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Crossed Cerebellar Diaschisis in a Status Epilepticus Patient with Stroke-Mimicking Changes: A Case Report with Suboptimal Outcome

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Patient: Female, 45-year-old
Final Diagnosis: Epilepsy of combined genesis (structural and toxic)
Symptoms: Loss of consciousness • no verbal contact • tonic-clonic seizure
Clinical Procedure: Assisted ventilation • EEG • tracheostomy
Specialty: Neurology • Radiology

Objective: Rare disease

Background: Crossed cerebellar diaschisis is a rare phenomenon characterized by reduction of hemispheric cerebellar blood flow and metabolism that occurs contralateral to supratentorial injury. This finding is generally detected after ischemic stroke, but can also be observed during status epilepticus.

Case Report: A 45-year-old woman with a history of focal epilepsy and alcohol abuse presented with an episode of seizure with initial stroke-mimicking changes and no epileptiform activity on electroencephalogram. Upon further examination, the radiological findings revealed a broad cytotoxic edema in the left hemisphere and a smaller lesion in the right cerebellum, showing a rare phenomenon of crossed cerebellar diaschisis. Later, diagnosis of status epilepticus was established. Although the initial trend of the patient's condition was negative, after weeks of therapy and intensive care, the patient slightly improved in her condition and there was a partially reversible lesion in the left cerebral hemisphere and right cerebellum.

Conclusions: It is crucial to detect seizures in patients with stroke-like changes on unenhanced computed tomography examination, and especially in cases in which there are no arterial occlusion on computed tomography angiography and asymmetric arterial vasodilatation are seen. Status epilepticus can mimic stroke, establishing this as a major diagnostic challenge.

Although the radiological findings in the left cerebral hemisphere lesion and the right cerebellar hemisphere were similar, its characteristics on diffusion-weighted imaging and apparent diffusion coefficient value differed, raising an important question of the exact mechanics of how crossed cerebellar diaschisis occurs, as it seems to be a rare phenomenon.

Keywords: Brain Edema • Cerebellum • Diaschisis • Epilepsy, Tonic-Clonic • Seizures

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Background

Status epilepticus is a neurological disorder that demands immediate evaluation and treatment. This condition is described as a seizure that lasts more than 5 min or as a series of seizures in rapid order without complete neurological recovery in the interictal period, which heightens the risk of long-term neuronal consequences, for instance, functional deficits and neuronal injury [1,2]. Radiological findings of status epilepticus can vary and even mimic other diseases, for example, a stroke, which can prove to be a diagnostic challenge when establishing a proper diagnosis. Stroke-mimicking changes include various causes, such as metabolic derangements, seizures, complex migraine, central nervous system infections, sepsis, non-stroke cardiovascular events, and functional disorders. Thus, status epilepticus can mimic stroke, establishing this as a major diagnostic challenge [3].

Crossed cerebellar diaschisis is a rare phenomenon that is characterized by reduction of hemispheric cerebellar blood flow and metabolism that occurs contralateral to supratentorial injury, resulting in tissue hypoxia, anaerobic glycolysis, and cytotoxic edema [4,5]. Crossed cerebellar diaschisis is believed to develop due to excessive excitatory neuronal activity along the

