Methods

- 30 Epilepsy patients (11 males, 19 females) with medical refractory partial temporal lobe epilepsy. Ages ranged 17 to 65 years (mean 37 ± 12 years).
- MEG studies performed over a five year period (2000 – 2005).
- 148 channels MEG: Magnetometers (4-D Neuroimaging Magnes WH2500).
- Eleven subjects (3 males, 8 females) without neurological disorders, aged 19 to 49 years.

Objectives: These studies explore the capability of magnetoencephalographic (MEG) coherence imaging to localize the site of epileptogenicity in patients with medically refractory temporal lobe epilepsy.

Methods: An archival review of single equivalent current dipole (ECD) MEG analysis of 30 presurgical temporal lobe epilepsy (TLE) patients was undertaken with data extracted subsequently for coherence analysis by a blinded reviewer. Postoperative outcome was assessed by Engel classification. MEG coherence images were generated from 10 minutes of spontaneous brain activity with the patient in a resting state. The mean coherence across frequencies between 3-50 Hz was calculated to locate areas of high coherence. These areas were then compared to surgically resected brain areas outlined on MRE. The sequence of coherence images was averaged for left and right hemispheres to study the hemispheric dynamics and ascertain the laterality of the epileptogenic network. Reliability between runs was established by calculating the correlation between epochs. Statistical differences between coherence values of patients and controls were established.

Results: With the ECD method, 11 (37%) cases were indeterminate and an overall match rate for Engel class I outcomes was determined to be 50%. With coherence analysis a match rate for overall Engel class I outcomes was determined to be 76.9%.

Conclusion: Coherence analysis is more sensitive than the ECD method and demonstrates reliability from run-to-run. It is more suited as a clinical investigational modality in TLE and provides unique functional information that predicts a favorable postsurgical outcome.

Abstract

Objective: This study examines the capability of magnetoencephalographic (MEG) coherence imaging to localize the site of epileptogenicity in patients with medically refractory temporal lobe epilepsy.

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Conclusion: Coherence analysis is more sensitive than the ECD method and demonstrates reliability from run-to-run. It is more suited as a clinical investigational modality in TLE and provides unique functional information that predicts a favorable postsurgical outcome.

References and Acknowledgment


Coherence analysis provided more accurate localization of the epileptogenic region in comparison with the ECD method. The study outlines an asymmetry in signal intensity weighted towards the mesiopolar region of the left temporal lobe. Despite this lack of concordance, 2/3 patients (cases 3, 25) achieved a class Ia outcome.

Engel Ia outcome was identified in 26/30 cases (87%). Class Ia outcomes comprised 22/26 (85%). 4 patients retained disabling seizure activity postoperatively rendering suboptimal Engel classifications (cases 7, 10, 14, 21).

The difference in means between controls and patients was statistically significant (p = 0.007). Of the 19 cases in which MTS was not apparent on MR imaging, coherence analysis provided localizing data that predicted a class I outcome in 11/19 (58%). In the remaining 5 cases, coherence analysis was not useful in 5 cases (11, 14, 20, 29) and predicted incorrectly the site of epileptogenicity in 3 cases (7, 10, 21) even though the findings agreed with those of the preoperative investigations.

Coherence imaging of (Salmen 2006) analysis was performed on the MR-FOCUS-ICA (Moran, 2004, 2005) temporal brain activity from the resting state to identify cortical sources that interact strongly within each of 23 frequency bands between 3-50 Hz. Freeware available at: www.meg imaging.com

MEG data (Hz)

MEG Coherence Imaging

Transients and oscillations of brain electric activity are found in MEG, EEG and fMRI recordings of spontaneous brain activity. These transients waveforms and oscillations can be captured and visualized using time-frequency techniques such as the Short-time Fourier transform (STFT). After transforming to a time frequency representation, the signal is decomposed into a series of time-frequency (STFT) windows. Coherence is a measure of linear dependence between signals from different brain regions for each STFT frequency component.

Coherence Imaging: Calculation

1. A transient of brain activity (divide data into 7.5 sec windows)
2. Cross-correlation between second windows temporal sequences of sources are converted to temporal source FFT spectra
3. Calculate cross-spectra matrix between source activity for each frequency
4. Calculate coherence between all network sources

For each active cortical site the average coherence with all other sources is calculated for each frequency.

MEG data (Hz)

MEG Coherence

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