3114. Seizure onset zone localization from clinical ictal EEG in refractory epilepsy

GHENT UNIVERSITY

W. Staljanssens[1], Gregor Strobbe[2], Roel Van Holen[1], Vincent Keereman[1,3], Stefanie Gadeyne[3], Evelien Carrette[3], Alfred Meurs[3], Francesca Pittau[4], Shahan Momjian[5], Margitta Seeck[4], Paul Boon[3], Stefaan Vandenberghe[1], Serge Vulliemoz[4,6], Kristl Vonck[3], Pieter van Mierlo[1,6]

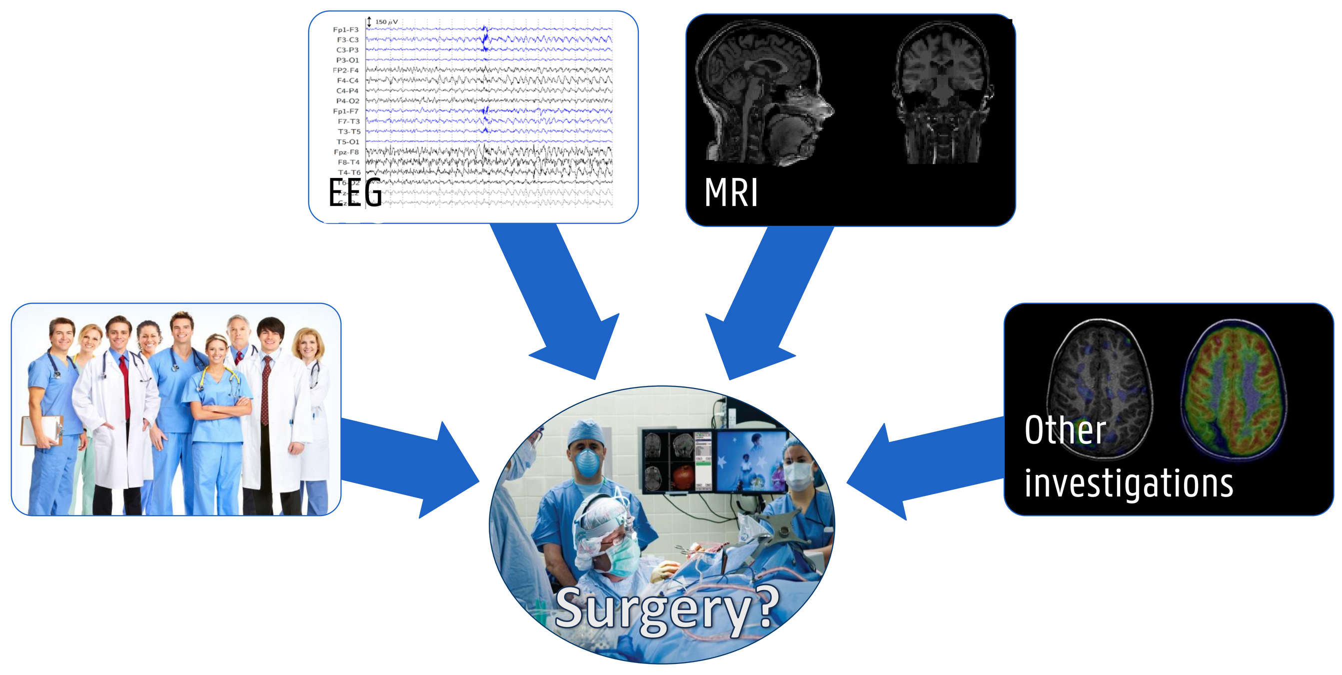
[1] MEDISIP, Ghent University – imec, Ghent, Belgium. [2]Epilog, Gent, Belgium. [3] LCEN, Ghent University Hospital, Ghent, Belgium. [4]EEG and Epilepsy Unit, University Hospitals and Faculty of Medicine of Geneva, Geneva, Switzerland, [5]Department of Neurosurgery, University Hospitals of Geneva and University of Geneva, Geneva, Switzerland. [6] Functional Brain Mapping Laboratory, University of Geneva, Switzerland.

It would be of high clinical value to be able to localize the SOZ based on non-invasive ictal EEG recordings

Of the 70 million epileptic patients worldwide, ± 30% cannot be helped with medication.
They are referred to the presurgical evaluation: can they benefit from epilepsy surgery?