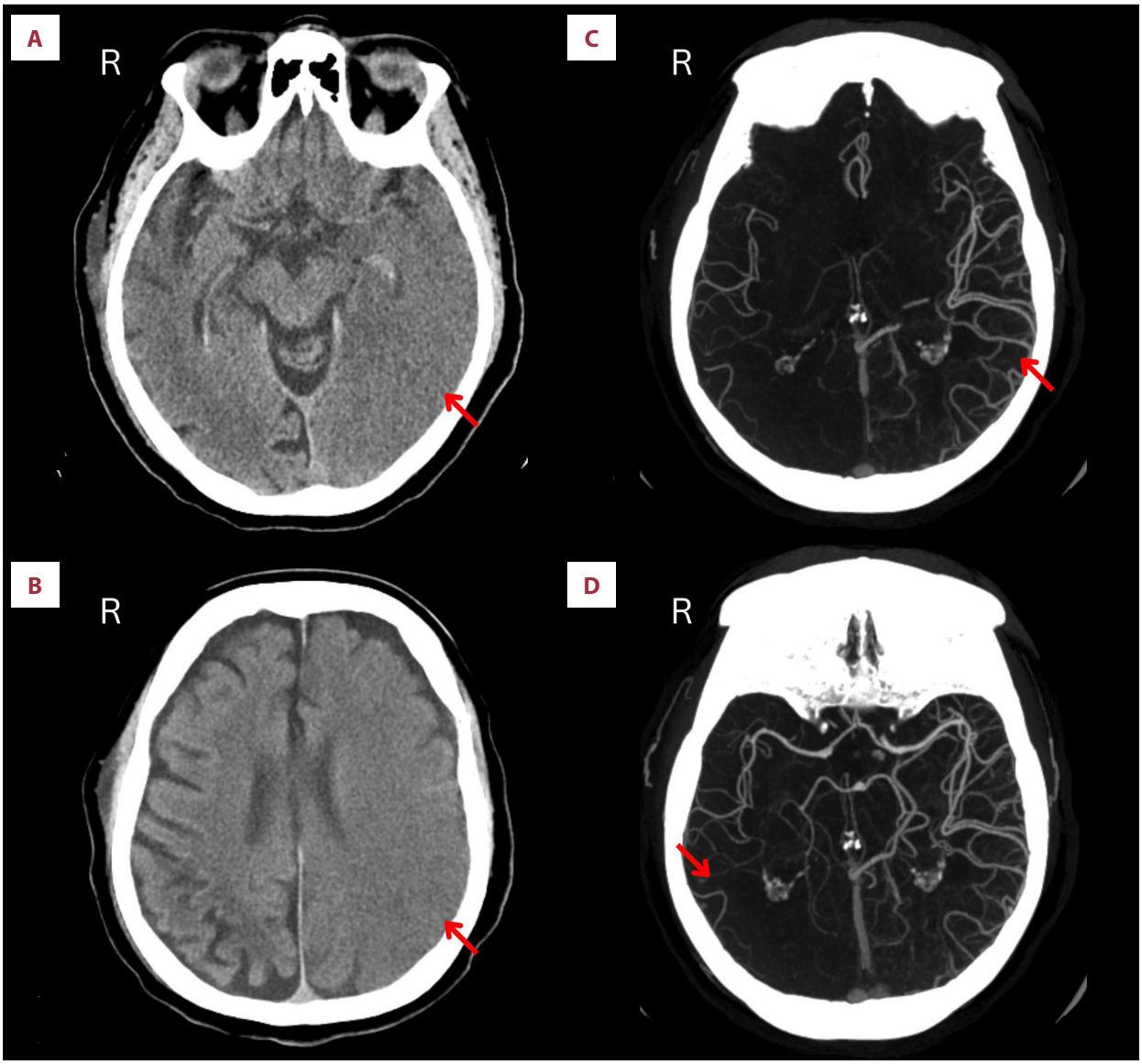

Figure 1. (**A, B**) Axial computed tomography brain scan showing mild hypodense acute ischemia zone throughout the left cerebral hemisphere, except the basal nuclei. (**C, D**) Angiography maximum intensity projection revealing more pronounced vasodilated cortical branches in the left middle cerebral artery than the right side with no conclusive data for lumen narrowing, double lumen fillings or pathological expansions.

