Head modeling effects on the individualized targeting and optimization of multi-channel TES in pharmacoresistant epilepsy

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***Abstract*— The principle of epilepsy surgery is to localize and to resect the *epileptogenic zone (EZ)* but surgery might not be feasible when the focal cortical dysplasia (FCD) is overlapped with eloquent areas of the brain. Multi-channel transcranial electric stimulation (mc-TES) has been proposed recently as a neurotherapeutic approach. However, the selection of the individual head model is crucial to achieve accurate optimized mc-TES in the FCD. Here, we evaluate simulations of optimized TES montages when using different individual head models.**

I. Introduction

In patients with focal epilepsy who do not respond to dequate antiepileptic drugs, epilepsy surgery is the most effective treatment option [1]. The principle of epilepsy surgery is to localize and resect the EZ. However, resection may not be feasible if the epileptogenic zone overlaps with eloquent cortical areas, such as Broca's area. For these patients, mc-TES may become a promising treatment alternative [2]. Here, we investigate the influence of head modeling on the targeting and the optimization of individual mc-TES montages.

II. Methods

All procedures were approved by the ethics committee of the University of Erlangen (Ref No 4453 B). The patient is a 20-year-old female with epilepsy. The seizure semiology can be described as distributed thinking and inability to speak. As she met the criteria for pharmacoresistance, a presurgical evaluation for possible surgery was done [2]. Simultaneous Electro- and Magneto- Encephalographic measurements were acquired followed by 3T Magnetic Resonance Imaging. Our proposed pipeline *DispNeuro* [3] was used for constructing an individual six-compartment skull conductivity calibrated (4.1 mS/m) head model with white matter anisotropy (6CAC) and an individual three-compartment head model with isotropic brain and standard skull conductivity (10 mS/m, 3CI_10). We then performed FEM forward computations and inverse estimation using subaverages to identify the FCD [2]. We used a mc-TES array of 39 possible positions, utilizing the optimization method, ADMM [2] in a two-phase fashion for the mc-TES determination.

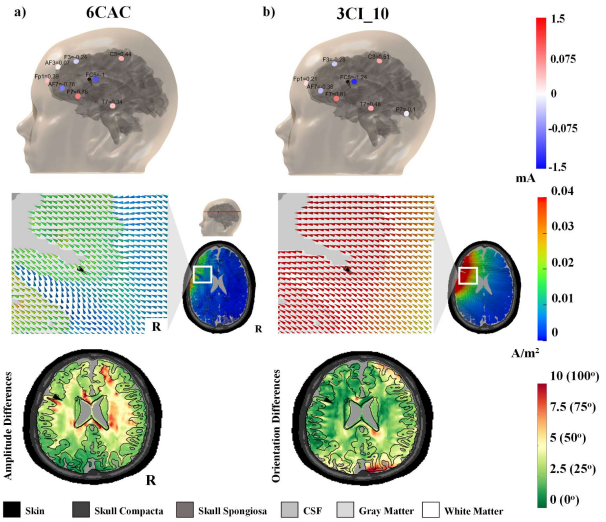

Figure 1. Comparison between different head models (**a.** 6CA_Cal versus **b.** 3CI_100) for mc-TES in epilepsy. First row: The individual optimized mc-TES montages for both head models. Second row: The current density on the target region (black cone) for each model. Amplitude and Orientation differences on the current density. The annotation R (Right) demonstrates MRI direction.

III. Results and Conclusion

We observe (Fig. 1) that the optimized mc-TES when using the 3CI_10 is considerably different from the mc-TES with the 6CAC (1st row). When also using the 3CI_10, the current follows an unrealistic flow compared to the 6CAC (2nd row) while the amplitude (orientation) at the target region (black cone) has 10 (50°) times higher (different). We conclude that the use of individually and calibrated head models for mc-TES are important for accurate stimulations in epilepsy.

References

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