LOCALIZATION OF EXPERIMENTAL EPILEPTIC FOCUS - Comparison of ICA and TCA

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Introduction In 40-60% of cases with interictal activity in EEG, fMRI analysed with hypothesis driven methods cannot locate any foci with simultaneous EEG/fMRI. This study compared localization potential of two data-driven methods: spatial independent component analysis (ICA) and temporal cluster analysis (TCA). Data was obtained from an experimental focal epilepsy model, which includes dynamic induction of epileptic activity, simultaneous EEG/fMRI, and deep anesthesia [1].

Methods Reported results are from five pigs (23+/-2kg) studied under isoflurane anesthesia (1.4-1.7 ET%, burst-suppression EEG) and muscle relaxant. Penicillin (6000IU) was injected via a plastic catheter (inserted into the somatosensory cortex) during fMRI (GRE-EPI, TE=40ms, 300ms/two slices, acquisition delay 1700ms) in 1.5T. Epileptic spikes between acquisition artifacts were reviewed from EEG and total power calculated. ICA [e.g., 2] (FastICA with default parameters, 50 components, z-score 9-10) and TCA [e.g., 3] were compared in the efficiency of localization of experimental epileptic focus. With TCA, cross-correlation (r=0.40-0.50) between voxel time series and calculated histogram (whole brain data set, threshold= 75%) was applied to obtain activation map. Map means were also obtained and compared to EEG power change.

Results Spiking resembling interictal epileptic activity appearedwithin 49sec – 2min 44sec after injection. For all five animals, both TCA and ICA (Fig 1, same animal, two slices) provided activation maps with relevant voxel clusters around penicillin injection site (assumed epileptogenic focus area). Additional spread of voxels occurred (e.g., 1.B, slice on the right), but mainly strongest focal cluster was close to injection site. Map means saturated after increase, corresponding to EEG power change due to spiking (an example in Fig. 2., same animal than in Fig. 1).

Discussion In experimental focal epilepsy *a priori* knowledge exists of the location of the epileptogenic area. For each animal, mapping of penicillin injection site was possible with data-driven analyses. In conclusion, both ICA and TCA can enable localization of developing focal epileptic focus, without any hypothesis about the BOLD signal development.

References 1. Mäkiranta, 2004, http://herkules.oulu.fi/isbn9514274296/
2. Kiviniemi et al., 2003, Neuroimage 19(2):253
3. Morgan et al., 2004, NeuroImage 21(1):473

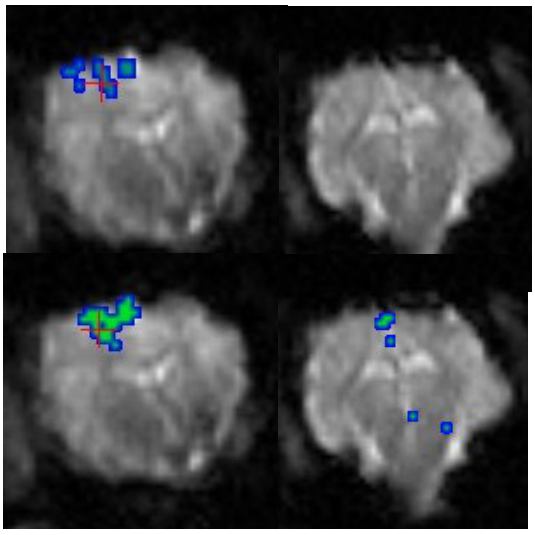

Figure 1. An example of **A.** TCA activation map and **B.** one spatial ICA component voxels from the same animal. Red cross = penicillin injection site.

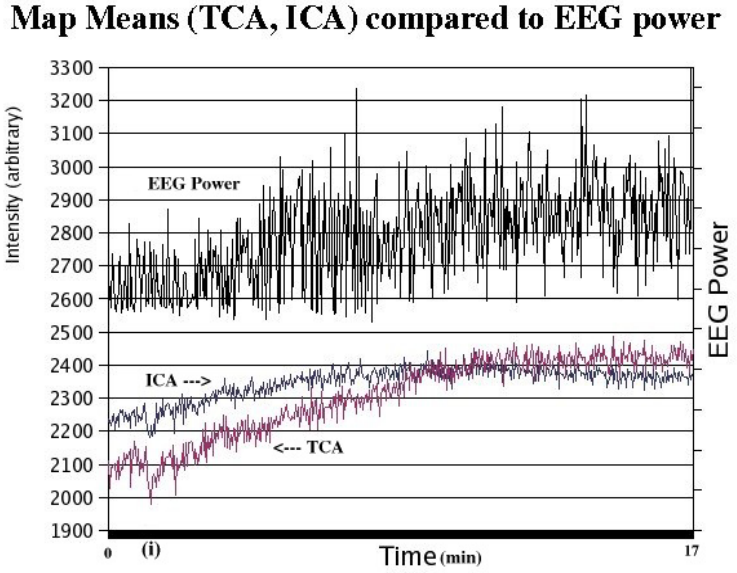

Figure 2. Average signal development in time. (i) = penicillin injection given.