Influence of model extent in forward simulations of tDCS: towards standardizing model extent

Chris Thomas[1], Yu Huang[12], Abhishek Datta[1]

[1] Research & Development, Soterix Medical, New York,NY

[2] Department of Biomedical Engineering, City College of New York, New York, NY

Computational models based on MRI are commonly used to predict brain current flow due to tDCS. The predictions from these models not only inform planning optimal stimulation strategies but also to analyze stimulation results on a post-hoc basis. Given that these models are based on individual MRI data, the field of volume (FOV) considered have been naturally restricted to the MRI volume collected. As a result, the model extent considered across studies has varied considerably – starting from head vertex down to level of the eyes, whole brain, jaw, whole head, etc. Further, with the availability of whole-body models, it raises the question whether model FOV should extend to even lower body regions to accurately predict cortical current flow. This uncertainty on the model extent that needs to be considered potentially impacts efforts on model validation and comparison across modeling studies.

The objective of this study was therefore to determine the FOV beyond which, computed cortical current flow magnitude would asymptote.

We considered multiple models derived from a single whole-body model obtained from the Virtual Family dataset. The “Duke” model representing a 34 year old male was adopted and was truncated from the head down to four different levels: upper-head (covering whole brain), whole-head (covering whole cranium), neck, and the torso. The intact whole-body model served as the “reference” model. We considered the classical M1-SO electrode montage and determined the induced cortical electric field magnitudes in each of the models. The differences between each model to the reference model was quantified using the relative difference measure (RDM) metric.

We observed a ~11% difference between the upper-head model in comparison to the whole-body model. The difference dropped to ~2% for whole-head model and did not drop significantly further for the other extents in comparison to the whole-body model.

Our results indicate that consideration of model FOV extending below the whole-head is not essential when computing cortical electric field. Forward modeling studies should incorporate models extending to the whole-head at a minimum to ensure accurate prediction.