

## Short communication

## A case of reversible postpartum cytotoxic edema in preeclampsia

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### Abstract

We report on a 32-year-old woman who developed reversible cortical blindness and right-sided weakness after cesarean section at 36 weeks of gestation, due to preeclampsia. An initial brain MRI demonstrated high signal intensity lesions in the bilateral occipito-parietal and left frontal lobes on T2-weighted and diffusion-weighted imaging. All of the lesions showed low signal intensity on apparent diffusion coefficient (ADC) map, which were compatible with cytotoxic edema, and MR angiography (MRA) showed diffuse vasospasm of the intracranial vessels. A follow-up brain MRI showed that most of the lesions disappeared and the vasospasm also resolved. This case suggests that the cytotoxic edema in preeclampsia may evolve differently from the pattern in cerebral infarction and explains the relatively benign course of the neurological signs in preeclampsia.

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### 1. Introduction

Preeclampsia, a pregnancy-related disorder, is characterized by hypertension, edema and proteinuria. Many patients with preeclampsia also develop neurological signs and symptoms such as headache, visual changes, confusion and depression of consciousness. A convulsion is considered the traditional sign that differentiates eclampsia from preeclampsia.

The pathophysiology of the neurological complications attributed to preeclampsia/eclampsia remains unclear. One proposed mechanism is that the cerebral vasospasm induced by severe hypertension results in cerebral ischemia and consequently allows cytotoxic edema formation. Another mechanism is proposed that acute hypertension induces the loss of autoregulation, causing the passive dilatation of cerebral arterioles, and consequently increasing the vascular permeability and encouraging vasogenic edema formation. Angiographic and pathologic investigations have found vasoconstriction and permanent infarction

in severely affected patients, supporting the former mechanism. However, the latter mechanism is supported by the reversible radiological findings, the relatively benign clinical course and the increased brain perfusion with SPECT imaging. Recent reports suggest the clinical usefulness of diffusion-weighted MR imaging (DWI) in discriminating cytotoxic edema and vasogenic edema in eclampsia [1–4]. We describe a preeclamptic patient with postpartum cortical blindness and right-sided weakness, in whom a brain MRI showed reversible cytotoxic edema.

### 2. Case report

A 32-year-old right-handed woman was admitted to the hospital because of total blindness and right-sided weakness, which developed 1 day post-partum. During prenatal care, she had been diagnosed with preeclampsia due to hypertension, proteinuria and edema. She reported no history of hypertension or other illness prior to pregnancy. The cesarean section was performed at a private clinic at 36 weeks of gestation, due to aggravated preeclamptic symptoms. One day after delivery, she experienced sudden bilateral total blindness and right-sided weakness, and was transferred to our hospital 6 days following the onset of

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symptoms. Upon admission, she was alert and fully oriented; however, she was unable to see anything and could only perceive bright light. Both pupils were the same size and promptly constricted to light. There was no papilledema on fundus examination. She had right-sided motor weakness that was more severe in her upper extremity. The deep tendon reflexes were hyperactive on the right side. Her initial blood pressure was 170/110 mm Hg and laboratory studies showed normal findings, with the exception of low serum albumin (2.7 g/dl) and proteinuria (4.6 g/24 h urine collection).

Brain MRI (Signa 3.0 T, GE, Milwaukee) performed on the seventh day after symptom onset showed an area of high signal intensity on T2-weighted imaging and DWI (*b* value, 1000 s/mm<sup>2</sup>) in the subcortical white matter and the adjacent gray matter of the bilateral occipito-parietal lobes and the left

Table 1  
Transcranial Doppler ultrasonographic findings

Vessel (mm)	Depth	Mean flow velocity (cm/s)		
		One week from onset (Rt/Lt)	Three weeks from onset (Rt/Lt)	Seven weeks from onset (Rt/Lt)
MCA	60–64	136/156	88/111	75/94
ACA	68–72	113/118	65/77	63/72
ICAs	72–76	125/99	75/62	59/60
ICAc	36–40	46/52	32/37	38/44
BA	84–88	100	54	61

MCA, middle cerebral artery; ACA, anterior cerebral artery; ICAs, internal carotid artery at siphon; ICAc, cervical internal carotid artery; BA, basilar artery.

frontal lobe (Fig. 1). The apparent diffusion coefficient (ADC) values of the bilateral occipital lesion and left frontal lesion were  $445–467 \times 10^{-6}$  and  $390 \times 10^{-6}$  mm<sup>2</sup>/s, re-

