

# Epileptic seizures with reversible lesions in bilateral frontoparietal lobes: A case report and literature review

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## Abstract

Magnetic resonance imaging (MRI) is recommended for patients with epileptic seizures to rule out an underlying focal lesion. However, the radiological characteristics of epilepsy are not well elucidated. Transient periictal MRI abnormality (TPMA) refers to reversible MRI signal changes observed in epileptic patients. A 32-year-old man presented with a 2-week history of epileptic seizures, which initially manifested as focal aware seizures and progressed to a generalized tonic-clonic seizure on the third day. Electroencephalography showed sharp waves, sharp and slow wave complexes, and irregular  $\delta$  waves over bilateral temporal lobes. After admission, brain MRI showed abnormal signals in the bilateral frontoparietal lobes. He was administered oral oxcarbazepine (75 mg twice daily). During follow-up he was seizure-free; the abnormal MRI signals persisted at 2 weeks, but were completely resolved at 4 months. The possibility of TPMA should be considered in patients with epileptic disorders, and differentiated from a potential epileptogenic lesion.

## Keywords

Epilepsy, MRI, periictal MRI abnormalities, case report

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## Introduction

Epilepsy is a common neurological disorder characterized by episodic convulsions associated with transient confusion. More than 50 million people worldwide (approximately 1% of the global population) are affected by epilepsy.<sup>1</sup> This disorder is the result of excessive neuronal discharge in the cerebral cortex. The cause of epilepsy is unknown in a vast majority of cases, although structural

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abnormalities, such as intracranial space-occupying lesions, brain injury, vascular diseases, infections, and birth defects are the underlying cause of seizures in some cases. Epileptic patients often show abnormal findings on electroencephalogram (EEG); however, negative EEG findings do not rule out the condition. Magnetic resonance imaging (MRI) is recommended for epileptic seizures to detect structural lesions in and around the brain.<sup>2</sup>

The radiological characteristics of epilepsy have not yet been well elucidated. Transient periictal MRI abnormality (TPMA) is a recently identified phenomenon in epileptic patients, which manifests as reversible MRI signal changes. TPMA may be attributable to vasogenic and cytotoxic edema that results from a cascade of events triggered by the seizure discharge, which is related to the increased metabolic demand at the seizure focus. In a majority of patients, TPMA is a transient phenomenon that shows complete or partial resolution within days. However, in a few cases it induces irreversible brain damage and eventually leads to a new seizure focus. TPMA is most commonly observed secondary to status epilepticus, and has rarely been reported in patients with focal aware seizures or secondary to generalized tonic-clonic seizure.<sup>2-4</sup> Herein, we report an epileptic patient with reversible lesions in bilateral frontoparietal lobes.

## **Case report**

A 32-year-old, previously healthy man presented to us with a 2-week history of epileptic seizures. At onset, he experienced two episodes of focal aware epileptic seizures that manifested as left-arm convulsions. Both episodes lasted for approximately 2 to 3 seconds, and were followed by spontaneous recovery. There were no signs of altered sensorium. On the following day, he again experienced two episodes of focal aware epileptic seizures. On the third day after