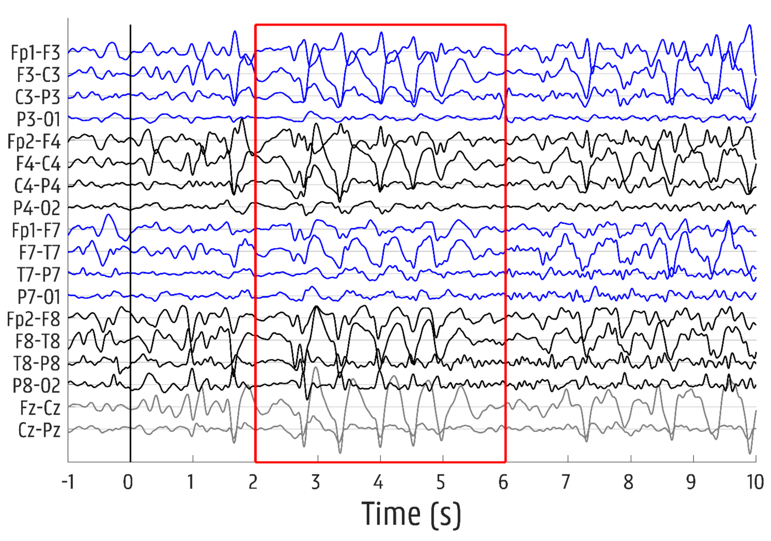
Up to now, neurologists inspect the EEG visually to localize the seizure onset zone (SOZ)

- time consuming
- labor intensive
- subjective
- sometimes invasive EEG needed: medical risks



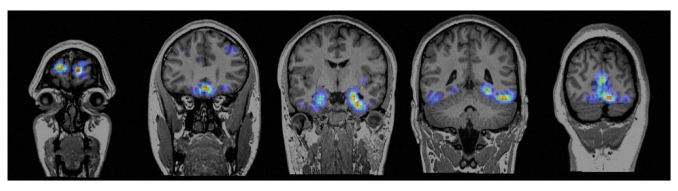
We propose an approach for SOZ localization based on EEG source imaging and functional connectivity analysis

Ictal EEG epoch



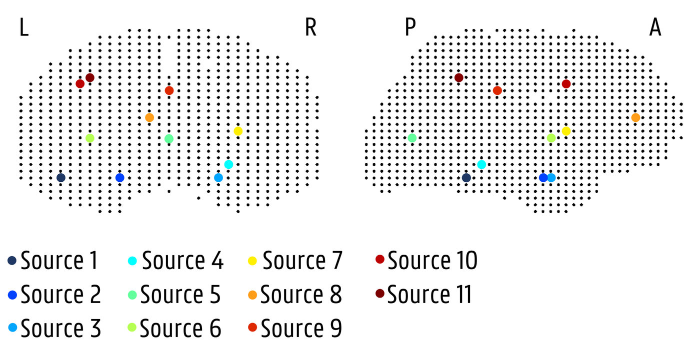
- 27 patients, 110 seizures (24 TLE, 3 ETLE)
- Engel I surgery outcome
- 27 – 32 electrodes
- (quasi) artifact-free epoch of 1-5s around seizure onset
- seizure frequency band (SFB) determined via FFT

EEG source imaging (ESI)

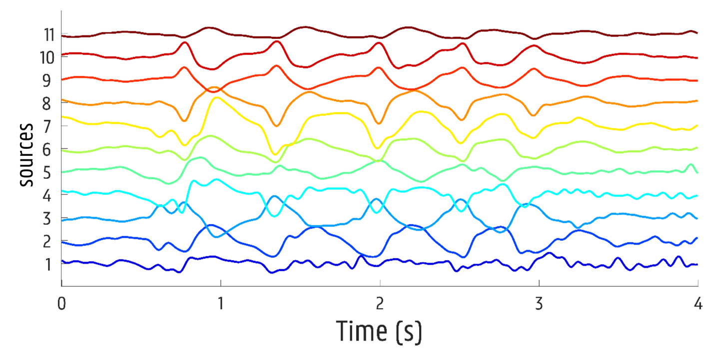


forward model: individual FDM head model (air – scalp – skull – CSF – GM – WM)
inverse solution: LORETA

