Localization of the motor cortex on magnetic resonance images by transcranial magnetic stimulation

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Introduction
✓ 30% of people with epilepsy do not respond to medication
✓ Surgically removing the epileptogenic zone is an option...
✓ ... provided this area is not responsible for critical functions
✓ Evolution to multimodal, non-invasive patient-specific mapping of critical brain regions (MRI, fMRI, MEG, TMS)
✓ “Gold” standard for motor cortex mapping is invasive implantation of cortical electrode grid (electrocorticography ECoG)
✓ Navigated transcranial magnetic stimulation (TMS) offers a non-invasive alternative for cortical mapping

Aim: improve TMS based localization of the motor cortex by including patient-specific electrical field simulations based on the SimNIBS pipeline

Results
✓ TMS simulations feasible using clinical data (3D-T1 & T2)
✓ Obtained TMS field map correlates well with ECoG data
✓ Validation complicated by the coarse sampling of ECoG

Future perspectives
✓ Adapt weighting method to combine different electrical field maps
✓ Optimize threshold used for localization
✓ Further validation in larger patient groups
✓ Include brain lesions with different electrical properties
✓ Determine potential for use in clinical routine

Current practice: deduce location of motor region from the navigated TMS positions with significant MEP, ignoring patient-specific anatomy

Proposed method: patient MRI used for finite-element based electrical field simulation, weighted average over TMS sites based on EMG recordings

Proof of concept: example of foot mapping (patient 1) & hand mapping (patient 2), compared to ECoG and fMRI