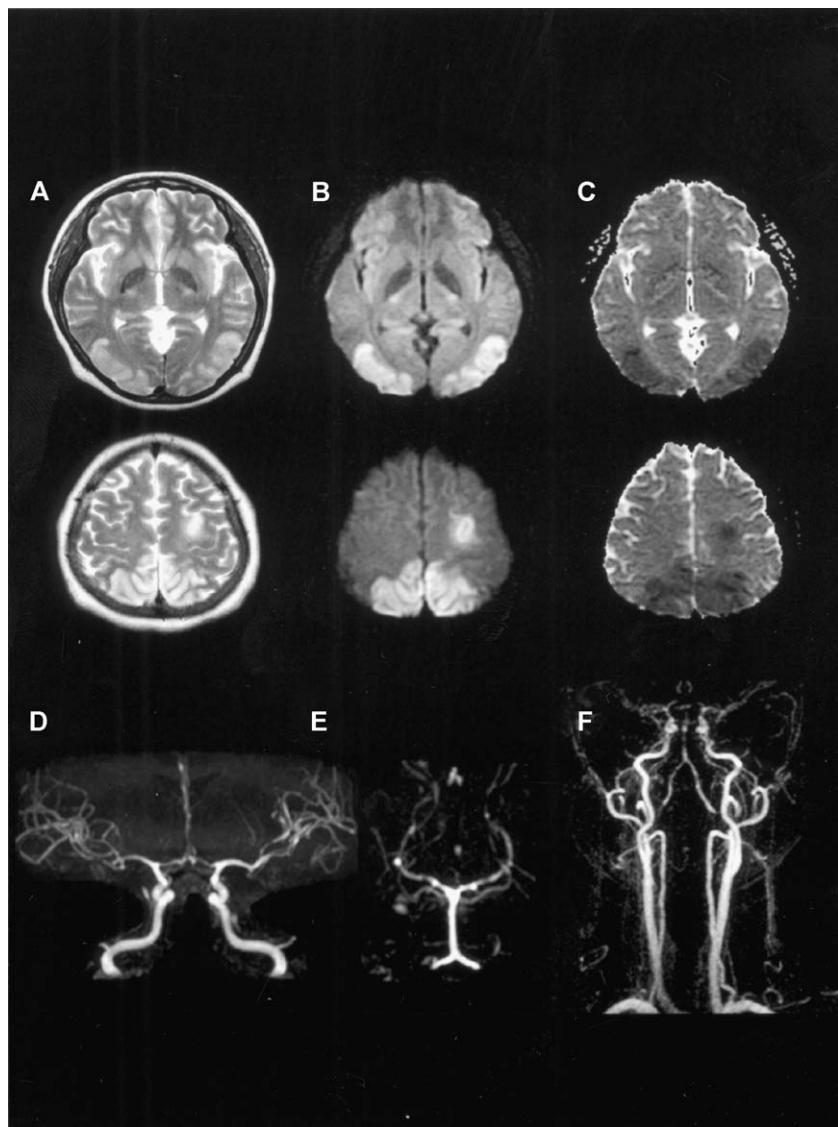


Fig. 1. Initial brain MRI and MR angiography. (A) T2-weighted image shows high signal intensity lesions on the bilateral occipito-parietal and left frontal lobes. (B) Diffusion-weighted image shows high signal intensity lesions in this area. (C) ADC map shows low ADC values in the corresponding lesions. (D–F) Diffuse vasospasm of bilateral MCA, ACA and PCA are noted.

spectively, whereas normal appearing right frontal lobe was  $685 \times 10^{-6} \text{ mm}^2/\text{s}$ . Decreased ADC values suggested that these lesions represented cytotoxic edema, not vasogenic edema. MR angiography (MRA) showed diffuse vasospasm of the intracranial vessels. Transcranial Doppler ultrasonography (TCD) showed an increased mean flow velocity (MFV) in both sides of the intracranial vessels (Table 1). The patient was treated with intravenous nimodipine, dexamethasone and magnesium sulfate. Following treatment, the decreased visual acuity and motor weakness were much improved at 3 weeks after the onset of symptoms.

A follow-up brain MRI and MRA, performed 3 weeks after symptom onset, showed that most of the lesions had

disappeared, leaving only small foci of high signal intensity, especially in the left frontal and bilateral occipital lobes on T2-weighted imaging and DWI. The vasospasm of the intracranial vessels was also resolved (Fig. 2). A follow-up TCD was performed at 3 and 7 weeks after symptom onset. The MFV of both sides of the intracranial vessels decreased to normal ranges, with the exception of the left MCA. The MFV of the left MCA had decreased compared to the initial study, but was still above the normal ranges in follow-up studies. Seven weeks after the onset of symptoms, the visual acuity and right-sided weakness had fully recovered and only mild signs of optic ataxia and simultanagnosia remained, which were compatible with Balint's syndrome.

