

Magnetic resonance imaging findings in brain resulting from high-voltage electrical shock injury of the scalp

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Abstract

We report a case of high-voltage electrical injury to scalp, focusing on the magnetic resonance imaging (MRI) findings in brain. A 51-year-old male suffered burns to the right side of scalp and loss of consciousness following electric shock. Brain abnormalities were detected on MRI taken 4 days after the insult. Right parietal lobe neuroparenchyma beneath the scalp burn defect demonstrated homogeneous hypointensity on T1-weighted MR images, while T2-weighted images depicted hyperintensity mainly in white matter forming finger-like projections. Follow-up MRI showed that the abnormality had disappeared, indicating that the cerebral edema was reversible.

Key words: Brain imaging; electrical burn; electrical injury

Introduction

Electrical injuries are increasing worldwide and occur commonly in children and young adults. The incidents among utility or construction workers tend to be high-voltage accidents, while among children low-voltage exposures are commoner. A smaller group includes electrical injury due to lightning strikes. Of late, more number of injuries are being evaluated with magnet resonance imaging (MRI).^[1] Therefore, in the relevant clinical scenario, recognizing the imaging characteristics of electrical injury is important, both for its relevance in investigating sequelae to electrical injuries and to differentiate these imaging appearances from other disease processes.

Case Report

A 51-year-old gentleman suffered an accidental electrical shock on his scalp region while working with a high-voltage line as part of his occupation. Eyewitnesses claim he lost consciousness for about an hour. He suffered burns on the right side of scalp and both hands and feet. He was evaluated at a peripheral emergency department and was later referred to our institution. Four days after the incident, the patient underwent initial brain MRI. MRI demonstrated homogeneous hypointensity on T1-weighted (T1W) [Figure 1], while T2W [Figure 2A] and FLAIR [Figure 2B] depicted hyperintensity mainly in white matter. The T2W/FLAIR hyperintensities formed finger-like projections in the subcortical white matter beneath the scalp burn defect. No evidence of restricted diffusion [Figure 3] or blooming

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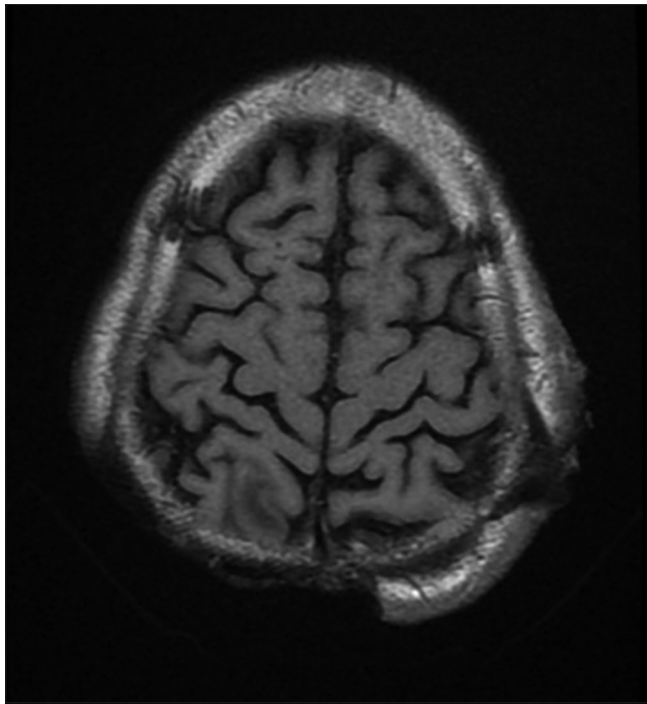


Figure 1: Axial T1W image showing homogeneous hypointensity in the right parietal lobe white matter beneath the scalp burn defect

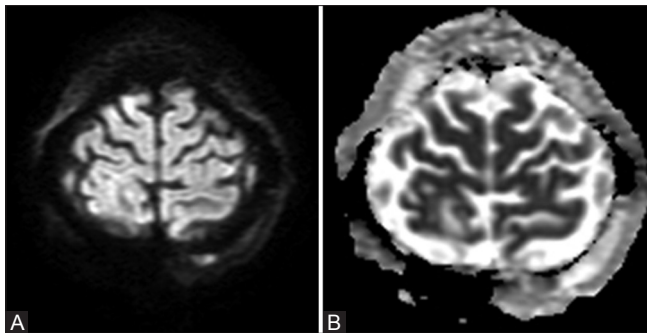


Figure 3 (A and B): No restricted diffusion evident in the abnormal area

on gradient recalled echo (GRE) sequences [Figure 4] was noted. In addition, a few punctate foci of nonspecific T2W/FLAIR hyperintensities were seen within the deep white matter of bilateral fronto-parietal lobes.

With corroborative history, matching scalp and site-specific neuroparenchymal changes, the diagnosis of electrical shock injury to scalp and brain was made. Based on the imaging findings in neuroparenchyma alone, differential diagnosis of subacute ischemia, encephalitis, and underlying mass lesion should have been considered. But the pertinent history emboldened us to defer contrast-enhanced examination or cerebrospinal fluid study and instead keep the patient on follow-up.

