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CASE IMAGE

Injury to the circuit of Papez: An overlooked cause of recurrent seizures

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Key Clinical Message

Papez' circuit is a unique neural pathway in the limbic system that is correlated with seizure activity. Injuries affecting Papez' circuit are often small and unusual in location but can be identifiable in MRI and functional imaging modalities, which can be helpful in the workup of refractory epilepsy.

Abstract

The Papez circuit is a unique neural pathway in the limbic system of the brain. We review a patient presenting with recurrent seizures as the main manifestation of Papez' circuit pathology. The radiologic features of ischemia involving the mammillothalamic tract in Papez' circuit were correlated with the seizure activity.

KEYWORDS

cerebral ischemia, hippocampus, limbic system, mammillothalamic tract, Papez' circuit, seizure

1 | CASE REPORT

A 17-year-old previously well-female presented with recurrent generalized tonic–clonic seizures lasting for a minute with postictal confusion. On examination, there were no focal neurologic deficits. Electroencephalogram (EEG) showed postictal changes, without specific epileptiform discharges. Brain MRI demonstrated an abnormal signal in the left anterior thalamic region and mammillothalamic tract (MTT) denoting chronic lacunar infarction (Figure 1). There was associated atrophy of the left mamillary body and fornix suggesting transsynaptic degeneration. Diffusion tensor imaging demonstrated a significant decrease in the tracts number of left Papez' circuit compared with the right side.

2 | DISCUSSION

The Papez' circuit is a closed cerebral neural circuit, starting from the hippocampus, then coursing through the fornix, mammillary body (MB), MTT, anterior nucleus of the thalamus (ATN), cingulum, entorhinal cortex/parahippocampal gyrus then back to hippocampus.[1] It was reported that the circuit is associated with learning, memory, and emotion functions as well as seizure activity. Using the convulsant toxin pentylenetetrazole in animal models was helpful in recognizing the role of MTT and MB as an important pathway in seizure propagation to the thalamic anterior nucleus and frontal cortex.[1,2] On MRI, the MTT can be identified on axial and coronal T2-weighted sequences as thin craniocaudally

