

## Diffusion-weighted magnetic resonance imaging in a case of osmotic demyelination syndrome with fatal outcome

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### Abstract

Hyponatraemia with rapid correction of serum sodium may cause an osmotic demyelination syndrome (ODS) with damage to pontine and/or extrapontine areas of the brain. The prognosis of ODS can range from complete recovery to death; at present, our ability to predict clinical outcome is very limited. We describe here a patient with ODS and increased signal intensity in the striatum on diffusion-weighted MRI, with corresponding low apparent diffusion coefficient values (indicating restricted water diffusion). This case provides a further example of the typical MRI appearance of extrapontine ODS and suggests the potential value of diffusion-weighted MRI in predicting prognosis in ODS.

### INTRODUCTION

The outcome of patients with osmotic demyelination syndrome (ODS) (central pontine myelinolysis [CPM] and/or extra-pontine myelinolysis [EPM]) ranges from complete recovery to death.<sup>1</sup> At present, our ability to predict clinical outcome in patients with this condition is very limited as this does not appear to depend on the severity of the neurological deficit during the acute phase of the illness, lesion size on neuroimaging, degree of hyponatraemia, or electrophysiological findings.<sup>1,2</sup> Patients with severe manifestations such as quadriplegia and inability to speak or swallow, or profound parkinsonism can make an essentially complete recovery, but other similarly affected patients may have virtually no improvement. Here, we report on a patient with fatal outcome after ODS, in whom diffusion restriction in the basal ganglia (striatum) was demonstrated on brain magnetic resonance imaging (MRI) performed early in the course of her illness. This case adds to the limited existing literature suggesting that diffusion-weighted imaging (DWI) may be useful in predicting prognosis in ODS.<sup>2,3</sup>

### CASE REPORT

The patient was a 34-year-old woman who presented with a five day history of frequent vomiting and three day history of confusion. She

had initially presented to a different hospital with anxiety and insomnia, and her blood pressure was found to be elevated (systolic pressure of 200 mm Hg), for which amlodipine and prazosin were prescribed. Her serum Na<sup>+</sup> at this time was 141 mmol/L; urine dipstick revealed 3+ protein and renal ultrasound showed echogenic kidneys with poor cortico-medullary differentiation. Prior to this, she had been well with no medical problems. On examination at our hospital, she was afebrile, dehydrated and had a blood pressure of 156/84. She was disorientated with a Glasgow Coma Scale (GCS) score of 14/15. There were no focal neurologic signs. ECG showed left ventricular hypertrophy. Serum Na<sup>+</sup> was very low at 92 mmol/L, K<sup>+</sup> 2.2 mmol/L, chloride 54 mmol/L, creatinine 119 µmol/L, and urea 6.1 mmol/L; urine sodium was 10 mmol/L. Computed tomography of the brain showed bioccipital cerebral oedema. The hypovolaemic hyponatraemia was attributed to vomiting, which in turn was thought to be related to hypertensive encephalopathy.

An intravenous infusion of normal saline was commenced (four pints over 24 hours) (1 pint = 0.47 litre) with potassium supplementation. She was given amlodipine and perindopril for the hypertension. Several hours later, she became more alert. 24 hours after presentation to hospital, her serum Na<sup>+</sup> had increased from 92 to 114 mmol/L. Over the next few days, normal saline

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infusion was continued at a rate of 2-4 pints over 24 hours, with a progressive increase in serum  $\text{Na}^+$  and  $\text{K}^+$ . Her blood pressure ranged between 130/60 and 170/80. On day 3 of her hospitalisation, she was noted to become drowsier again (GCS score 12/15); serum sodium was 129 mmol/L. Her normal saline infusion was given at a reduced rate. The next day, her conscious state deteriorated further (GCS score 9/15) and she became quadriparetic. Blood pressure was normal. Serum sodium was 134 mmol/L.

