Determination of anisotropic ratio of the skull for EEG source localization in patients with epilepsy

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I. Introduction

Epilepsy is a neurological disorder characterized by abnormal brain activity, which affects about 1% of the people worldwide. When patients do not respond to medication, the surgical removal of the epileptic focus can be considered. EEG source analysis aims at localizing the origin of these epileptic events. It consists of 2 subproblems: The *forward* problem determines the electrode potentials at the scalp given a source and the *inverse* problem estimates the source parameters given a measured set of electrode potentials. The conductivity of the skull highly affects the dipole location and is known to be anisotropic. In this study we want to determine the anisotropic ratio to accurately model the conductivity of the skull.

II. Methods

We used a spherical head model with a three-layered skull, a spongiform layer between two hard layers, to compute the simulated scalp potentials as seen on Figure 1. The

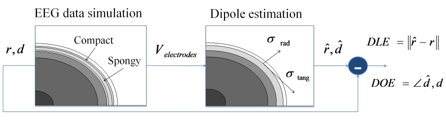

Figure 1. Simulation setup.

conductivities of the spongy and hard bone layers were chosen as 0.02865 S/m and 0.0064 S/m, respectively [1]. We investigated dipole localization and orientation errors due to assuming an anisotropic head model in the inverse solution for 17071 simulated dipoles on a 5 mm 3D grid. The initial radial (σ_{rad}) and tangential (σ_{tang}) conductivity values are based on a model of parallel and serial resistors [2]. We perturbed these values as: [0.8:0.1:1.5]σ_{rad} and [0.1:0.1:2.4]σ_{tang}. The global minimum was found at σ_{rad}=0.0105 S/m, σ_{tang}=0.0191 S/m as shown in Figure 2.

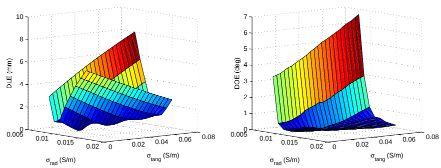

Figure 2. Mean error over all dipoles.

III. Conclusions

The radial skull conductivity has the highest influence on dipole estimation. The orientation error is less affected by variations in the conductivity of the skull. The found anisotropy ratio with minimum localization error was 1:1.8 (radial: tangential conductivity). These results suggest that the commonly used value of 1:10 is over-estimated [3].

References

[1] M. Akhtari et al. Conductivities of three-layer live human skull. *Brain Topogr*, 14, 2002.

[2] M. Fuchs et al. Development of volume conductor and source models to localize epileptic foci. *J Clin Neurophysiol*, 24, 2007.

[3] G. Marin et al. Influence of skull anisotropy for the forward and inverse problem in EEG. *Human Brain Mapping*, 6, 1998.

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