Spikes, Slowing, and Functional Connectivity: Multimodal MEG in Epilepsy Surgery

Dario J. Englot MD PhD; John David Rolston MD PhD; Doris D. Wang MD, PhD; Heidi E. Kirsch; Srikantan S. Nagarajan Ph.D.; Edward F. Chang MD

University of California, San Francisco

CNS 2016 ANNUAL MEETING San Diego CALIFORNIA SEPTEMBER 24-28, 2016

Introduction

Potential uses of magnetoencephalography (MEG) to help noninvasively identify the epileptogenic zone (EZ) in epilepsy surgery and predict seizure outcome include: i) epileptic spike localization, ii) slow wave lateralization, and iii) measurements of resting-state functional connectivity. This study evaluates multimodal MEG techniques to aid the presurgical evaluation of patients with intractable focal epilepsy.

Methods

We studied 132 focal epilepsy patients who received MEG followed by resection at our institution (follow-up mean = 3.6 years). Interictal spike mapping was performed using dipole source modelling, and MEG/EEG recordings were evaluated for prominent asymmetric slowing (1-4 Hz). In 61 adults without invasive lesions, functional connectivity maps were generated.

Results

Interictal spikes were modelled in 78% of 132 patients, and among those with successful modelling, MEG findings were concordant/specific to the region of resection in 66% of patients (Fig. 1). Whereas 85% of patients with concordant/specific MEG spikes became seizure-free, this outcome was achieved by only 37% of individuals with non-specific or discordant MEG spikes (Fig. 2; $p < 0.001$, Chi-square).

Asymmetric large-amplitude slowing was observed on interictal MEG recordings in 16% of 132 patients, and lateralized to the EZ in all but one (95%) patient (Fig. 3). MEG was significantly more sensitive for asymmetric slowing than EEG, as lateralized EEG slowing was only present in 52% of individuals with MEG slowing, and none of the patients without MEG slowing had asymmetric EEG slowing (Fig. 4; $p < 0.001$, Chi-square). Finally, patients with increased regional functional connectivity within the resection site (eg, Fig. 5) were more likely to achieve post-operative seizure freedom (88%) than those with neutral (64% seizure free) or decreased (48% seizure free) connectivity (Fig. 6; $p < 0.02$, Chi-square).

Conclusions

Multimodal use of MEG offers a novel and valuable approach for noninvasive localization of the EZ and prediction of seizure outcome in epilepsy surgery.

Learning Objectives

1) Understand multiple potential uses of magnetoencephalography (MEG) in presurgical evaluation of epilepsy patients;
2) Understand the strengths and weaknesses of MEG in localizing the epileptogenic zone;
3) Appreciate the value of MEG in predicting post-operative seizure outcome.

Fig. 1: MEG Spike Concordance

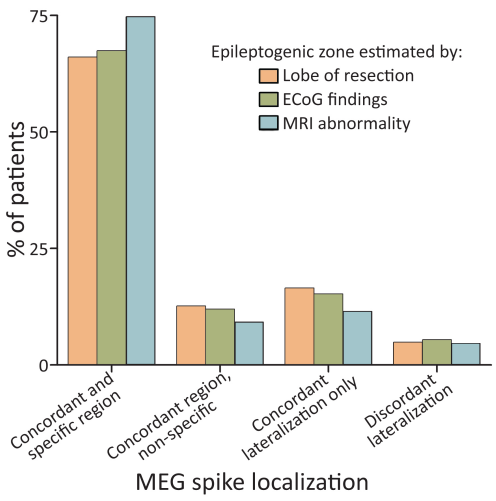

Fig. 2: Spikes and Seizure Outcome

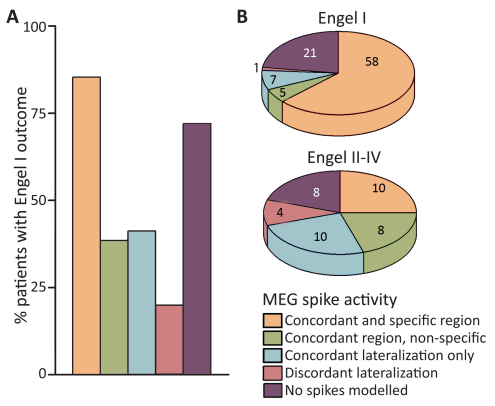

Fig. 3: Large Amplitude MEG Slowing

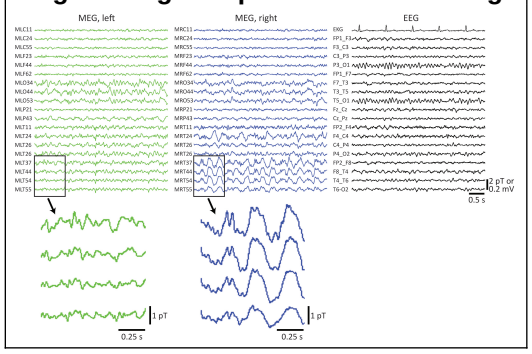

Fig. 4: MEG vs. EEG Slowing

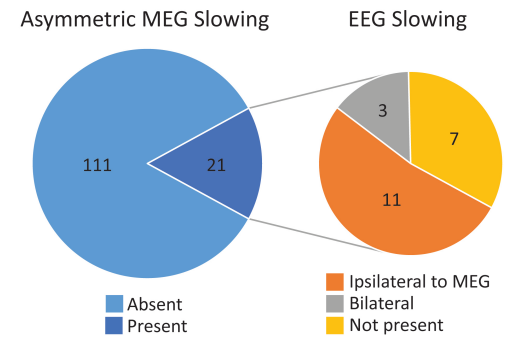

Fig. 5: Example of patient with increased connectivity at EZ

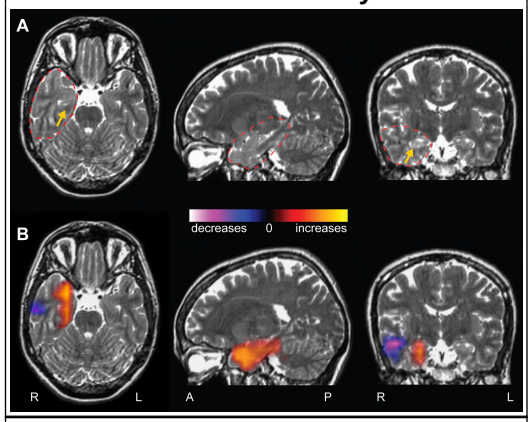

Fig. 6: Connectivity and Seizure Outcome