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S09_1. Skull Defects Influence MEG Source Reconstruction

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Skull conductivity inhomogeneities include naturally occurring large conductivity variations such as fontanels in infants or the spongy bone structure embedded in the compact bone. Artificial skull inhomogeneities comprise, for example, surgical holes or sutures. During the modeling process, artificial skull inhomogeneities might be introduced due to erroneous segmentation or meshing. Skull conductivity inhomogeneities are known to influence electroencephalography (EEG) signals and consequently EEG source reconstruction. However, they are thought to have no or minor influence on magnetoencephalography (MEG) signals and MEG source reconstruction. In this talk, the influence of skull conductivity inhomogeneities caused by surgical holes and modeling errors on the MEG forward and inverse problem will be assessed.

We implanted an artificial current dipole in the brain of rabbits and measured simultaneously electric surface potentials (64 channels) and magnetic fields (16 channels). One or two skull defects (holes) were introduced in a surgical procedure. The electric potential amplitudes changed up to a factor of 10 and the magnetic field amplitudes up to 20%, when comparing the data measured over intact skull and skull with one or two holes.

We constructed individual finite element method (FEM) models for the rabbits, including gray and white matter, cerebrospinal fluid (CSF), intracranial blood vessels, compact and spongy bone, skull defects, ocular humour and lens, and body. The computed magnetic field and electric potential differences based on models with and without skull defects confirmed the experimental results. Artificial skull inhomogeneities (a number of small holes) introduced due to erroneous segmentation and meshing resulted on average in 20% amplitude change of the magnetic field; however, in worst cases up to 200%.

We conclude that skull conductivity inhomogeneities have a nonnegligible effect on the MEG forward and inverse problem. Especially when source positions are expected to be in the vicinity of the conductivity inhomogeneity and when a large difference with respect to the skull conductivity is indicated, the modeling approach should take the inhomogeneities into account.

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