Edge-Enhancing Gradient Echo MRI at 7T for Detection of Focal Cortical Dysplasia in Epilepsy

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CONFLICT OF INTEREST

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BACKGROUND

- Focal cortical dysplasia (FCD) is a common resected epileptogenic lesion in children and in adults

- A majority of Type I FCD remain undetected on imaging, as well as a large number of Type II FCD

- 3D-Edge Enhancing Gradient Echo MRI (EDGE) is a promising new method of identifying FCD

BACKGROUND

- Gains in contrast-to-noise ratio (CNR), signal-to-noise ratio (SNR), and spatial resolution using 7T MRI should further enhance the utility of EDGE

- Sensitivity to the optimal inversion time makes translation to 7T challenging given the extreme non-uniformities in the transmit field (B1+)

HYPOTHESIS

By utilizing a combined MP2RAGE-EDGE sequence, the efficiency of the acquisition can be optimized to improve SNR and B1+ transmit uniformity.

METHODS

- We used a combined MP2RAGE-EDGE sequence for diagnosis of FCD in epilepsy with 7T EDGE MRI

- Select patients were chosen to illustrate the spectrum of FCD as seen on 7T EDGE.

- All subjects were scanned on a 7T Siemens Terra MRI with a 32Rx/8Tx head coil operating in parallel-transmit mode with B1 shimming
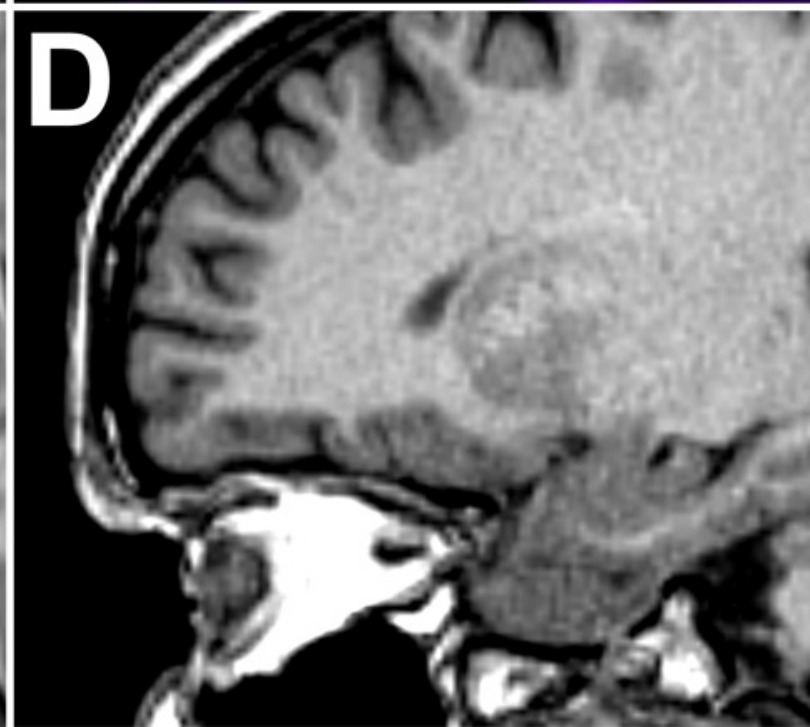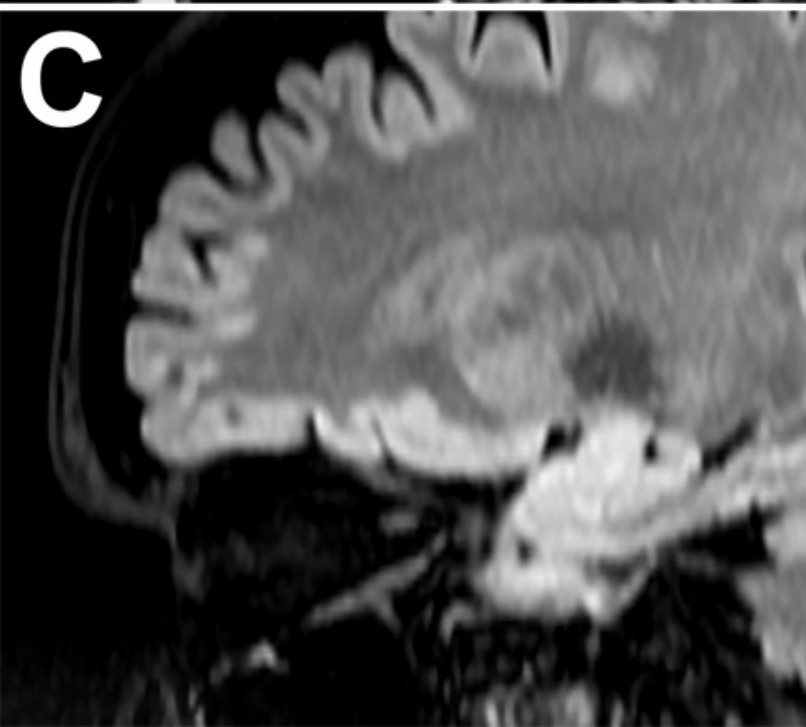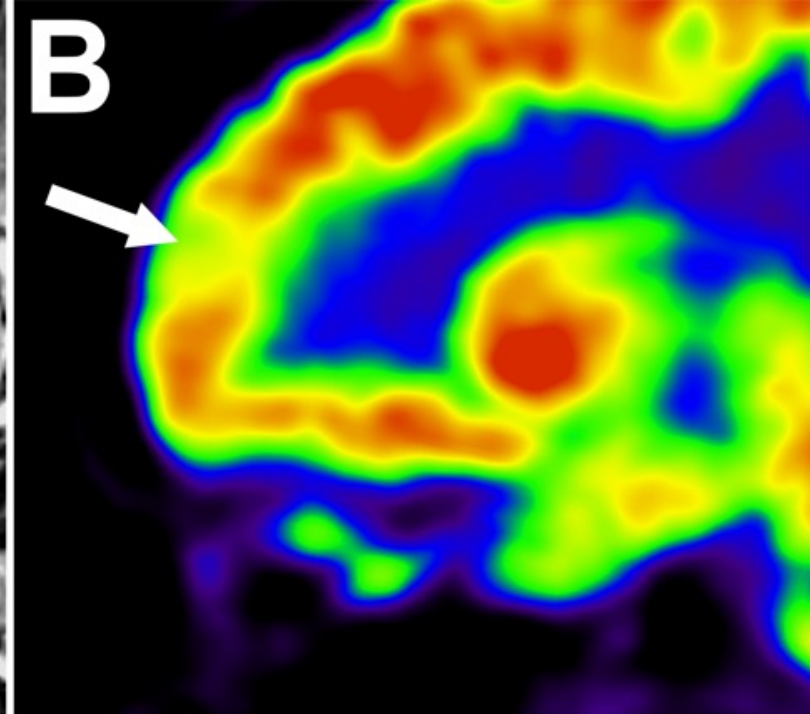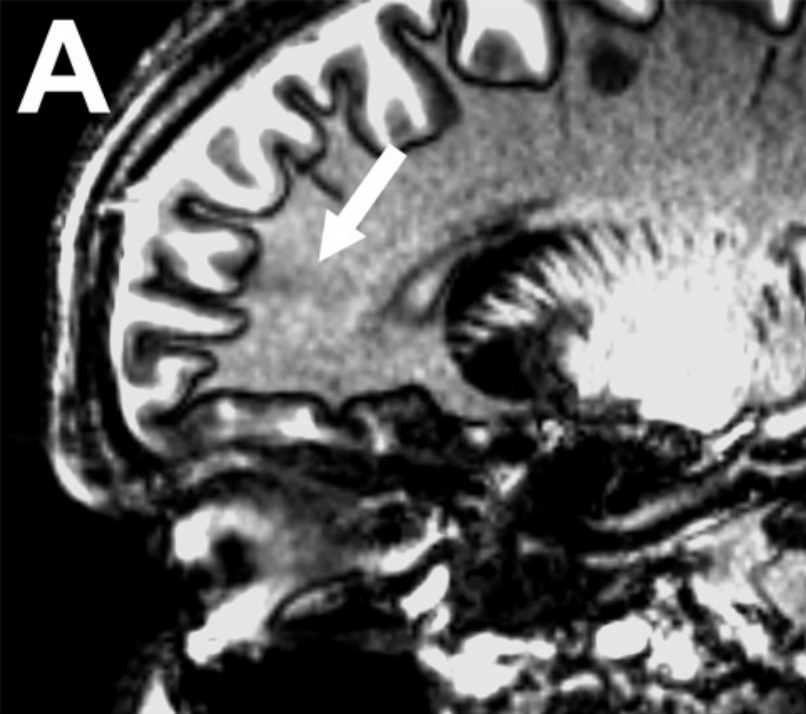
PATIENT 1
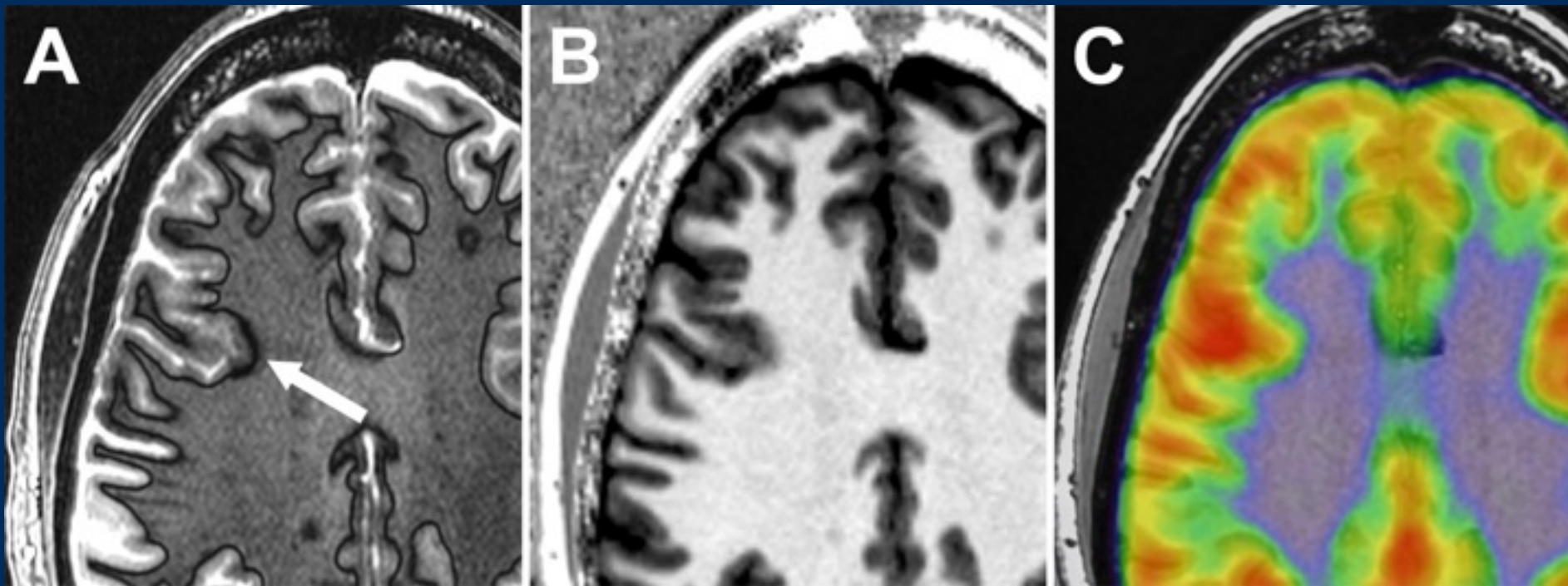
(A) Axial 7T EDGE image showing clear thickening and blurring of the GM-WM boundary line (arrow) of the base of the posterior right inferior frontal sulcus. (B) Axial 3T MP2RAGE T1-weighted uniform image does not clearly show the lesion. (C) Axial FDG-PET/MR fails to reveal the lesion without corresponding hypometabolism.

