Significance of Insular Magnetoencephalography (MEG) Dipole Clusters in Patients with Refractory Focal Epilepsy

Nitin Chourasia MD 1, Michael Quach MD 2, Jay Gavvala MD, MSCI 2

Departments of 1Pediatric Neurology and 2Adult Neurology, Baylor College of Medicine, Houston, Texas, United States

Background & Objective

- Insular epilepsies are notoriously difficult to diagnose and frequently imitate frontal, temporal and parietal lobe epilepsies.
- MEG has been shown to be an effective diagnostic tool in identifying insular epilepsies.
- However, in the current clinical workflow, it is unclear if the MEG dipole clusters (DC) could represent possible benign variants or indicate primary epileptogenic zone vs a secondary epileptogenic network.

- We identify patients with MEG based insular involvement in refractory epilepsy and describe their clinical and MSI characteristics to evaluate the following:
  - Do insular dipole clusters (DC) in MEG represent normal variants?
  - Does the presence of insular MEG DC imply a primary insular onset epilepsy?
  - Does an insular MEG DC focus correlate with seizure outcomes after surgical intervention involving the insula?

Methods

- The database for magnetic source imaging (MSI) studies for patients with refractory focal epilepsy completed at Baylor College of Medicine affiliates St. Luke’s Hospital and Texas Children’s Hospital from 2015-2018 was retrospectively evaluated.
- All patients with MEG insular dipole clusters (> 5 spikes) on MSI reports, including a subset of patients who underwent subsequent epilepsy surgery with a minimum follow up of six months were evaluated.
- Primary dipole clusters were designated as group of MEG spikes most frequently seen.
- Data obtained included age, sex, seizure semiology, age of seizure onset, seizure frequency, MRI brain, EEG and MEG findings (primary vs secondary cluster), surgical approach- (stereotactic EEG (SEEG)/ subdural grids), inclusion of insular coverage and presence of insular spikes on intracranial EEG, region of resection/laser ablation and seizure frequency post-operatively.

Results

- A total of 36 out of the 319 (11.3%) patients had MEG DC localized to the insula (among other regions).
- This included 20 (55.6%) adults and 16 (44.4%) children (age < 18).
- Mean age was 22 ± 14 years with 17 (47.2%) females and 19 (52.8%) males.
- Nineteen (52.8%) patients had primary insular DC and 17 (47.2%) had secondary insular DC.
- Twenty-four (66.7%) patients had some form of surgical intervention, while twelve (33.3%) were in the pre-surgical evaluation phase at the time of this review.
- Sixteen patients had intracranial epilepsy surgical evaluation (14 SEEG and 2 subdural grids).
- Out of the 14 SEEG cases, 11 had targeted insular coverage while 3 did not.
- Ten (90.9%) of the 11 patients with insular coverage by SEEG electrodes had interictal insular spikes during intracranial electrocorticography monitoring.
- In four (45.5%) of these 11 patients, the insula was identified to constitute the ictal onset zone based on intracranial EEG data.

Highlights & Conclusions

- Out of 11 patients with MEG DC in the insula who underwent intracranial EEG monitoring, 5 were determined to have an ictal onset zone including the insula (45.5%)
- Insular DC identified on surface MEG were also noted with intracranial stereotactic EEG depth electrode contacts in the insula.
- The presence of insular MEG DC however, may not definitely imply a primary insular onset epilepsy but likely reflect the extent of epileptogenicity within the intralobe.
- Patients with MEG DC that underwent resection/ablation that did not include the insula had no worse of an outcome as compared to ones where insula was included in the resection or ablation.
- Targeted evaluation of the insula with sEEG may help understand the role of insula within the epileptogenic network.

References


Table 1. Surgical outcomes in insula vs non-insula intervention

<table>
<thead>
<tr>
<th>Engel Outcomes</th>
<th>Intervention (Resection, Ablation)</th>
<th>Not Intervening Insula</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Clinical characteristics of patients with MEG insular DC and intracranial evaluation

<table>
<thead>
<tr>
<th>MRI Brain</th>
<th>EEG</th>
<th>MEG</th>
<th>Age</th>
<th>Sex</th>
<th>Seizure Semiology</th>
<th>Seizure Frequency</th>
<th>MRI</th>
<th>EEG</th>
<th>MEG</th>
<th>Outcome</th>
<th>Engle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brainstem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Illustrative example of MEG dipole cluster localization and intracranial EEG