No relevant Financial Disclosures
Outline

Traditional SEEG analysis
Brainstorm Analysis
  Interictal
  Ictal
Sensor vs Source Level
Multimodal Integration
SEEG: Question of Scale

Intracranial EEG commonly referred to as “gold standard”
Recent literature highlights increasing adoption of SEEG as the intracranial EEG modality of choice
However, this trend can be problematic with an expectation to “Apply Subdural EEG principles to SEEG”
Right-handed F, with seizure onset at 6 y/o

Habitual seizures: left hand tingling → dyscognitive
Frequency: 1-2x per week (SS aura daily)

MRI: bilateral perisylvian polymicrogyria and pachygyria, right greater than left.
Interictal Spikes: POP 12-15, PLAT 2-9, PLON 5-7 20%
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SEEG practice in the US

**Physician Perceptions of SEEG**

Most respondents believed that the benefits of SEEG were patient comfort (97%), ability to perform bilateral exploration (92%), testing multiple hypothesis (79%), and ability to perform repeat epilepsy surgery evaluations (77%). Perceived disadvantages of SEEG included the challenges of data interpretation (58%) and the need for additional time for planning and interpretation (49%). Centers variably reported the impetus for SEEG arising from emerging literature (70%) or following national trends (52%).

Gavvala et al Stereotactic EEG practices Journal of Clinical Neurophysiology 2022
Workflow

Anatomy

Sensors

Intracranial EEG

Analysis

Co-registration

Source estimation

Interictal Ictal Source vs Sensor Level Analysis
Interictal Processing

2D Spike Layout
Source Localization of waveform (Is SNR sufficient?)
Source Level Interictal Processing (Frequency Band specific)
SEEG analysis: Interictal Spike
SEEG analysis: Interictal Spike

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1

SPS1-SPS2
SPS2-SPS3
SPS3-SPS4
SPS4-SPS5
SPS5-SPS6
SPS6-SPS7
SPS7-SPS8
SPS8-SPS9
SPS9-SPS10
SPS10-SPS11
SEEG analysis: Interictal Spike 2D layout
sLORETA on cortex and MRI viewer
SEEG analysis: Low voltage Fast
sLORETA of a specific frequency band
Ictal Processing

Source Localization of waveform (Is SNR sufficient)?
Sensor level Ictal processing
   Epileptogenic Index
   Epileptogenic Fingerprint
Source Level Ictal Processing
   Frequency Band specific
   Restricted Region of Interest
Sz type 1 (left hand aura): **Onset SPS 7-10/PLON 6-16/PLAT 6-8**

Insert EEG picture with clearly labeled EEG onset and clinical onset; use arrows to help show this.
Sz type 1 (left hand aura): **Onset SPS 7-10/PLON 6-16/PLAT 6-8**
sLORETA on Cortex

Focus of source
Localized power

10 s
sLORETA results on MRI volume (sz 1)
Epileptogenicity of brain structures in human temporal lobe epilepsy: a quantified study from intracerebral EEG

Fabrice Bartolomei, Patrick Chauvel and Fabrice Wendling

The "Connectivity Epileptogenicity Index" (cEI), a method for mapping the different seizure onset patterns in StereoElectroEncephalography recorded seizures

Alexandra Balatskaya, Nicolas Roehn, Stanislas Lagarde, Francesca Pizzo, Samuel Medina, Fabrice Wendling, Christian-Georges Bénar, Fabrice Bartolomei

Epileptogenic zone quantification offers real advantages for facilitating SEEG interpretation and predicting surgical outcome. Ictal (EI, cEI) or combined ictal–interictal (Spikes × EI, Spikes × cEI) SEEG markers outperformed the classical interictal markers (Spikes, HFO, Spikes × HFO), both for detecting the EZ and predicting the seizure freedom. Combining ictal and interictal markers in a single measure improved detection accuracy. Spikes × EI showed the best precision against the clinical analysis. The resection rate of the EZ defined by ictal markers and by Spikes × EI significantly correlated with surgical prognosis. However, complete EZ resection was not mandatory to control seizures.

RESEARCH ARTICLE

The role of quantitative markers in surgical prognostication after stereoelectroencephalography


1AP-HM, Timone Hospital, Epileptology and Cerebral Rhythmology, Marseille, France
2Aix Marseille Univ, INSERM, INS, Inst Neurosci Syst, Marseille, France
3INSERM U999, LTP, Marseille, France
4Université de Bourgogne, 1, 153, Bourgogne, France

The role of quantitative markers in surgical prognostication after stereoelectroencephalography
Characteristic time-frequency pattern emerged for contacts located inside epileptogenic zone.

- single or multiple pre-ictal sharp transient(s) or spike(s)
- narrow frequency bands of fast activity
- simultaneous suppression of slow pre-ictal frequencies.
Source Level Ictal Analysis
Source Level Ictal Analysis
Time-frequency decomposition on PIN 5-6

Rhythmic activity
On PIN 5-6

30 s
sLORETA of rhythmic activity using filter (5-55 Hz)
Seizure fingerprint on Source Level
Seizure fingerprint on Source Level
Multimodal Analysis: Case Example

Right-handed male onset of seizures as a child. Semiology: Staring, right arm immobility, left hand automatisms, unresponsiveness and hypermotor movements with post-ictal aphasia. MRI with L frontal opercular cortical dysplasia. Underwent a phase II subdural evaluation ~ 15 years ago and was told he wasn’t a resective surgery candidate.
Repeat Surgical Evaluation (External)

EMU:
- Interictal abnormalities: Sharp waves: Left temporal
- Ictal:
  - Semiology: Staring, right arm immobility, left hand automatisms, unresponsiveness and hypermotor and post-ictal aphasia
  - EEG Seizure pattern: Left temporal delta activity

MRI: Post surgical changes of left craniotomy, no clear evidence of dysplasia

PET: left mesial/anterior temporal lobe hypometabolism

MEG: left temporal spike cluster
Future Directions

Statistical Parameters to Validate the Reliability of Modeling Result

• Confidence Volume Ellipsoids
• Taking into account density of SEEG sampling

Automated Processing
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