MEG-Constrained High Resolution Surface Coil MR Imaging and Single Voxel Proton MR Spectroscopy Evaluation of Refractory Extratemporal Epilepsy

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Purpose
Surgical resection of an epileptogenic focus is considered when drug therapy fails to control seizures. Identifying a cortical abnormality with MR imaging is more predictive of successful surgical outcome than scalp EEG localization or invasive monitoring. It is time intensive and difficult to carefully examine the entire brain with high-resolution MR imaging or spectroscopy. Constraining the search to regions most likely to contain the epileptogenic focus should improve the probability of successfully identifying anatomical lesions. MEG sensitively detects interictal epileptiform activity. Magnetoencephalography (MEG) directed high-resolution surface coil MR imaging and MR spectroscopy (MRS) may identify occult surgical lesions in "nonlesional" extratemporal epilepsy patients, and provide more accurate preoperative localization than surface EEG and semiology alone.

Materials & Methods
Seven patients (3 males and 4 females, median age 18.5 years, range 10 to 36 years) were evaluated. MR imaging and MRS findings were correlated with semiology and EEG. One patient with benign Rolandic epilepsy (BRE) was studied to validate the research protocol. Six patients with medically refractory nonlesional extratemporal epilepsy underwent high resolution 3D T1 SPGR and T2 FSE surface coil MR imaging and single voxel proton MRS over the regions of focal clustered MEG epileptiform activity and homologous contralateral locations. These same locations also were evaluated in seven normal volunteers to establish normative MRS data. Statistical significance of MRS metabolite ratio differences was evaluated using the t-test and ANOVA.

Results
MEG identified focal interictal extratemporal epileptiform activity in all seven patients. High-resolution MR imaging and MRS were normal in the BRE patient. Eight epileptiform clusters (5 frontal, 2 neocortical temporal, and 1 parietal) and the homologous contralateral locations were examined in the six medically refractory patients. High-resolution MR imaging revealed subtle frontal heterotopia correlating to MEG-identified epileptiform activity in one patient that had been occult on multiple prior conventional MR studies. No anatomical abnormalities were identified in the remaining five patients. MRS revealed a consistent trend toward decreased NAA/Cr ratio on the epileptic sides compared to the control sides and normative data that did not reach statistical significance (P = 0.3). The neocortical temporal Cho/Cr ratio was statistically significantly higher (P < 0.009) over the epileptiform focus than either the control side or
normative data. In the frontal and parietal lobes, the Cho/Cr ratio was not significantly different between the epileptic side and either the control side (P = 0.31) or normative data (P = 0.26).

Conclusion
Surgical outcome for nonlesional extratemporal epilepsy is especially disappointing, and identifying a lesion substantially improves the probability of a good or excellent surgical outcome. Using MEG to constrain a high resolution MR imaging evaluation can identify occult lesions in this difficult patient population. MR spectroscopy was not helpful for lateralizing the epileptogenic focus. Although the NAA/Cr ratio trended toward reduction on the epileptic side, the difference did not reach statistical significance. An elevated Cho/Cr ratio may indicate gliosis or increased membrane turnover on the epileptic side, but reached statistical significance in the neocortical temporal lobe only.

References