Localizing Value of MEG in Refractory Partial Epilepsy: Surgical Outcomes

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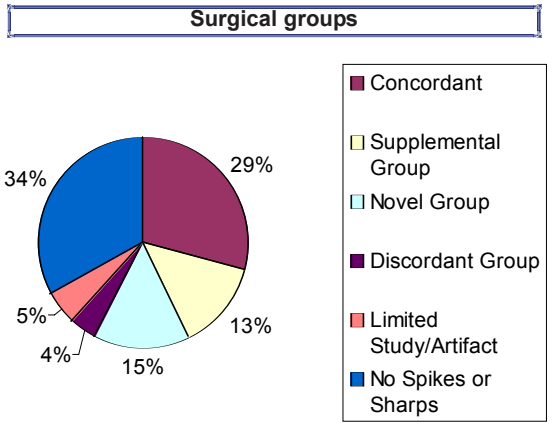
Objective: Retrospective review of epilepsy surgery patients having MEG scans to localize epileptic foci to determine if MEG had a significant impact on improving patients' seizure free outcome.

Introduction

Evaluation of patients with refractory partial epilepsy can be challenging when MRI is considered normal, or noninvasive testing (scalp EEG, PET/SPECT, clinical semiology) results are discordant. Since magnetoencephalography (MEG) has been shown to capture epileptic dipoles arising from superficial and deeper sources that do not project in a radial fashion (spikes captured best by EEG), it may provide pivotal data when determining resection of an epileptogenic zone or the potential locations for intracranial implantation.

A review was done of patients evaluated in the Epilepsy Surgery Program at Henry Ford Hospital who had completed the presurgical evaluation, and had post surgical follow-up (at least 2 years). Almost all patients had intracranial implantation prior to surgical resection. MEG data was analyzed and compared to findings of scalp EEG (interictal and ictal), MRI, and area of resection. The value of MEG data was then classified into groups (see below) based on accuracy of localization, and value concerning the actual surgical resection. Only patients with Engel Class I or II outcome were included in this classification. Exceptions to this included patients who had well defined intracranial ictal patterns, but limited resection due to overlap with eloquent cortex or multifocal epileptogenic regions. Since most patients with poor outcome would not be considered to have valid localization data, they were placed in an Undetermined category.



Results

- Interictal activity was identified in the MEG data in 61 of 90 patients (68%).
- Determination of accuracy of localization of interictal MEG data could be determined in 75 of the 90 cases. Cases with Engel Class III or IV outcome (n=15) were eliminated due to lack of confirmation of localization accuracy. Rare exceptions from this exclusion were in patients with well-defined intracranial ictal patterns, but limited resection because of overlap with eloquent cortex, or independent multifocal foci.
- Interictal MEG data was Concordant in 22 patients (29.3%), Supplemental in 10 patients (13.3%), and Novel in 11 patients (14.6%). All groups included cases with temporal or extratemporal foci.
- Three patients (4%) had data that did not match with subsequent localization of the epileptogenic zone (Discordant group).
- In 25 patients (33.3%) no spikes or sharp waves were seen in the MEG data.
- Four of the 75 patients (5.3%) had data contaminated by artifact.
- Of the 75 patients in this analysis, 43 (57.3%) had MEG data that provided additional information for the surgeon.

Methods

Brain activity was recorded with 148-channel MEG system and a 32-channel EEG system. Ninety patients (Male=41, Female=49; age range 8-66 years) had MEG and MRI scans prior to surgical resections. Prolonged intracranial (ECoG) recordings were also performed on all 90 patients. Interictal MEG data were analyzed using the single equivalent current dipole (ECD) technique.

Single ECD [1] analysis was performed on epileptiform discharges to localize the sites of epileptiform activity which were then overlaid on coregistered MRI images to merge physiologic and structural data.

The data obtained from MEG was compared to noninvasive studies and subsequent resection and then classified into the following groups:

- Concordant (C) group - localization of interictal MEG data was concordant with MRI abnormality or scalp EEG findings.
- Supplemental (S) group - localization of interictal data from MEG encompasses the MRI or scalp EEG findings and in addition the MEG data shows either i) narrowing the irritative zone to a compartment of a specific lobe (e.g. temporal lateral neocortex, temporoplar) which is not determined by scalp EEG, or ii) discordant with falsely localizing MRI or scalp EEG data.
- Novel (N) group - interictal MEG data which accurately localized the epileptogenic zone, when MRI was normal or EEG findings did not localize the epileptogenic zone.
- Discordant (D) group - shows interictal MEG data that subsequently does not localize to the epileptogenic zone.
- Limited Study Artifact (LSA) group - included patients with limited or uninterpretable studies due to artifact.
- No Spikes or Sharps Recorded (NSR) group - no epileptiform activity identified with MEG study.

Conclusion

The results show that MEG is useful in localizing the epileptogenic zone as a non-invasive technique before surgical resection. This study is consistent with the other MEG outcome studies (Stefan 2003, Iwasaki 2005). These results provide further evidence that epileptiform activity can be detected non-invasively with MEG, and provide localization information to the surgeon. As we have shown in the Supplemental and Novel Groups, MEG was able to produce valuable information for surgical resection. This information may improve surgical outcome results for patients who do not have a favorable outcome.

References

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1. Bowyer SM, Mason KM, Tepley N, Smith B, Barkley GL. MEG Validation Parameters for Clinical Evaluation of Interictal Epileptic Activity. J Clin Neurophysiol 2003;20:87-93.