PRESURGICAL MAPPING OF THE LGN AND VISUOTOPIC ORGANIZATION OF THE PRIMARY VISUAL CORTEX USING FMRI

Paige-Ashley S. Campbell¹, John Collins², Shasha Wu³, Sandra Rose³, James X. Tao³, Peter C. Warnke⁴, Naoum P. Issa³

1. Pritzker School of Medicine
2. Dept. of Radiology, University of Chicago
3. Dept. of Neurology, University of Chicago
4. Dept. of Surgery, section of Neurosurgery, University of Chicago
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• Resective surgery is the preferred treatment in medically refractory focal-onset epilepsy.
• However, visual field defects are common complications, especially with anterior temporal lobectomy.
• With the development of laser interstitial thermal therapy (LITT) the risk to the visual system is potentially more significant since the lateral geniculate nucleus (LGN) is near the hippocampus and can be lesioned during ablation of mesial temporal lobe structures.
• Given the risk of complete hemianopia with its ablation, a functional method for identifying the LGN is needed
METHODS

fMRI was performed to identify visual structures in patients undergoing presurgical planning for medically refractory epilepsy.

Two patients had cerebral cavernous malformations in or near the visual pathways, and three had mesial temporal lobe epilepsy.

Images were acquired in a Philips 3T MRI scanner during visual stimulation. Visual stimuli consisted of flickering monochrome checkerboard patterns. For visuotopic mapping images were restricted to subsets of the visual field.

The location of the LGN was identified based on visually driven BOLD signal responses in the expected region of the LGN, and was confirmed by diffusion tensor imaging (DTI).
RESULTS

- Different visual stimuli produced activation in adjacent regions of the occipital cortex, outlining the visuotopic organization of the primary visual cortex.

Figure 1. Visuotopic mapping of primary visual cortex. A. fMRI activity in primary visual cortex to stimuli with different polar angle. B. fMRI activity in primary visual cortex to stimuli with different eccentricity. The 3rd column shows the regions of the visual field that activated the correspondingly colored portion of primary visual cortex.
• While DTI failed when the anatomy of Meyer’s Loop was abnormal, functional mapping was able to identify the location of the LGN.

Figure 2. fMRI responses in the LGN from three patients. A, B. Axial sections showing activation in the primary visual cortex as well as at the expected location of the LGN on both sides. C. Coronal section showing activation in the expected location of the LGN on the right, with activation on the left in a similar location but with abnormal (post-surgical) temporal lobe anatomy that prevented reconstruction of optic radiations.
RESULTS

• The combination of fMRI and DTI was able to consistently identify the LGN during clinical imaging for presurgical planning.

Figure 3. Colocalization of LGN using fMRI and DTI reconstruction of the optic radiations. A. Visual fMRI responses from a patient showing activation in the primary visual cortex and the expected locations of the LGN on both sides. B. Reconstruction of the optic radiations from DTI images. C. Overlay of fMRI responses (A) and optic radiations (B) showing that the two techniques identify the same locations as the LGN.
DISCUSSION

• DTI has been used to identify the LGN but is complicated by the curvature of Meyer’s loop and often provides only a probabilistic estimate of LGN location.

• fMRI identification of the LGN can be done without complex post-acquisition analysis and is complementary to DTI data.

• The combination of fMRI and DTI increases confidence in the localization of visual structures that should reduce the likelihood of postoperative visual field defects when used in planning for stereotactic approaches like LITT and high-intensity focused ultrasound (HIFU).