PATIENT 2

(A) Sagittal 7T EDGE image shows subtle hypointense subcortical band (arrow) extending to the ependymal surface of the lateral ventricle. (B) Sagittal FDG-PET shows focal neocortical hypometabolism (arrow) in the same region. (C) Sagittal 3T FLAIR and (D) MPRAGE fail to show the lesion.

PATIENT 3
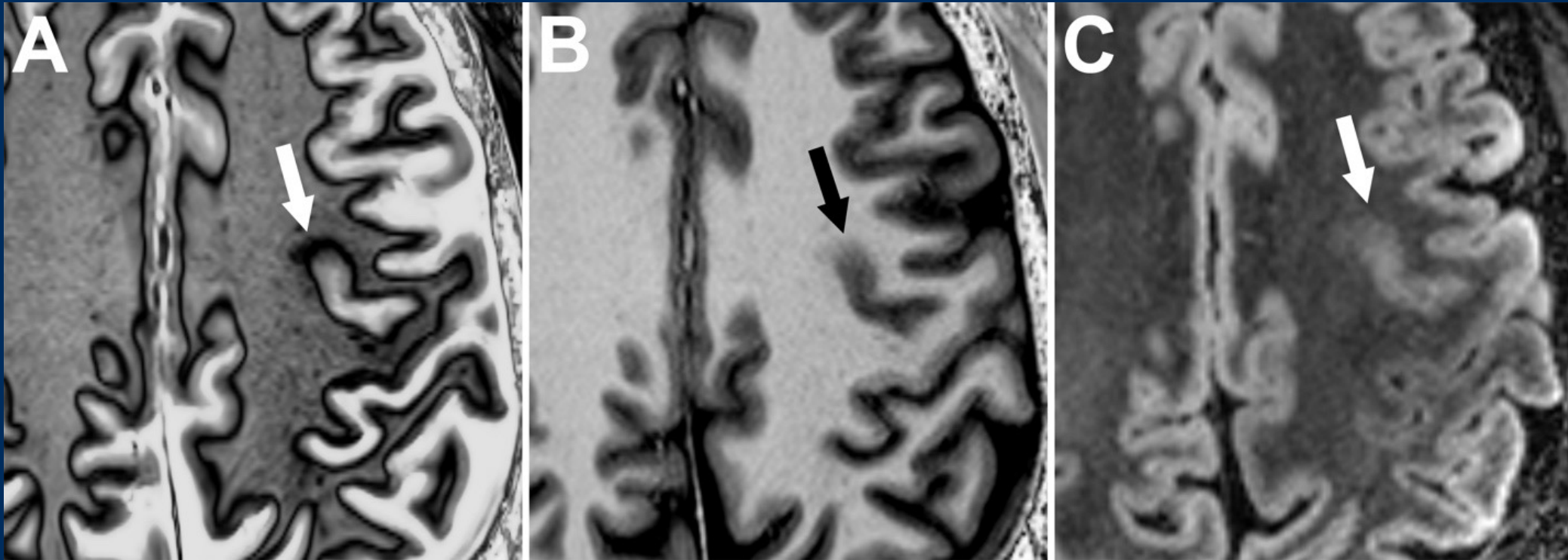
(A) Axial 7T EDGE shows thickening of the GM-WM boundary line in the left superior frontal sulcus (arrow) consistent with FCD. Axial (B) 7T MP2RAGE T1-weighted uniform image and (C) FLAIR show more subtle blurring of the GM-WM junction (arrow).

RESULTS

- 7T EDGE-MP2RAGE sequences detected previously unnoticed presumed FCDs in patients with normal 3T MRI scan.

- Higher SNR at 7T resulted in enhanced resolution (0.8 mm isotropic vs. 1.0 mm isotropic) and nearly doubled SNR compared to 3T EDGE.

- Careful optimization led to more uniform images, enabling imaging of challenging areas like the basal temporal lobe.

SUMMARY

- EDGE-MP2RAGE enhances the detection of gray matter-white matter abnormalities

- EDGE-MP2RAGE represents an integral time-efficient part of a 7T epilepsy protocol in patients with drug-resistant focal epilepsy.

QUESTIONS

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