# Conductivity measured by DTI: Influence on EEG source localization evaluated in a FEM model of an animal head

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**Introduction**:

Source localization based on EEG/MEG data is a widely used technique to investigate neuronal activity. The accuracy of the results depends in particular on the applied volume conductor model. Volume conductor modeling using the Finite Element Method (FEM) makes it possible to take into account the anisotropic conductivity of e.g. the white matter tracts. In our study we investigated the influence of this anisotropy derived by diffusion tensor imaging in an animal model. The effective medium approach to determine the conductivity tensor from the diffusion tensor was proposed by Tuch et al. [1] and applied to EEG/MEG simulations by Haueisen et al. [2].

**Material and Methods**:

We constructed a FEM volume conductor model (see Fig. 2) of the head of a rabbit from T1-weighted MR-images by semi-automatic tissue segmentation into four different tissue layers (skin, skull, gray and white matter). By applying a T-STEAM diffusion weighted sequence (Fig. 1) with six diffusion weighted directions [3] we performed DTI to obtain the anisotropy of white matter tissue. The orientation of the diffusion tensors was selected to model anisotropic conductivity tensors in the white matter of the rabbit's brain and assuming an anisotropy ratio of 1:10. 1360 dipoles in the cortical region separated by 0.6 mm and orientated radially served as sources. Using this anisotropic model we computed EEG potentials at 100 electrodes (see Fig. 2) placed on the rabbit's head. With these potentials we performed source localization applying the same model but with isotropic conductivity. The forward and inverse solution was obtained with the Inverse Toolbox of the Simbio Project including the NeuroFem solver [5].

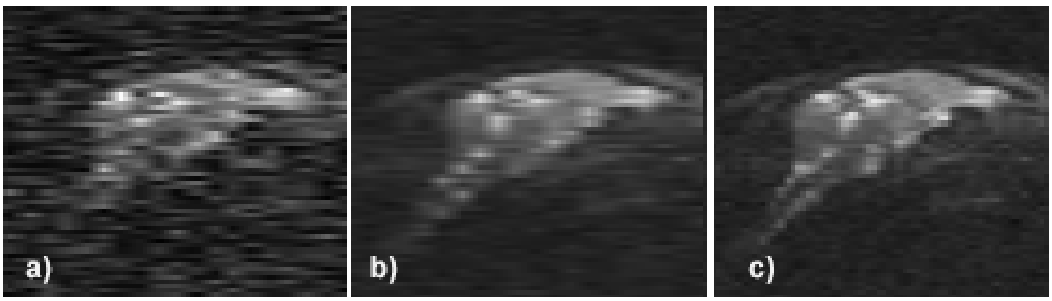


**Fig. 1.** Sagittal diffusion weighted image of a rabbit brain measured with a TSTEAM-sequence. (a) single image, (b) 16x averaged, (c) increased resolution by slice interleaved measurement.

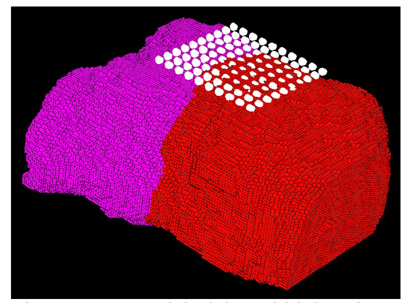

**Fig. 2.** FEM-Model of the rabbit head showing the EEG electrode setup.

**Results**:

All dipoles were shifted in their location and changed their orientation due to the different volume conductor models, which were used for the forward and inverse solution. Shifts up to 2 mm were obtained with a mean value of 0.459 mm. The mean deviation of dipole orientation was 9.8° and the mean absolute magnitude change of the dipole was 36.7%. In Fig. 3, the results of the changes in dipole magnitude, dipole shift and dipole orientation are mapped onto a segmented slice of the rabbit's brain. In the region of white matter the conductivity tensors are displayed schematically (in light blue). As seen from Fig. 3 there appears to be local correlation between the white matter structures (represented by the conductivity tensors) and the changes in properties of the dipoles. However, we were not able yet to predict these sensitivity maps directly from the known distribution of the anisotropic conductivity tensors.

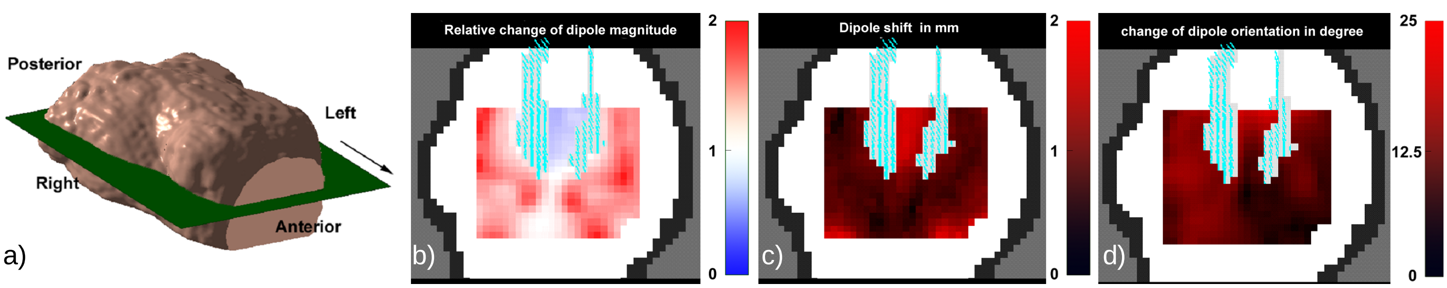


**Fig 3.** a) Surface of the rabbit's brain indicating the slice position which was used for the mapping of the results; b) map of dipole magnitude changes, c) dipole shifts and d) changes of dipole orientation.

**Discussion**:

Volume conductor modeling in EEG source localization procedures including anisotropy may improve the accuracy of dipole estimation. On average, dipole shifts due to anisotropy were within the procedural accuracy of EEG source localization. However, about two percent of the dipoles exhibited localization errors significantly higher than the procedural limit. The low localization errors and the relatively high magnitude changes are in good agreement with [2].

**References**

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