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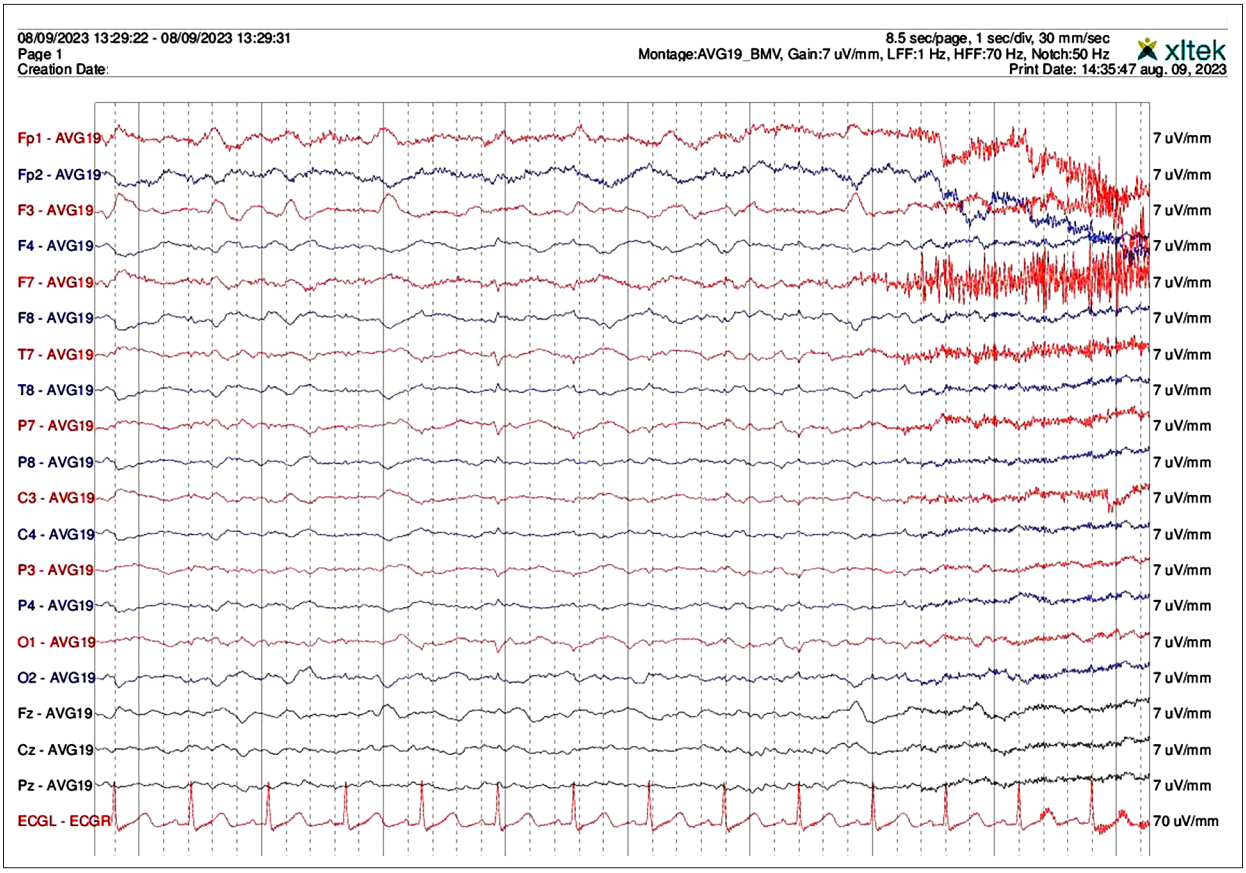

Figure 2. Day 4 electroencephalogram recording a disorganized diffuse background slowing in the theta spectrum. The forehead region of the left hemisphere showing epileptiform activity.

cortico-ponto-cerebellar pathways [6,7]. This finding is generally detected after ischemic stroke, but can also be observed during status epilepticus. As the neurological outcome can differ widely from full neurological recovery to persistent disability, early diagnosis and treatment are crucial [8].

In this article, we present a rare case report of a crossed cerebellar diaschisis lesion in a status epilepticus patient, with initial stroke-mimicking changes. Initially, the electroencephalogram (EEG) did not reveal typical findings for this particular diagnosis, with the lesion mimicking a stroke; however, after the deterioration of the patient's condition, the examinations were conducted repeatedly, and eventually the diagnostic test findings disclosed a peri-ictal edema and a crossed cerebellar diaschisis with status epilepticus. This clinical case illustrates the key radiological findings and shows an interesting outcome of a prolonged negative trend in the patient's condition.