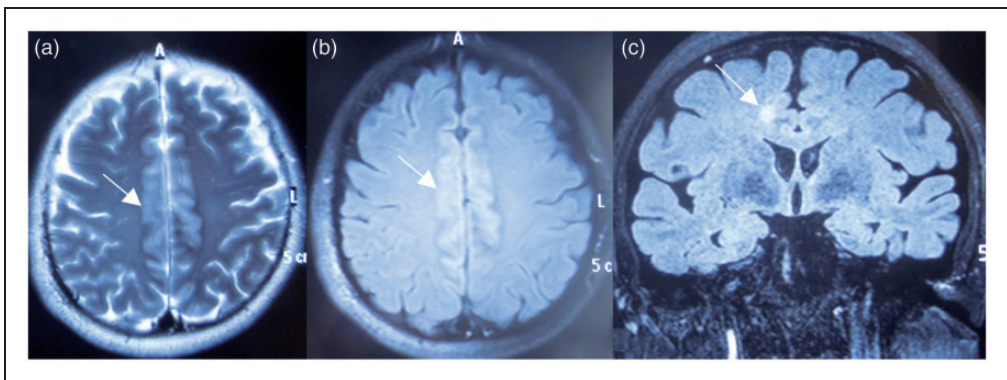
onset, the seizure progressed to generalized tonic-clonic seizure associated with turning of the eyes, flexion of the arms, extension of the legs, and asynchronous jerks of limbs, with tongue bites and loss of consciousness. There was no sphincter disturbance. The convulsion lasted for 1 to 2 minutes and was followed by spontaneous recovery, whereas the consciousness disturbance lasted for about 20 minutes. The patient complained of paresthesia in the left extremities. One week after onset, he experienced transient sensory loss in the left limbs, which lasted 2 minutes. There was no history of trauma, infection, or febrile convulsions. The family history was unremarkable. Neurological examination showed no abnormality. EEG showed sharp waves, sharp and slow wave complexes, and irregular  $\delta$  waves originating from the bilateral temporal lobes (predominantly on the left side). One week prior to admission, conventional MRI and brain magnetic resonance spectroscopy and angiography showed no abnormalities. Laboratory examinations, including blood and urine routine examination, hematological, biochemistry, coagulation profile, thyroid function, cerebrospinal fluid routine, cerebrospinal fluid immuno-antibodies, and tumor biomarkers were all normal. The autoimmune antibodies, including N-methyl D-aspartate receptor (NMDA-R), contactin-associated protein 2 (CASPR2), alpha-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptor 1 (AMPA1), AMPAR2, leucine-rich glioma inactivated 1 (LG11), and  $\gamma$ -aminobutyric acid receptor 2 (GABAR-2), were detected. The clinical manifestations of autoimmune encephalitis that can cause epilepsy are not specific. We tested the common autoimmune antibodies listed above. To exclude the possibility of a tumor, tumor markers were tested including carbohydrate chain antigen 242, alpha-fetoprotein, carcinoembryonic antigen, prostate-specific antigen, and squamous cell carcinoma antigen. Repeat brain

MRI on the second day after admission showed poorly-defined abnormal signals in the bilateral frontoparietal lobes, which appeared hypointense on T1-weighted imaging and hyperintense on T2-weighted imaging, fluid-attenuated inversion recovery (FLAIR) imaging, and short tau inversion recovery imaging (Figure 1). A diagnosis of generalized tonic-clonic seizure secondary to focal aware seizure was made. Antiepileptic therapy with oxcarbazepine (oral, 75 mg twice daily) was initiated. During the observation period, the patient remained seizure-free. Repeat MRI after 2 weeks showed persistence of the abnormal signals. However, after a follow-up period of 4 months, MRI showed complete resolution of the abnormal signals (Figure 2).

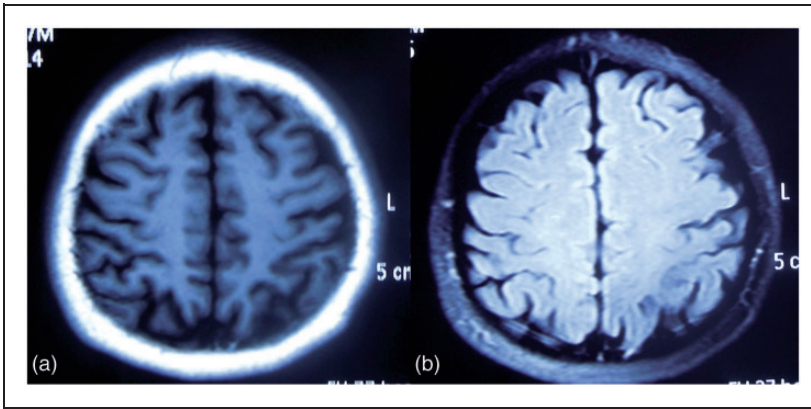
## Discussion

Neuroimaging, especially brain MRI, is widely used to rule out any structural cause of epileptic seizures; however, radiological changes during the periictal period have rarely been reported. Since the 1980s, cases have been reported of partial status epilepticus where patients developed