1.5-Tesla brain MRI on day 4 of hospitalisation showed bilateral and symmetrical hyperintensity of the putamina and caudate nuclei on diffusion-weighted imaging and T2 FLAIR, with corresponding hypointensity on the apparent

diffusion coefficient (ADC) maps; there was no discernible increase or decrease of signal intensity in the pons (Figure 1). ADC values of the putamina, caudate nuclei, pons, thalamus and deep white matter were measured with a constant ROI of 30 mm<sup>2</sup> (Table 1). Lumbar puncture revealed normal opening pressure and cerebrospinal fluid content. There was no evidence of non-convulsive status epilepticus on electroencephalography. The patient was intubated for airway protection. Subsequently, dextrose 5% was used for intravenous fluid replacement. Over the ensuing two weeks, the patient's clinical condition remained poor: GCS off sedation was  $\text{E}_4\text{V}_1\text{M}_4$ ; she was quadriplegic with bilateral upgoing plantar responses and a right gaze preference. There were

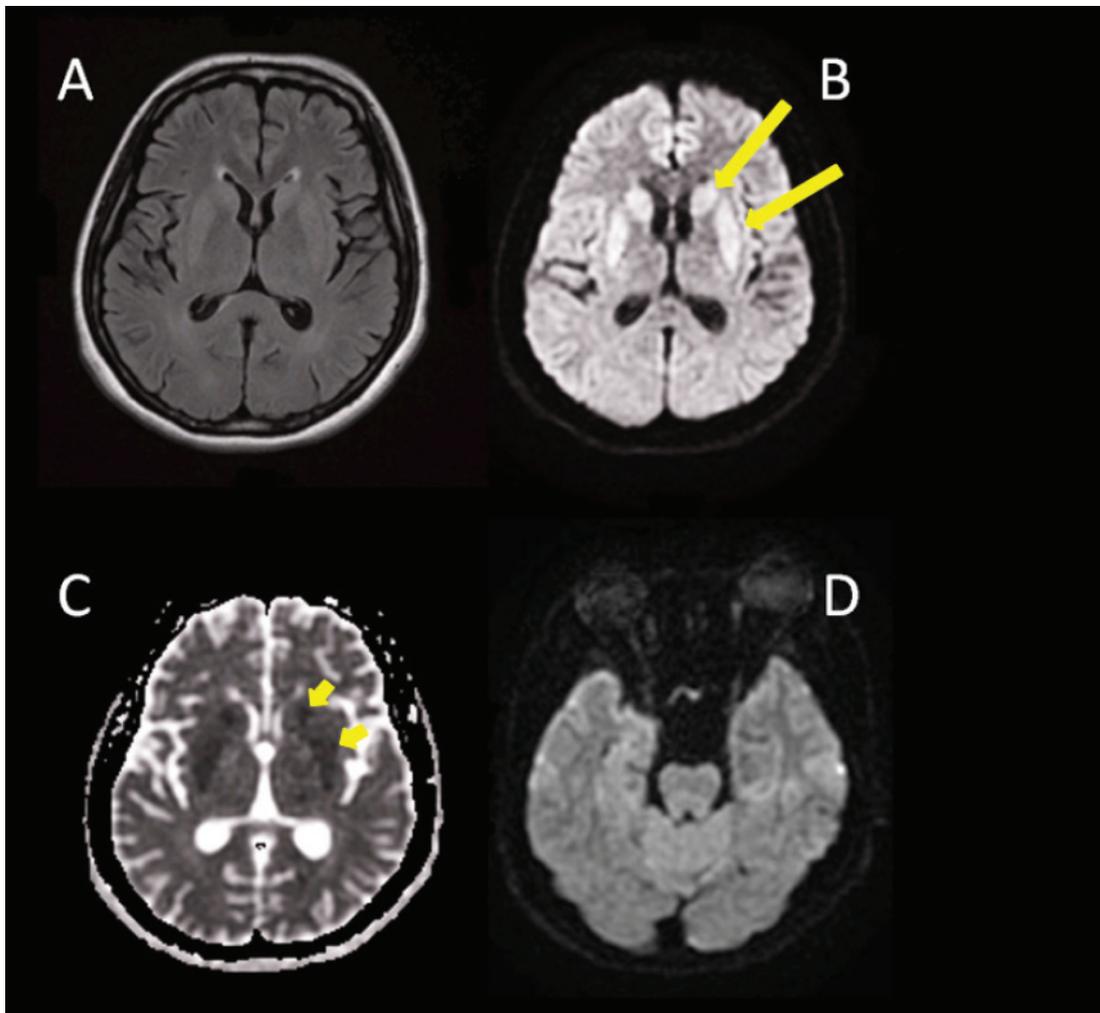


Figure 1. Axial brain MRI performed one day after symptom onset showing symmetrically increased signal in the putamina and caudate nuclei on FLAIR (A) and DWI (B) (long arrows), with corresponding areas of decreased ADC (short arrows) (C). The increased striatal signal on FLAIR (A) is relatively faint. There is no discernible increase or decrease of signal intensity in the pons on any of these sequences; DWI is shown in (D).

