomyelitis in an adult patient

Magnetic resonance and diffusion-weighted imaging findings

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ABSTRACT

Acute disseminated encephalomyelitis (ADEM) is an uncommon inflammatory disease of the central nervous system and can be defined strictly as scattered focal or multifocal (disseminated) inflammation of brain or spinal cord, or both. An ADEM usually reveals patchy demyelinated lesions with a high signal on T_2-weighted sequences. Here, we report a case of a 39-year-old man with ADEM. Echo-planar "trace" diffusion magnetic resonance imaging revealed high signal intensity changes at the lesion sites on b=1000 s/mm^2 images, initially suggesting restricted diffusion. On corresponding apparent diffusion coefficient (ADC) maps, however, the lesions have a high signal intensity and high ADC values, compared with the normal white matter. This was consistent with the presence of elevated diffusion, and hence, vasogenic edema.

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Acute disseminated encephalomyelitis (ADEM) is an uncommon inflammatory demyelinating disease of the central nervous system (CNS). It is usually triggered by an inflammatory response to viral infections and vaccinations. The course of ADEM is usually monophasic and affects children more commonly than adults, although, it can occur at any age. The main symptoms are decreased level of consciousness varying from lethargy to coma, convulsions, and multifocal neurologic symptoms, such as hemi-, para-, and tetraparesis, cranial nerve palsies, and movement disorders. In some cases, behavioral changes varying from irritability, depression, delusions, and psychosis may dominate the symptoms. In MRI, ADEM causes multiple sclerosis (MS)-like, but more asymmetrical, white matter lesions.[1-6] In this study, we present MRI and diffusion-weighted imaging (DWI) findings in a 39-year-old man with ADEM.

Case Report. A 39-year-old man was admitted with an acute onset of fever, headache, and progressive lethargy. He had developed mild upper respiratory symptoms and cough for 10 days. Examination showed lethargy and meningismus, but he was arousable and oriented to a person, place, and time. Brainstem responses were intact. Fundus oculi was normal. Electroencephalogram

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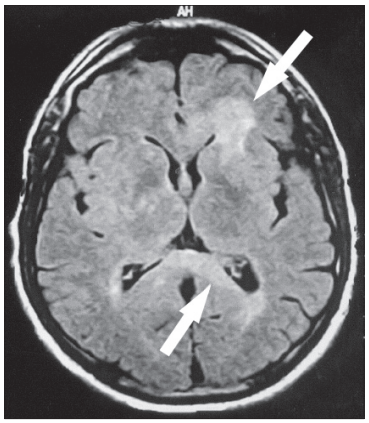

Figure 1 - Fluid attenuated to inversion recovery image shows asymmetrically distributed high signal lesions in bilateral periventricular, subcortical white matter and the splenium of corpus callosum (thin white arrows).

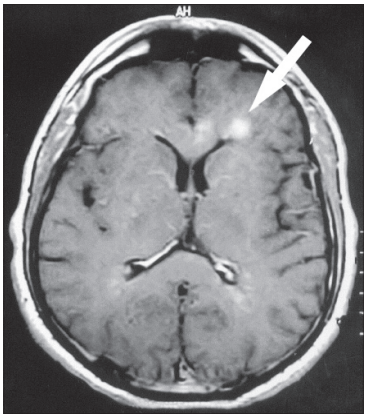

Figure 2 - Post-contrast T_1-weighted image demonstrates the extensive enhancement in the white matter adjacent to frontal horn left lateral ventricle (short white arrow) and some in corpus callosum.

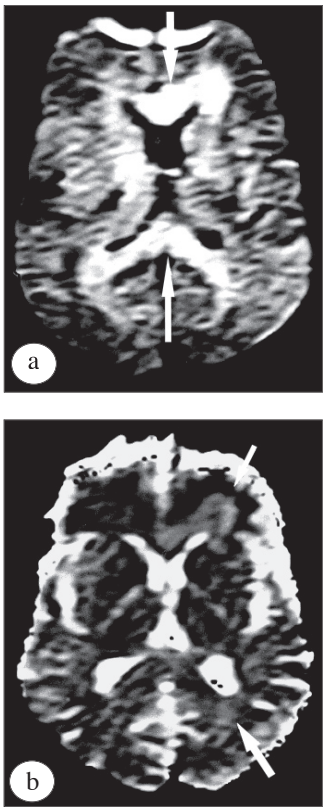

Figure 3 - Diffusion-weighted images. **a)** b=1000 mm^2/s (heavily diffusion-weighted) image reveals high-signal changes in the periventricular white matter and the corpus callosum (long white arrows), **b)** Apparent diffusion coefficient (ADC) image [same slice as (a)] demonstrates a high ADC value in the periventricular white matter and the corpus callosum (white arrows).