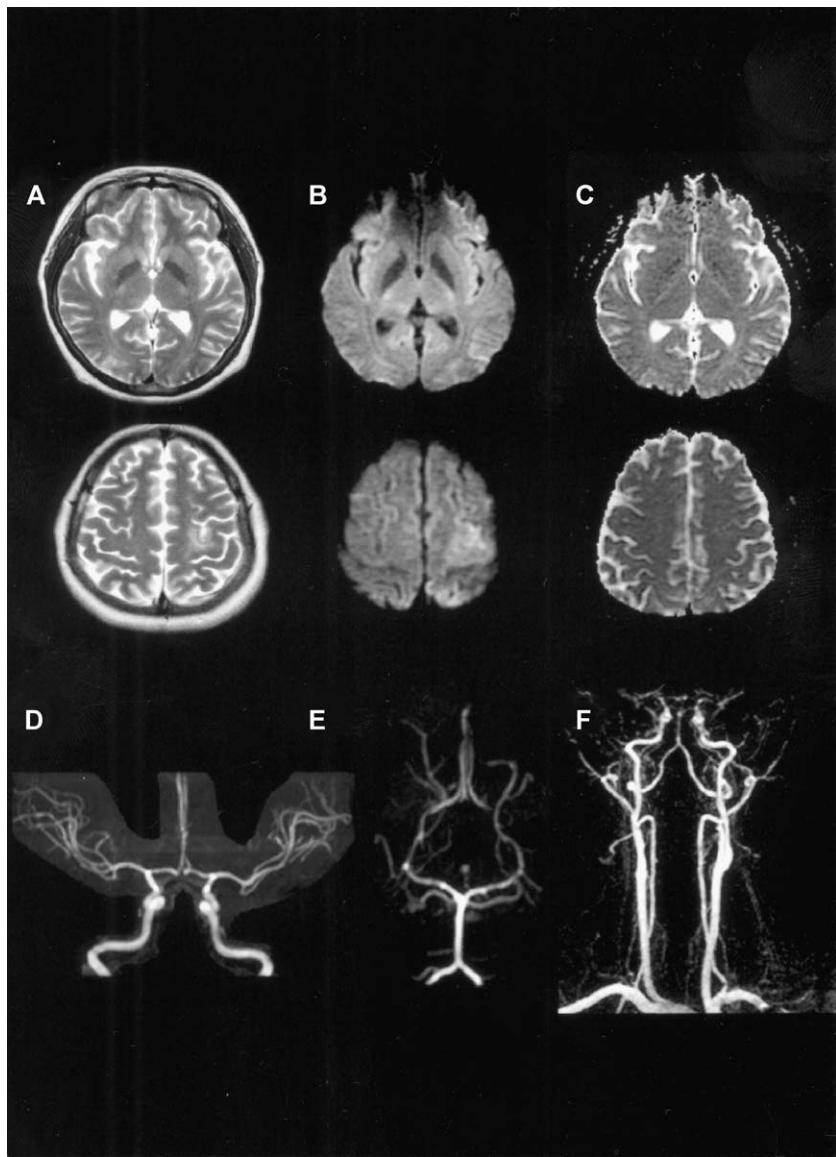


Fig. 2. Follow-up brain MRI and MR angiography. (A–B) Most of the lesions disappeared on T2-weighted and diffusion-weighted images, except small foci of high signal lesions on the left frontal and bilateral occipital lobes. (C) ADC map shows complete resolution of the lesions. (D–F) Diffuse vasospasm of intracranial vessels is resolved.