**Table 1: Brain MRI ADC values (x 10<sup>-3</sup>)**

Region	Right	Left
Putamen	6.19	6.57
Caudate nucleus	7.67	7.78
Central pons	7.50	
Periventricular area (anterior)	8.91	8.74
Periventricular area (posterior)	8.97	8.68

no involuntary movements; she never developed dystonia or parkinsonian tremor or rigidity. On the 16<sup>th</sup> hospital day, she developed hospital-acquired pneumonia, intravenous line-related sepsis and worsening renal function due to sepsis. Despite treatment with broad-spectrum antibiotics and dialysis (complicated by traumatic insertion of a peritoneal dialysis catheter), the patient died on day 21 of hospitalisation. Her death was attributed to multidrug-resistant infections, occurring as complications of her poor neurological status. Autopsy was not performed.

## DISCUSSION

In our patient, the over-correction of severe hyponatraemia (exceeding 10 mmol/L in 24 hours), biphasic course (transient improvement of encephalopathy, followed by worsening a few days later) and imaging findings of bilateral and symmetrical lesions in the striatum<sup>4</sup> are consistent with a diagnosis of ODS. The MRI findings are unlikely to be due to hypertensive encephalopathy or posterior reversible encephalopathy syndrome, where symmetrical abnormalities are typically seen in the posterior parieto-occipital regions of the brain, rather than affecting the basal ganglia as in our patient.<sup>5</sup>

DWI is a relatively new MRI technique sensitive to the motion of water. The most widely used clinical application of DWI has been in the detection of acute cerebral infarction. Recently, however, DWI has been applied to a variety of other cerebral diseases.<sup>6</sup> In ODS, abnormalities on DWI may be seen before findings are conspicuous on conventional MRI sequences<sup>7</sup>, which in some cases may be delayed for up to two weeks after illness onset.<sup>8,9</sup> In most cases of ODS, *increased* rather than decreased ADC is seen<sup>6,10</sup>, although *decreased* ADC (suggestive of cytotoxic oedema)

has also been reported in a few cases.<sup>3,7,11-13</sup> It has been increasingly reported that restricted diffusion on MRI (with decreased ADC) may predict a worse prognosis in a variety of cerebral diseases, including hypoxic-ischaemic encephalopathy, acute disseminated encephalomyelitis and herpes encephalitis.<sup>6,14-17</sup> However, there have been no large studies correlating the ADC with clinical outcomes in ODS. Nevertheless, the presence of severe brain damage and cytotoxic oedema may have been a predictor of poor outcome in our patient. It has been proposed that the variable clinical outcomes of patients with these conditions may reflect the type of cerebral oedema predominating (cytotoxic vs. vasogenic)<sup>6,13</sup>; other, as yet unknown, pathophysiological processes may also be important.<sup>10</sup>

In the patient with ODS reported by Shin *et al.*<sup>2</sup>, brain MRI performed 5 days after symptom onset showed striatal hyperintensity on T2 sequences but normal DWI/ADC; this patient with profound parkinsonism subsequently made a complete clinical recovery. Dervisoglu *et al.* described a patient with ODS causing confusion, quadriplegia and dysarthria.<sup>3</sup> Although brain MRI performed on the day of symptom onset demonstrated diffusion restriction, this normalised rapidly on repeated imaging, in parallel with the patient's clinical improvement. The authors proposed a relationship between rapid ADC normalisation and a favorable clinical outcome. Cramer *et al.* reported on two patients with ODS where MRI performed a week after symptom onset showed restricted diffusion in the pons and thalamus.<sup>12</sup> One patient with quadriplegia died. The other patient had mostly recovered from his quadriplegia by 10 weeks, but the authors reported that "a new intention tremor" had developed (no further details were provided). It is worth noting in this context that patients with ODS can sometimes recover from

severe weakness only to later develop disabling movement disorders.<sup>18</sup>

In conclusion, the present case adds to the current limited literature suggesting that DWI/ADC may be useful in predicting prognosis in ODS. These preliminary observations need to be confirmed by studies involving a larger number of patients.

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