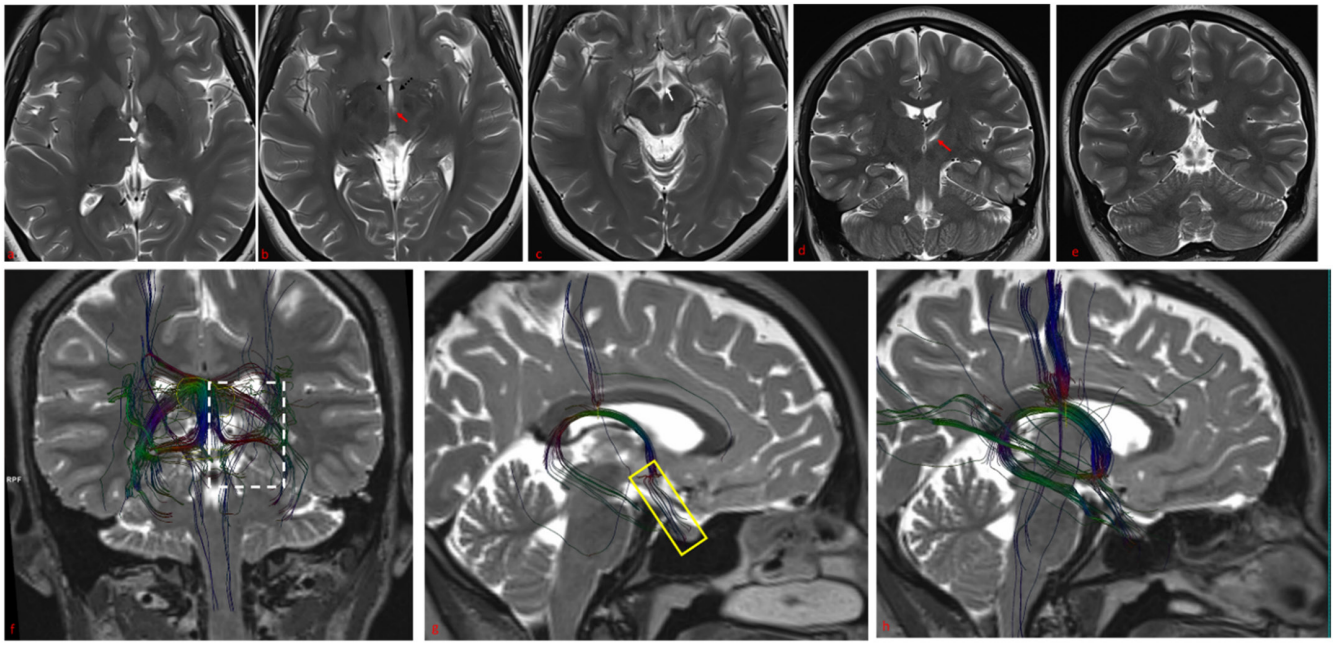

FIGURE 1 Axial T2-weighted (A) magnetic resonance imaging shows left anterior thalamic hyperintense (arrow) chronic infarction. Inferior axial T2-weighted images (B, C) show left mammillothalamic tract hyperintensity (red arrow) and atrophic left mammillary body (white arrow). Anteriorly, column of the left fornix is atrophic (dashed arrow). Note normal right-sided structures (black arrowhead). Coronal T2-weighted images (D–E) show abnormal signals in the left mammillothalamic tract (red arrow), and atrophic left fornix crus (white arrow). Diffusion tractography coronal (F), left (G), and right parasagittal (H) images demonstrate a decrease in the left Papez' circuit (dashed rectangle) and mammillothalamic tracts (yellow rectangle).

oriented low-signal white-matter tracts on either side of the midline, posterior to the slightly larger hypointense columns of fornix.[1] In our case, the seizure activity was attributed to an abnormality in the Papez' circuit based on MRI features of chronic infarction in the left ATN and MTT, atrophic left mamillary body, and fornix, along with the diffusion tractography findings of decreased tracts of left Papez' circuit. It was suggested that the extensive neural connections between ATN and medial temporal lobe structures might explain the role of Papez' circuit abnormalities in the propagation of seizures.[3] In a case report of an adolescent with recurrent complex partial seizures, the imaging findings included atrophied right MB, anteromedial thalamus encephalomalacia, and gliosis of the MTT.[4] Similar to our case, the absence of hippocampal abnormality was suggestive of MTT pathology. The MRI abnormalities seen in the MTT and MB were assumed to be due to transsynaptic degeneration after thalamic infarct. Transsynaptic degeneration occurs due to separation of the distal axon from its metabolic supply from the soma.

There is a paucity of literature data on the relationship between Papez' circuit abnormality and EEG recordings. No specific epileptiform discharges were noted in our case. Though, it was reported that theta rhythm is correlated with the strong connection between the ANT and the hippocampus in propagating seizures.[5] In a recent case report of intractable temporal lobe epilepsy,[6] stereotactic EEG monitoring demonstrated the reciprocal effect of endogenous epileptiform potentials starting in the hippocampus, which retrogradely propagated in the Papez' circuit toward the thalamus.

Injuries affecting Papez' circuit are often small and unusual in location. A better understanding of the functional anatomy of Papez' circuit is crucial to identify related injuries in MRI as an epileptogenic focus. Also, identifying MTT radiologically is important for planning potential epilepsy treatments, like deep brain stimulation.

AUTHOR CONTRIBUTIONS

Loai Aker: Conceptualization; writing – original draft; writing – review and editing. **Surjith Vattoth:** Conceptualization; formal analysis; writing – original draft; writing – review and editing. **Yahya Paksoy:** Conceptualization; formal analysis; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors do not have any financial relationship with any commercial organization that may have a direct or indirect interest in the content. The authors do not have a conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy. No patient identifier will be disclosed in the case presentation or attached images. A consent form can be provided to the editor upon request.

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