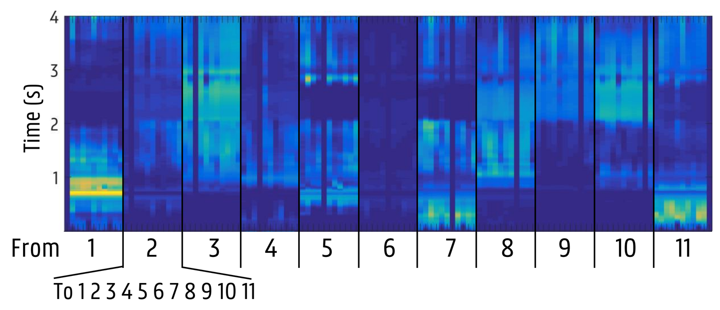
Source selection: local maxima



1 time series per selected source

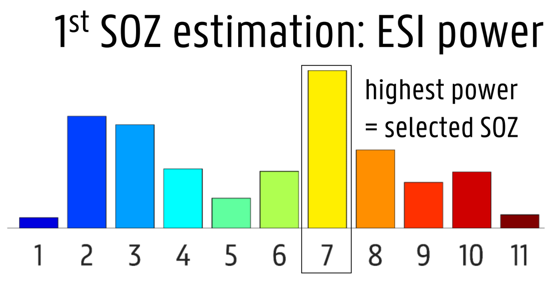


Connectivity analysis in SFB

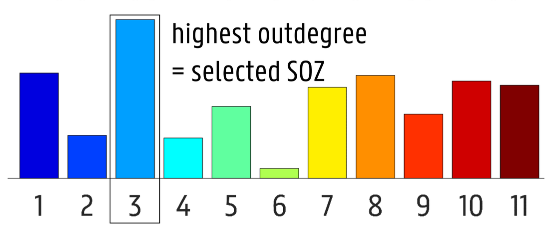


Time-varying Granger causality: swADTF
(van Mierlo et al., 2013)

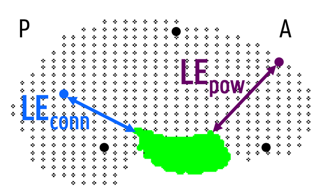
1st SOZ estimation: ESI power



2nd SOZ estimation: ESI+connectivity

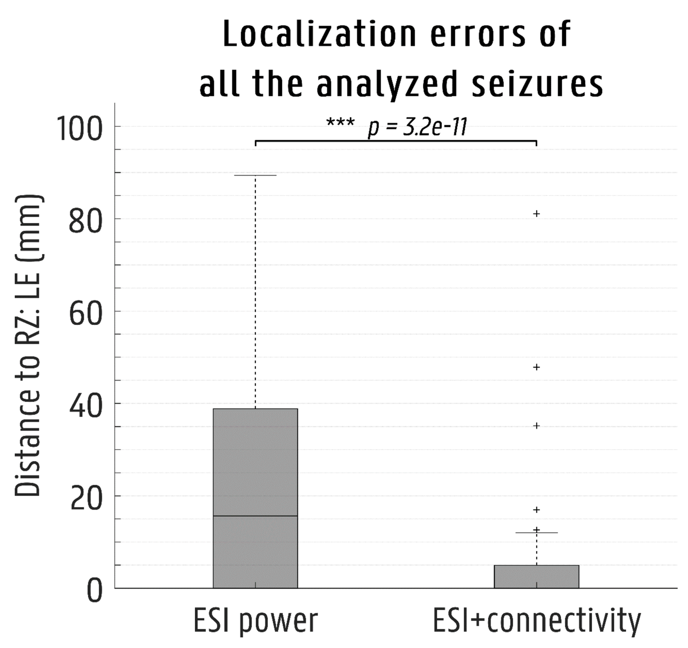


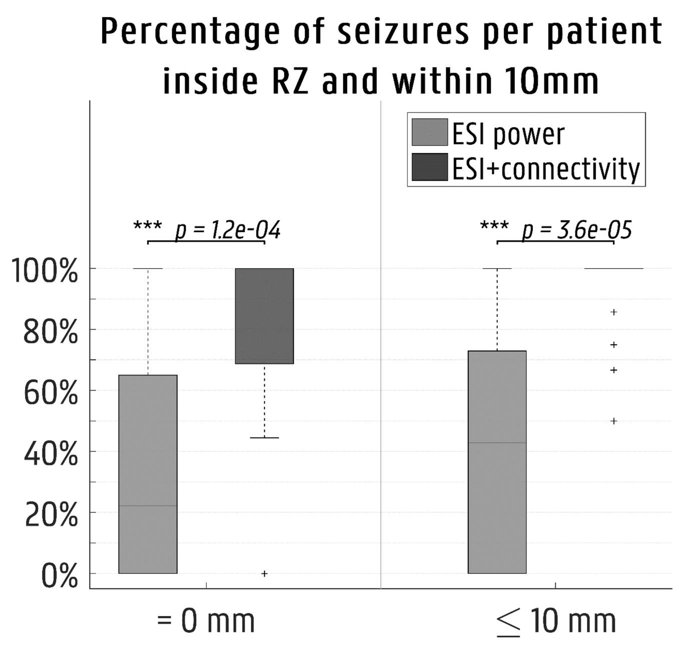
Validation



- Source with highest outdegree
- Source with highest power
- Other selected sources
- Resected Zone (RZ)