Case Report

A 45-year-old woman was found in a state of generalized tonic-clonic seizure while having consumed large amounts of alcohol. No further information on the last known well time of the patient or the length of the seizure was available. The seizure was managed with diazepam 10 mg, after which she did not regain consciousness. Two months earlier, she had had a previous episode of focal seizure, with no lasting damage. It was also known that the patient had a long history of alcohol abuse. Upon admission, her condition was severe, with a Glasgow coma scale score of 7, blood pressure of 153/110 mmHg, and heart rate of 90 beats/min (tachycardia). The patient was unresponsive and only reacted to painful stimuli. To establish a better understanding of the possible damage, a computed tomography (CT) scan of the patient's brain was performed, revealing mildly hypodense acute ischemic zone throughout the left cerebral hemisphere, except for the basal nuclei (**Figure 1**). At first look, the lesion mimicked a stroke, but further examination of the brachiocephalic and intracranial vessels revealed no lumen narrowings, double lumen fillings, or pathological expansions. Nevertheless, the network of cortical branches in the left middle cerebral artery was more pronounced than in the right internal cerebral artery (**Figure 1**). After laboratory and CT results, an initial diagnosis of postictal confusion and a left ventricle overload was established. Myoclonic epilepsy was suspected as well, and the patient was

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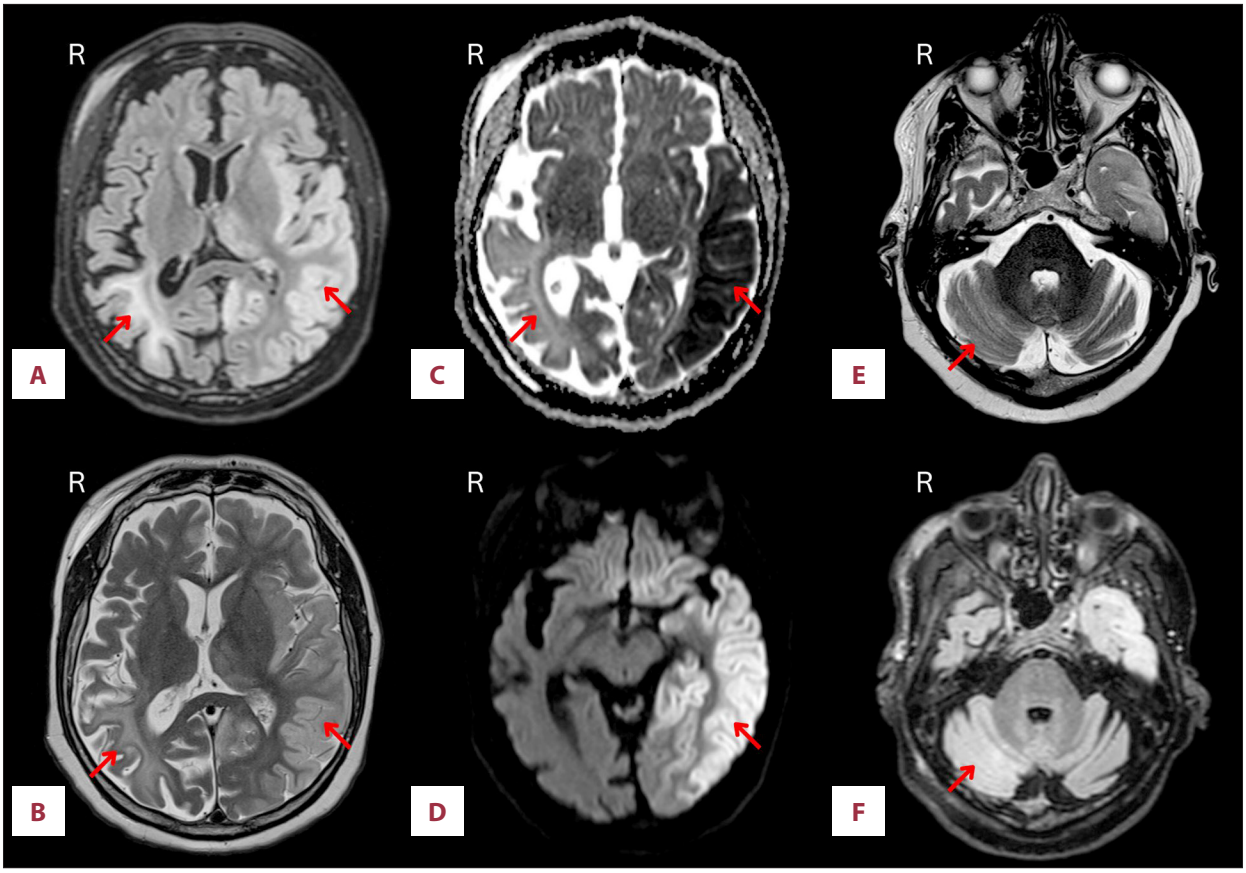