### 3. Discussion

Posterior leukoencephalopathy syndrome (PLES) is a rapidly evolving neurologic condition characterized by headache, decreased alertness, altered mental functioning, seizures, visual loss and, occasionally, focal neurologic signs [5]. Preeclampsia/eclampsia is considered one of the common causes of PLES. Cerebral vasospasm has been documented previously in patients with preeclampsia/eclampsia [6–9]. Vasospasm provokes mainly cytotoxic edema by cerebral ischemia, resulting from the direct impairment of the blood supply. However, mild ischemia induced by vasospasm may produce vasogenic edema only by disrupting the blood–brain barrier and, in turn, the vasogenic edema causes cytotoxic edema, because elevated tissue pressure due to marked vasogenic edema impairs the microcirculation [2,10,11]. The reported MRI findings of preeclampsia/eclampsia showed variable spectra, from vasogenic edema to cytotoxic edema, and sometimes with a mixed pattern [2–4,6]. DWI and ADC map can distinguish cytotoxic brain edema from vasogenic brain edema in various conditions, and help to predict the progression to cerebral infarction [3,10,12]. Cytotoxic edema displays hyperintense signals on DWI and hypointense signals on ADC map. On the other hand, vasogenic edema displays variable signal intensities on DWI and hyperintense signals on ADC map. In previously reported eclamptic cases, the MRI findings that were consistent with cytotoxic edema progressed to infarction on follow-up imaging, and the patients showed a clinically poor prognosis [2,4].

In this case, the initial MRI findings, taken 7 days after symptom onset, showed lesions due to cytotoxic edema with hyperintense signals on DWI and hypointense signals on ADC map in the bilateral occipitoparietal lobes and left frontal lobe. Interestingly, most of the lesions had disappeared on a repeated MRI performed 2 weeks later and only small foci of the cerebral infarction remained. The observations suggest that the initial cytotoxic edema in preeclampsia does not always progress to cerebral infarction. This reversible cytotoxic edema has been reported in Wernicke encephalopathy, traumatic brain injury, and permanent and transient MCA occlusion in animal models [13–16]. Also, partial or complete normalization of DWI abnormalities occurred in acute ischemic stroke patients following recanalization [17,18], suggesting that the severity of cytotoxic edema, expressed as an ADC value, determined the reversibility and was dependent upon the extent of cerebral ischemia. Dardzinski et al. [15] reported that the brain damage was potentially reversible when ADC values were between 450 and  $550 \times 10^{-6}$  mm<sup>2</sup>/s, but below that range irreversible damage occurred in an experimental focal cerebral ischemia model. In this case, the ADC value of the left frontal lesion was lower than that range and irreversible damage remained in

follow-up imaging. On the other hand, the ADC values of the bilateral occipital lesions were comparable to the lower limit of that range and most of those lesions showed reversible changes.

Another interesting point is the correlation between the TCD and MRI findings. This case demonstrated the diffuse vasospasm of intracranial vessels by MRA and TCD, and follow-up studies showed reversible changes in vasospasm, similar to other reported cases. The left frontal lobe lesion, responsible for right-sided weakness, showed initial cytotoxic edema and eventually progressed to cerebral infarction. The TCD examination showed that the MFV of the left MCA was higher than the right MCA, especially on the follow-up examination. This suggests that the development of cytotoxic edema and the eventual progression to cerebral infarction may be influenced by the severity of the vasospasm in the involved blood vessels. As to the increased MFV in preeclampsia/eclampsia by TCD examination, some studies suggested that increased velocity reflected the cerebral hyperperfusion due to the breakdown of autoregulation and forced vasodilatation [19,20]. Also the vasospasm was regarded as a protective response to extremes of arterial pressure not the pathological one [21]. Usually, the vasogenic edema was provoked by such mechanism and it showed reversible course as the clinical symptoms improved. However, we favor the vasospasm as the pathogenic mechanism of the present case, because of the presence of cytotoxic edema and remaining small infarction on the brain MRI.

The neurologic signs in preeclampsia/eclampsia develop from a benign form of vasogenic brain edema, to a severe form of cytotoxic brain edema, and finally, to a cerebral infarction. The vasospasm of intracranial vessels is regarded as one of the main underlying mechanisms of these pathological changes. The coexistence of vasogenic and cytotoxic edema in eclampsia and other PLES suggests that different disease spectra may occur in the same patient attributed to the underlying severity of the vasospasm [2,11]. Vasospasm, unlike the complete occlusion of a blood vessel, could induce mild to severe cerebral ischemia dependent on the degree of vessel constriction, and this variability results in diverse clinical and radiological expressions, in both different patients and different territories of the same patient.

In conclusion, this case shows that cytotoxic edema in preeclampsia caused by vasospasm, may have a different evolution pattern from cytotoxic edema caused by the complete occlusion of a blood vessel, which usually progresses to cerebral infarction. This reversibility may depend upon the severity of the vasospasm and explain the relatively benign course of the neurological signs in preeclampsia. The MRI, especially the DWI and the ADC values, may be of great help in discriminating between reversible and irreversible cerebral lesions, which developed in a patient with preeclampsia/eclampsia.

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