The patient was discharged soon after. MRI obtained 2 months after the insult showed complete resolution of the right parietal lobe white matter T2W/FLAIR signal

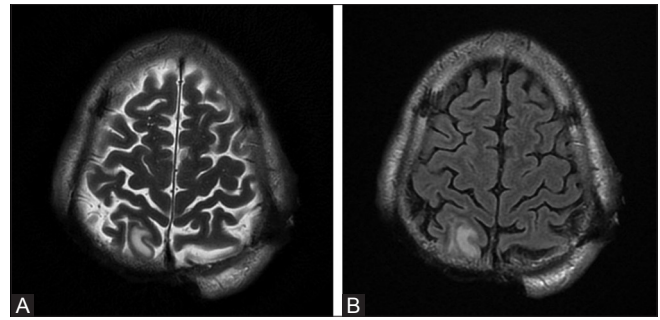


Figure 2 (A and B): Axial T2W (A) and FLAIR (B) images showing hyperintensity mainly in white matter forming finger-like projections in the right parietal lobe beneath the scalp burn defect

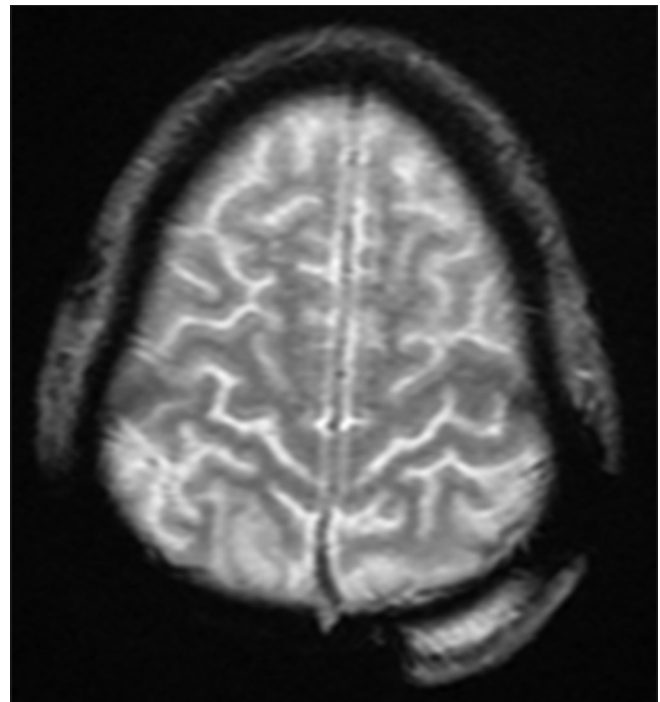


Figure 4: No blooming in the right parietal lobe beneath the scalp burn defect

intensity abnormality without evidence of significant volume loss [Figure 5A and B], leading us to conclude that the patient's imaging findings represented a transient cerebral electrocution injury.

Discussion

The evaluation of cerebral electric injuries^[2] is limited due to the sporadic nature of electrical injury. The available literature mostly consists of case reports^[3,4] and animal experiments. Radiology plays an important role in the investigation for these kinds of accidents. The mechanisms by which electricity causes bodily injury are not completely defined but include several pathways. The most important is thermal,^[5] when current passing through the victim producing large quantities of heat resulting in external and internal burns. In another postulated mechanism

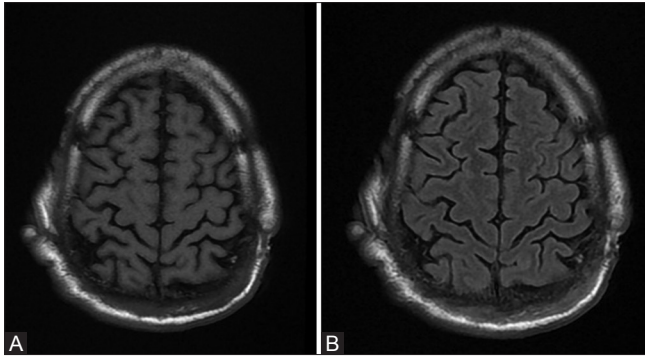


Figure 5 (A and B): Follow up MRI after two months on Axial T1W(A) and FLAIR(B) images showing complete resolution of altered signal intensities in the white matter of right parietal lobe

called electroporation,^[5] membrane proteins permanently change their structural arrangement and can no longer maintain transmembrane ion gradients, resulting in cell death. In addition, the actual physical forces involved in the injury (i.e., a person loses consciousness and falls from a height as a part of occupation) can injure the victim.

In 1995, Cherington^[6] classified electrical injuries into four groups, which helps in understanding electrical injuries, as well as in guiding appropriate imaging.

Immediate and transient: This includes injuries which are evident immediately after the event and they include confusion, paresthesia, amnesia, loss of consciousness, and weakness. These injuries most often resolve within minutes to hours. Computed tomography (CT) of brain is almost negative universally. There are case reports with MRI demonstrating T2W abnormalities consistent with the neurologic symptoms. Follow-up imaging is not performed in most of the cases, but when obtained, the T2 abnormalities seem to partially resolve. As in our patient, imaging obtained 2 months after the insult showed complete resolution of the T2 signal intensity abnormality without significant volume loss.

Immediate and prolonged or permanent: These types of injuries are less common but are debilitating. They include neuronal chromolysis, glial proliferation, hemorrhage, and infarction. The length and severity of the insult, as well as the path of the electricity in the human body are the factors contributing to this category.

Delayed and progressive: This is difficult to categorize clinically. These injuries are also debilitating and receive

disproportionate findings on MRI. Various conditions have been reported including myelopathy, basal ganglia disorders, and motor system diseases. They mostly carry a poor prognosis.

Event-associated injuries: This category is important radiologically and include trauma following the insult or hypoxic injuries in brain due to cardiac arrest.

Conclusion

Electrical shock injury produces characteristic reversible neuroparenchymal signal intensity alterations, which in the appropriate clinical setting is more or less diagnostic. Follow-up imaging helps to detect resolution of imaging findings, thus confirming the benign nature of the signal intensity alterations.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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