Figure 3. First axial magnetic resonance image. (**A**) FLAIR-weighted and (**B**) T2-weighted showing vasogenic edema throughout the left cerebral hemisphere including the temporal, occipital lobes, thalamus and hippocampus. On the right side an older deep peri-ictal lesion with atrophy from a previous seizure. (**C**) Diffusion-weighted apparent diffusion coefficient (ADC) and (**D**) diffusion weighted imaging (DWI) showing a decrease in ADC value and increased DWI signal throughout the left cerebral hemisphere and a slightly increased ADC value in the right cerebral hemisphere. As well as (**E**) T2-weighted and (**F**) FLAIR-weighted of cerebellum showing a small area of vasogenic edema in the right cerebellum, cortically affecting the amygdala as well, on the opposite side of the cerebral lesion – a crossed cerebellar diaschisis.

transported to the Neurology Department, where she started therapy of levetiracetam 2000 mg 2 times daily and carbamazepine 400 mg 3 times daily and thiamine 480 mg was added due to the patient's known history of alcohol abuse, high risk of vitamin B1 deficiency, and Wernicke encephalopathy. A higher dosage of levetiracetam was used because of the patient's severe condition and a suspected myoclonic epilepsy, or even status epilepticus. Also, the combination of levetiracetam and carbamazepine has shown good results in patients with focal structural damages of the brain, which were seen in this patient's case [9]. Further on, the choice of therapy was limited due to the patient having toxic liver damage and thrombocytopenia in her laboratory results; therefore, the doctors first choice of medications, such as sodium valproate, were not used.

Although the initial EEG upon admission revealed only diffuse background slowing, with lower amplitude in both the right hemisphere and left temporal region, epileptiform activity was registered only on day 4 of admission, increasing the suspicions of epilepsy as a diagnosis (**Figure 2**). To fully analyze the initial CT findings, brain magnetic resonance imaging (MRI) was performed on day 4, revealing an extensive peri-ictal edema throughout the left cerebral hemisphere, with an increased apparent diffusion coefficient (ADC) value and a small area of edema in the right cerebellar hemisphere, cortically affecting the amygdala as well, thus relating to crossed cerebellar diaschisis (**Figure 3**). Interestingly, there was also an older lesion in the right cerebral hemisphere showing scarring and atrophy, which, according to the patient's history, most likely was from a similar episode 2 months previously.

Her condition had a negative trend, and on day 6, her laboratory test results showed an increased inflammation marker, after which, a CT scan of her lungs revealed aspiration pneumonia. With that and the EEG revealing refractory status epilepticus, on

