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P021. Influence of Skull Defect Conductivity on MEG Signal and Source Reconstruction in an In Vivo Animal Experiment

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While the influence of skull defects on the electroencephalogram (EEG) has been reported, the magnetoencephalogram (MEG) is thought to have a negligible sensitivity to skull defects. However, quantitative experimental evidence under realistic conditions is rare. Our objectives are to experimentally investigate the influence of skull defects of varying conductivity on the MEG and EEGusing a controlled current source under a defect and to develop a finite element head model representing the skull defect influence.

Ethics approval was obtained (Freistaat Thüringen, Germany, 02 034/08). We measured a 64-channel EEG simultaneously to a 16-channel MEG produced by a miniaturized artificial coaxial dipole implanted in a rabbit brain tangentially to the inner skull surface in vivo. Followinga recording with intact skull, a skull defect was introduced above the dipole and successively filled with agar of increasing conductivity and recorded. Finally, the dipole was shifted in 0.35-mm steps from a position next to the skull defect to a position under the defect and further to the opposite side and a recording was taken at each step. The body, ocular humour and lens, compact and cancellous bone, skull defects and grey matter, white matter, cerebrospinal fluid (CSF), and intracranial blood vessels were segmented from a co-registered CT (0.4 mm^3) and a T2 MRI (0.4 mm^3). A node-shifted cubic mesh was derived (Vgrid). The EEG and MEG were forward simulated using a blurred dipole approach (SimBio). Source reconstruction from the MEG was performed using an unconstrained moving dipole fit.

Both EEG and MEG were significantly influenced by a conductive skull defect. The amplitude and topography change increased nonlinearly with increasing defect conductivity in measurement and simulation. Both, the EEG and to a smaller degree also the MEG topography, were altered in a fashion that is spatially corresponding to the skull defect location and geometry. The sources from the skull defect MEGs reconstructed with an intact skull model were displaced away from the defect. Their orientation was altered from the implanted source direction to point more radial to the skull defect boundary. When the sources were instead reconstructed with a head model incorporating the skull defects, the displacement was increasingly reduced as the modeled defect conductivity approaches the actual conductivity and the dipole orientation is gradually restored.

A realistic finite element head model is able to represent a skull defect and to compensate its influence on the MEG source reconstruction.We conclude that skull defects need to be accounted for in realistic volume conductor models.