showed slow wave activity. Blood chemistry tests were completely normal with the exception of an elevation of serum white blood count (16.3 cells/ uL). Cerebrospinal fluid examination 10 days after the onset of symptoms revealed a mildly increased protein level, a normal cell count, and an absence of oligoclonal bands. Serological testing for common neurotropic viruses, *Borrelia*, and mycoplasms were negative. In addition, results of cryptococcal antigen testing were negative. A vitamin B12 and antinuclear antibody levels, lyme titers and thyroid function tests were normal. To elucidate the underlying pathologic abnormality, MR studies were performed on a 1.5 T MR unit (Excelart, Toshiba, Tokyo, Japan), and T_1-weighted spin echo (SE) (repetition time/ echo time (TR/TE): 400 msec/10 msec) and T_2-weighted fast spin echo (TR/TE: 4000 msec/100 msec). Fluid attenuated inversion recovery (FLAIR) image shows asymmetrically (TR/TE: 8800 msec/130 msec, T_I: 2200 msec), T_1-weighted SE sequences before and after administration of gadolinium chelate (Gd-diethylenetriaminepentaacetic acid; Magnevist, 0.1 mmol/kg) and echo-planar DWI- MRI were obtained. On routine MR sequences, the periventricular white matter, and the corpus callosum were affected. Particularly, T_2-weighted and FLAIR images showed asymmetrically distributed high signal lesions in bilateral periventricular and subcortical white matter (**Figure 1**). On the post-contrast T_1-weighted images, there was the extensive enhancement in the peripheral cerebral white matter and the genu of corpus callosum (**Figure 2**). A diagnosis of ADEM was considered mainly based on the imaging findings. On diffusion MRI performed with the echo-planar trace sequence (TR=4400 msec, and TE=110 msec), b=1000 s/mm^2 DWI revealed high-signal changes in the peripheral cerebral white matter and the corpus callosum lesions likely consistent with restricted diffusion (ischemia-

cytotoxic edema) (**Figure 3a**). Automatically generated apparent diffusion coefficient (ADC) maps were studied. On ADC maps, the corresponding regions revealed high signal intensity. The ADC values were obtained by direct reading from the maps by using electronic evaluations with the region of interest, each including 16 pixels. At the sites with the lesions, the ADC values were high (**Figure 3b**). The ADC values from the affected regions of the parenchyma were consistent with increased mobility of water molecules (elevated diffusion). The ADC values in the high-signal lesions ranged from 1160-1410 $\mu m^2/s$. For comparison, ADC values of unaffected regions of the white matter ranged from the 707-1020 $\mu m^2/s$. Spinal MRI examinations were with normal limits. A diagnosis of ADEM was considered by clinical and imaging findings. The patient was given a large dose of intravenous corticosteroids. At follow-up 4 weeks later, the cerebral lesions had nearly resolved completely on MRI examination.

Discussion. The ADEM is an uncommon immune-mediated inflammatory demyelinating disease of the CNS. In contrast to MS, ADEM is usually a monophasic disorder with favourable long-term prognosis. The true incidence of ADEM is unknown. The disease is surely more frequent than reported.[7,8] The ADEM can occur at any age. It is more common in children due to higher frequency of immunization and exposure to the antigen. Both genders are affected with equal frequency, as opposed to female preponderance in MS. The ADEM typically begins within 6 days to 6 weeks following an antigenic challenge. Approximately 70% of patients report a precipitating event, for example viral or bacterial infections or vaccination. The pathology of ADEM reveals inflammation predominantly in the Virchow Robin spaces and diffuses, often symmetric, perivenular demyelination. The lesions are of similar histological age, and highest numerous in white matter, but also involve the deeper cortical laminae, thalami, hypothalamus, and other gray matter structures. The neurologic picture of ADEM usually reflects a multifocal but monophasic involvement.[9]

Magnetic resonance image is the primary modality of investigation in the diagnosis of ADEM. The MRI findings in ADEM are a reflection of the histopathology of the disease. Lesions are usually asymmetrical and tend to locate in the subcortical white matter. Less commonly basal ganglia, and thalami, corpus callosum, brainstem, cerebellar white matter, and spinal cord can be involved. Usually, all the lesions enhance with contrast, but in some patients there may be the enhancement of some lesions without enhancement of others. This is as the lesions in ADEM may evolve over several weeks. Lesions resolve partially in two thirds and vanish in nearly a third of patients.[10-12] In our patient; the diagnosis of ADEM was hypothesized on the basis of the typical lesions at MRI. Previous reports are available on diffusion-weighted MRI in patients with ADEM.[13-15] Recent reports on DWI of ADEM cited presence of variable patterns, increased and decreased diffusion coefficients. Sener et al,[14] described 2 distinct patterns; cytotoxic edema-like and vasogenic edema-like patterns on DWI in a patient with ADEM. It has been considered that increased diffusion coefficients likely represented demyelination, while decreased diffusion coefficients reflected accumulation of inflammatory cells.[13] However, DWI usually shows hyperintense lesions with increased ADC in the white matter. Rarely, the ADC values of the ADEM lesions have been reported to be decreased or normal.[13,15]

In our patient, on heavily DWI (b=1000 s/mm^2) of echo-planar diffusion MRI and ADC maps, high signal changes consistent with an increased diffusion pattern (vasogenic, demyelinating pattern) of water molecules were evident in bilateral periventricular and subcortical white matter, and corpus callosum. It has been explained by an increased density of cellular borders in the active zones of demyelination due to the accumulation of lymphocytes, monocytes, plasma cells, and mononuclear cells.[16] Increased ADC values may be caused by enlarged intra- and extracellular compartments due to demyelination, increase of water, and inflammatory cell swelling.[17]

In conclusion, the diffusion MRI appeared to be a promising and useful sequence to evaluate the changes in the brain tissue in ADEM, and in other infectious conditions. However, further studies are required for detailed evaluation of DWI patterns in ADEM.

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