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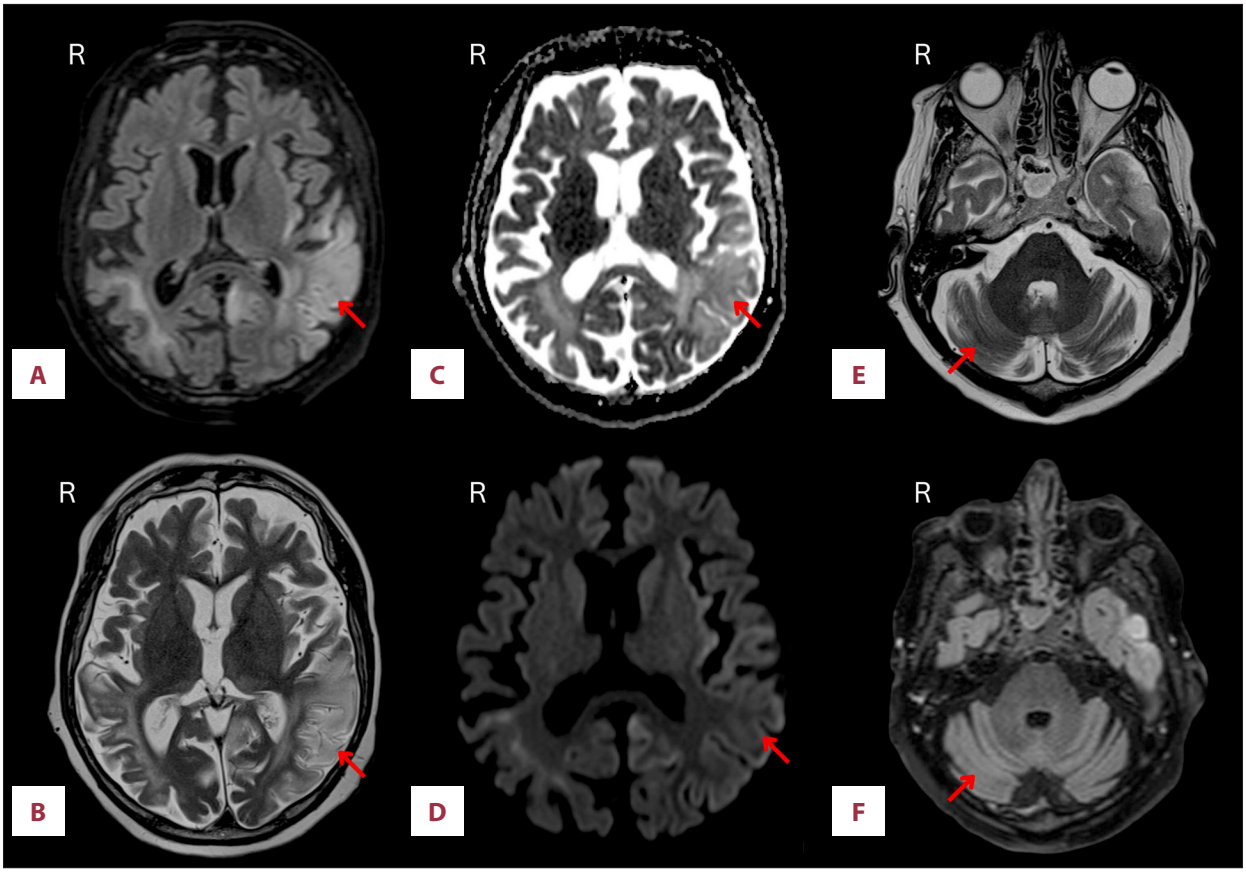

Figure 4. Second axial MRI (**A**) FLAIR-weighted and (**B**) T2-weighted showing a partially reversible post-ictal lesion on the left cerebral hemisphere with decreased size and intensity in comparison with the previous MRI. (**C**) Diffusion-weighted apparent diffusion coefficient (ADC) and (**D**) diffusion weighted imaging (DWI) revealing increase in ADC values and mimicking the intensity of the previous lesion on the right side and the (**E**) T2-weighted and (**F**) FLAIR-weighted of cerebellum with no longer visible right cerebellar lesion.

day 6 she was transported to the Intensive Care Unit for sedation, with assisted ventilation and antibacterial therapy of Augmentin 1.2 g 3 times daily. The patient's sputum and blood were taken for further microbiological analysis. After a few days, the patient showed signs of improvement, leading to the sedation being gradually withdrawn. With no sedation, the patient still required assisted ventilation, and a tracheostomy was performed on day 13. With gradual improvements, she regained spontaneous breathing on day 15, and on day 16, her EEG showed no signs of epileptiform activity. With this, the patient was cleared to be transported back to the Neurology Department on day 17. Upon assessment, the patient's condition was still serious. She was conscious but unresponsive to commands, fixed her view to the distance, occasionally moved her hands spontaneously, and reacted to painful stimuli with grimacing.