striking periictal focal cerebral edema that showed spontaneous resolution on serial computerized tomography scans along with neurological improvement.<sup>5,6</sup> The recent advances in MRI technology have greatly facilitated the diagnosis of central nervous system diseases, which led to the identification of TPMA in the context of status epilepticus. TPMA lesions usually appear hypointense on T1-weighted imaging and hyperintense on T2-weighted imaging, whereas the signal intensity can vary on diffusion-weighted imaging (DWI)<sup>7</sup> An increased DWI signal with decreased diffusivity is congruent with cytotoxic edema, and a decreased DWI signal with increased diffusivity demonstrates vasogenic edema.<sup>8,9</sup> Hong et al.<sup>10</sup> found DWI to be a sensitive modality for detection of focal edema following partial status epilepticus. Cytotoxic edema, as a result of  $\text{Na}^+/\text{K}^+$ -ATPase dysfunction and excessive release of excitatory amino acids, may increase membrane permeability and inhibit water diffusion. These changes typically manifest as high signal changes in the epileptogenic area on DWI. Nevertheless, vasogenic edema, as a result of acidosis triggered by seizure activity and the



**Figure 1.** Brain magnetic resonance imaging (MRI) on day 2 of hospitalization. Brain MRI shows poorly-defined abnormal signals in the bilateral frontoparietal lobes, which appear hyperintense on axial T2-weighted imaging (a), and axial (b) and coronal (c) fluid-attenuated inversion recovery (FLAIR) imaging.



**Figure 2.** Brain MRI at 4 months follow-up. Axial T1-weighted (a) and FLAIR (b) MRI reveals no abnormality.

breakdown of the blood–brain barrier, would facilitate water diffusion and appear as focal low signal changes on DWI.<sup>7,10</sup> The attenuation diffusion coefficient is indicative of cytotoxic edema. Several studies have shown a reduced attenuation diffusion coefficient in patients with focal status epilepticus.<sup>11,12</sup> In previous case reports, TPMA shows complete or partial resolution within days or weeks.<sup>4,13</sup> In the present case, we noted persistence of abnormal signals on repeat MRI performed 2 weeks after admission, and these abnormalities were found to have completely resolved on 4-month follow-up.

There is a robust topographic congruence between the clinical, EEG, and MRI findings in most cases. In the study of Xiang, perictal MRI abnormalities and electro-clinical findings in 10 of 14 patients showed an almost complete topographic concordance.<sup>7</sup> In more heterogeneous case series, including patients with different types of seizures affecting structures anatomically distant from the neocortical seizure focus, including the splenium of the corpus callosum and the contralateral cerebellar hemisphere and thalamus, the degree of this concordance is significantly lower.<sup>14</sup> A potential reason for this discordance is

seizure dynamics. The rapid seizure propagation from an epileptic focus can explain the nonconcordant topographic findings. In addition, pre-existing brain lesions, pharmacological interventions, and possible hypoperfusion or hypoxia may also contribute to the nonconcordance.<sup>7</sup>

The pathophysiological mechanism of TPMA is still unclear. Previous studies have suggested a potential link between focal seizures and high metabolic demands and a marked blood flow increase to the seizure focus.<sup>2</sup> Seizure activity can rapidly increase the metabolic demand and induce a significant increase in blood flow at the seizure focus, which may result in hyperperfusion and breakdown of the blood–brain barrier. Moreover, failure to compensate the focal glucose hypermetabolic demands may trigger anaerobic metabolism, and the subsequent release of lactate would cause further damage to the blood–brain barrier. In the initial days and weeks, vasogenic edema is reversible, and thus TPMA is usually a transient phenomenon. However, with the progression of seizures, an energy failure of the  $\text{Na}^+/\text{K}^+$ -ATPase pump may occur, and the ensuing water and  $\text{Na}^+$  influx to the cell could contribute to cytotoxic edema and irreversible neuronal death.<sup>10</sup>

In our patient, edematous lesions were observed in bilateral frontoparietal lobes. The differential diagnosis in this case included cerebral infection and intracranial venous thrombosis. All laboratory examinations and brain magnetic resonance angiography findings were normal in the present case, which was consistent with the preliminary diagnosis of TPMA. Accurate identification of TPMA is important, because this condition is liable to be misdiagnosed as the primary epileptogenic lesion.

In conclusion, this case illustrates the periictal radiological characteristics of epileptic seizures. It is important to be aware of the possibility of TPMA in patients with epileptic disorders, and to differentiate TPMA from a potential epileptogenic lesion on radiological examination.

### Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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