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Sensitivity of EEG leads to volume conductor properties

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Introduction

Our aim was to investigate the lead field sensitivity within realistically shaped finite element head models as a function of the model parameters.

Methods

By means of an effect-by-effect approach, the widely used (in EEG and MEG source analysis) homogenized isotropic three compartment head model (skin, skull, brain) is expanded to a more realistic six compartment head model (skin, skull compacta, skull spongiosa, cerebrospinal fluid (CSF), brain grey and white matter) with brain conductivity anisotropy (Olesch et al., 2010; Wolters et al., 2006; Wagner, 2011). In each successive step, an additional effect (either a further realistic tissue compartment or brain anisotropy) is incorporated into the simpler model of the previous step. For each incorporated effect the resulting changes in the lead vector field orientation and magnitude are assessed in the whole volume conductor as well as in the cortical compartment. Moreover, the direct visualization of the computed vector fields throughout selected regions of interest within the volume conductor allows an easy and intuitive result interpretation.

Results

Results of our presentation are (1) channeling effects of the vector field in lower resistive regions, for example, in the skin, skull spongiosa and the CSF; (2) resulting vector field orientation and magnitude in the cortical compartment changes by more than 50 degrees and 250 %, resp.; (3) vectors, located in areas of higher resistive regions tend to be oriented towards the nearest less resistive tissue; (4) when modeling brain conductivity anisotropy, the vector field is oriented more parallel to the main conductivity tensor direction.

Conclusion

The visualization of lead vector fields offers an intuitive way to better understand volume conduction effects and our presentation demonstrates that anisotropic multi-compartment realistically shaped head models are important for an accurate source analysis.

Literature

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