The patient continued the same antiseizure medication of levetiracetam and carbamazepine, and for the next few days, showed spontaneous movements in her eyes and legs, although the EEG still showed polymorphic slowing of the base rhythm on both sides of the brain. A follow-up CT scan on day 24 of the patient's lungs revealed no infiltrative changes, and the microbiological analysis of the sputum and blood revealed no bacteria. Furthermore, follow-up brain MRI was performed on day 26, three weeks after the initial scan, which showed that the previous changes in the left cerebral hemisphere have decreased in size and intensity, with no more decrease in ADC values. The lesion has completely disappeared in the right cerebellum (**Figure 4**), in comparison to the lesion seen on the first MRI, thus resulting in a partially reversible and suboptimal outcome. Since the patient showed small positive trends in her condition, there was little hope for a full recovery. Thus, the patient was dispatched to Social Services for further patient care and to continue her therapy.

Discussion

This case highlights both the diagnostic challenges of establishing a proper status epilepticus diagnosis and the rare finding

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of crossed cerebellar diaschisis that can occur with it. At first, the clinicians were unable to gather a full history of the patient due to limited medical records and her being unconscious. Even though she was found in a state of generalized tonic-clonic seizure, a proper assessment of the possible damages and causes needed to be done and a wide range of differential diagnosis to be considered. The initial CT scan showing stroke-mimicking changes (**Figure 1**) indicated that the cytotoxic edema present in the lesion caused a lack of oxygen. This was further supported by the asymmetrical arterial vasodilation in the left cerebral hemisphere (**Figure 1**), most likely as a response to the excited neurons and increased metabolism in them [10]. Stroke mimics are defined as acute onset of focal neurological symptoms, which are later diagnosed with a non-vascular origin. In the case of stroke mimics, it is important to analyze the vascular flow of the brain and look for lumen narrowings, double lumen fillings, or pathological expansions, which in the present case were all negative, thus excluding the possibility that the changes were of vascular origin [11].

The depression of the transneuronal cerebellar metabolism, apparent in crossed cerebellar diaschisis, develops as a consequence of interrupted cerebrocerebellar pathways and damage of the predominantly excitatory cortopontine-cerebellar projections [12,13]. The exact mechanisms of the crossed cerebellar diaschisis are unknown; however, in the present case, we could safely assume that the cytotoxic edema seen in the right cerebellar hemisphere (**Figure 3**) was caused by this phenomenon. Interestingly, although the lesion in the left cerebral hemisphere had partially healed and decreased in size and intensity, the right cerebellum had no lasting effects. This meant that the lesion, even though similar in the radiological examination, did not have any death of the neuronal cells. When analyzing the patient's ADC values and vascularity of the right cerebellum, there was no significant decrease in ADC values and no changes in vascular flow, indicating that, although the lesion persisted in the MRI scan, it had quite different characteristics, compared with the left cerebral lesion. This could perhaps mean that the cerebrocerebellar pathways had not conveyed the full effect of the epileptiform activity and might have conveyed only certain kinds of information through the cerebrocerebellar pathways.

On the second MRI, the ADC values of the left cerebral hemisphere had normalized, meaning that the rest of the lesion most likely was only partially reversible, and a further atrophy might occur. Similarly, the lesion in the right cerebral hemisphere, which most likely had occurred from a previous hospitalization 2 months prior, had partially reversible changes, thus raising the question if that lesion may have had another lesion in the left cerebellum, which might have been missed because no MRI was performed.

Conclusions

Status epilepticus is one of the leading causes of stroke-mimicking changes on CT, indicating it is an important differential diagnosis for cases with no arterial occlusion on CT angiography and asymmetric arterial vasodilatation. It is also crucial to perform a CT angiography scan in patients with the probable suspicion for stroke.

The diagnosis and radiological examinations performed in this case also highlight an interesting view of the mechanics behind crossed cerebellar diaschisis and what information it conveys in its connections. We can conclude that the effect of epileptiform activity in the left cerebral hemisphere did not fully convey the same severity of the lesion, as could be seen by the different ADC values and vascularization.

Department and Institution in Which the Work Was Done

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Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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