Güllmar, Daniel; Haueisen, Jens; Reichenbach, Jürgen R.:

The sensitivity of the EEG and MEG inverse solution to anisotropic conductivity - a whole human head simulation study

Original published in:	BMC neuroscience. - London : BioMed Central. - 10 (2009), Suppl. 1, art. P78, 2 pp.
Original published:	2009-07-13
ISSN:	1471-2202
DOI:	10.1186/1471-2202-10-S1-P78
[*Visited:*	2019-08-09]

BMC Neuroscience

BioMed Central

Poster presentation

The sensitivity of the EEG and MEG inverse solution to anisotropic conductivity – a whole human head simulation study

Daniel Güllmar*[1], Jens Haueisen[2] and Jürgen R Reichenbach[1]

Address: [1]Institute for Diagnostic and Interventional Radiology, University Hospital Jena, Jena, Germany and [2]Institute for Biomedical Engineering and Informatics, Technical University Ilmenau, Ilmenau, Germany

Email: Daniel Güllmar* - daniel.guellmar@med.uni-jena.de

* Corresponding author

from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P78 doi:10.1186/1471-2202-10-S1-P78

Introduction

Although it was demonstrated decades ago that the electrical conductivity of white matter tissue is anisotropic [1], this information is often neglected in EEG/MEG source localization studies using realistic head models. On the other hand, modeling methods like FEM [2] are able to include anisotropic conductivity. One reason for omitting this information may be the lack of a non-invasive method, capable to map spatially resolved anisotropic conductivity to incorporate this information in a realistic head model. Another reason may be that the benefit of including anisotropy information is not always obvious. This study aims to evaluate the sensitivity of the EEG/MEG inverse solution by neglecting white matter anisotropy for almost all possible cortical positions in gray matter in a whole-head high-resolution human FEM simulation study.

Methods

We employed a high resolution FEM head model (~3.3×10^6 elements) and distributed over 25.000 dipoles almost uniformly spaced over the cortical area (gray matter ribbon) with moments oriented perpendicular to the gray matter surface. For each of these dipole positions, we calculated the EEG and MEG forward solutions while considering the anisotropy of white matter. The latter information was derived from MR-Diffusion Tensor data. With the forward solutions EEG/MEG focal source reconstructions were performed by using a moving dipole fit approach and neglecting the anisotropy information of the white matter segment. The deviations between dipoles used to solve the forward solution and dipoles reconstructed by solving the inverse problem were evaluated by means of dipole shift, magnitude and orientation change.

Results

The results for the dipole shift show that the dipole localization errors are in general smaller with MEG compared to EEG when anisotropy is neglected. The magnitude errors, however, are very similar for both MEG and EEG. For the orientation error EEG was found to be less sensitive than MEG. Overall, we found that the results for EEG and MEG mapped onto the brain surface were very similar, although the maps for the MEG solution appeared sharper. In general, highly affected dipole positions were found mainly in the sulci of the medial part of each hemisphere but also in the main sulci of the temporal lobe. Strong influences were observed with dipole positions located in the posterior part of the lateral sulcus, the superior temporal sulcus, the postcentral sulcus and the transverse occipital sulcus.

Conclusion

Our results are important for EEG/MEG source localization procedures using ECD (equivalent current dipole) models with dipoles located in regions that are highly influenced by anisotropic conductivity. Therefore, localization analyses should consider anisotropy when modeling volume conductors.

References

1. Freygang WH, Landau WM: **Some relations between resistivity and electrical activity in the cerebral cortex of the cat.** *J Cell Physiol* 1955, **45:**377-392.
2. Wolters CH, Grasedyck L, Hackbusch W: **Efficient computation of lead field bases and influence matrix for the FEM-based EEG and MEG inverse problem.** *Inverse Problems* 2004, **20:**1099-1116.