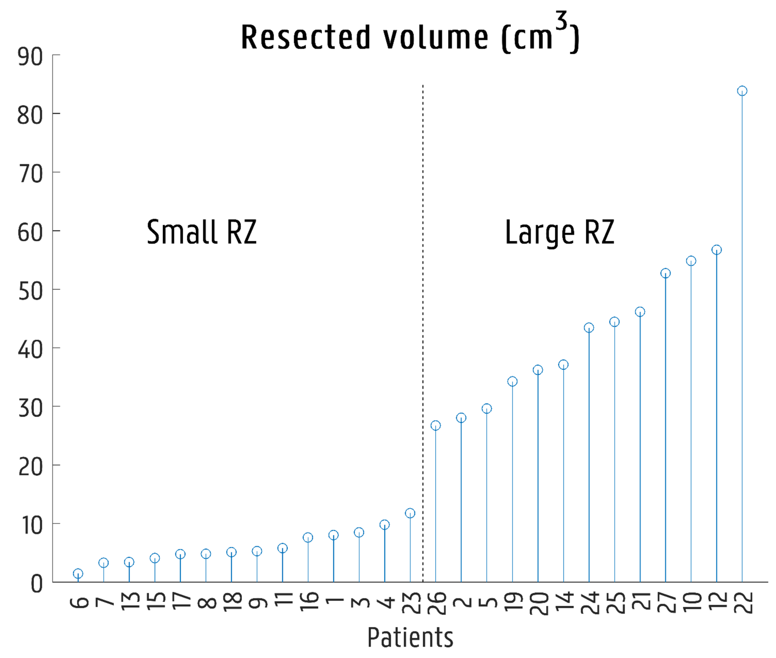
ESI+connectivity outperformed ESI power significantly, it was able to estimate the SOZ with high accuracy.

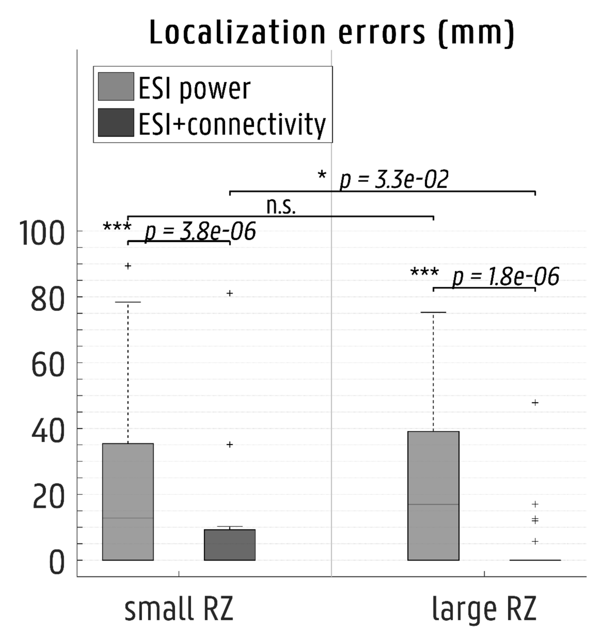




72% of the seizures were estimated inside the RZ, 94% within 10 mm of the RZ.
For 67% of the patients, all seizures were estimated inside the RZ, and for 85 % all seizures were estimated within 140 mm of the RZ.

The volume of the resected zone had a small influence on the performance.





There was no significant difference for small and large resections in the percentage of correctly localized seizures per patient.

We showed that it is possible to estimate the SOZ from clinical ictal scalp EEG with high accuracy using ESI and subsequent functional connectivity analysis. Given more research, it could be a valuable tool for the presurgical evaluation of epilepsy.

Willeke.Staljanssens@UGent.be

http://medisip.elis.ugent.be

van Mierlo P et al., Ictal onset localization through connectivity analysis of intracranial EEG signals in patients with refractory epilepsy, Epilepsia 2013 Aug;54(8):1409-18.

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