

Computational Study on Transcutaneous Frontal Nerve Stimulation: Simplification of Human Head Model

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Introduction: Migraine is a highly disabling disorder of the brain which may affect patients both socially and economically [1],[2]. It is primarily related to frontal nerve branches of the ophthalmic nerve [3]. Transcutaneous supraorbital neuromodulation may suppress episodic migraine attacks. However, results have indicated low efficacy [4]. This inconclusive response may be associated with neuro-anatomical variations in patients which may be investigated using computational models. This paper investigates the effect of model complexity on fiber activation estimates in transcutaneous frontal nerve stimulation.

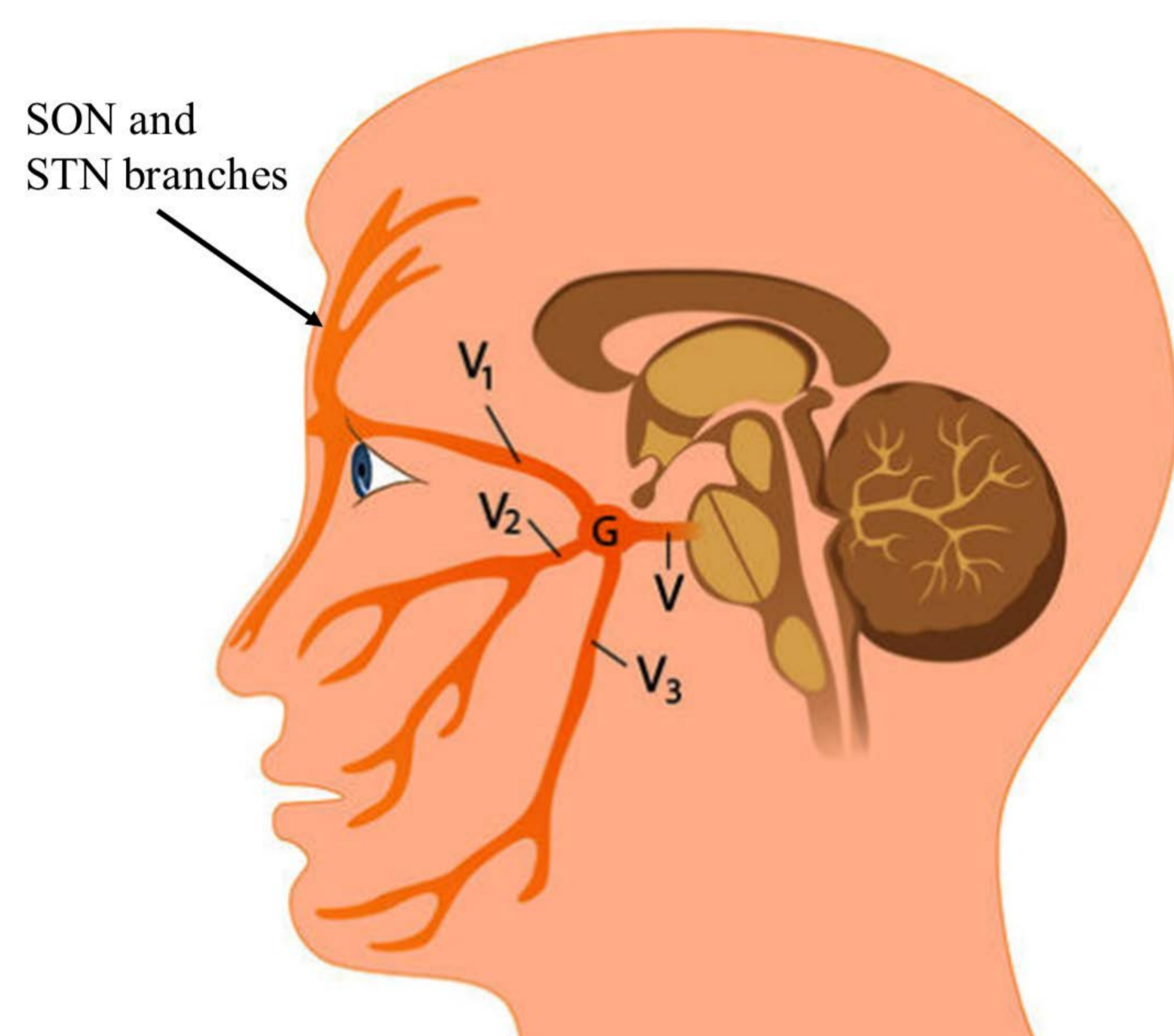


Figure 1. Trigeminal nerve (v) and its branches

Computational Methods: Three dimensional (3D) model of human head was derived from magnetic resonance imaging (MRI) scans for both simplified and realistic head models as shown in Fig.2a and 2b, respectively. Since in a complicated geometry (such as head volume conductor) the underlying differential equations cannot be solved analytically, the finite element method (FEM) was used to solve for the electrical potential distribution for each medium. The simulations were carried out using COMSOL Multphysics® while observing the quasi-static approximation of Maxwell equations demonstrated by Laplace formulation shown in below equation.

$$\nabla \cdot (\sigma \nabla V) = 0$$

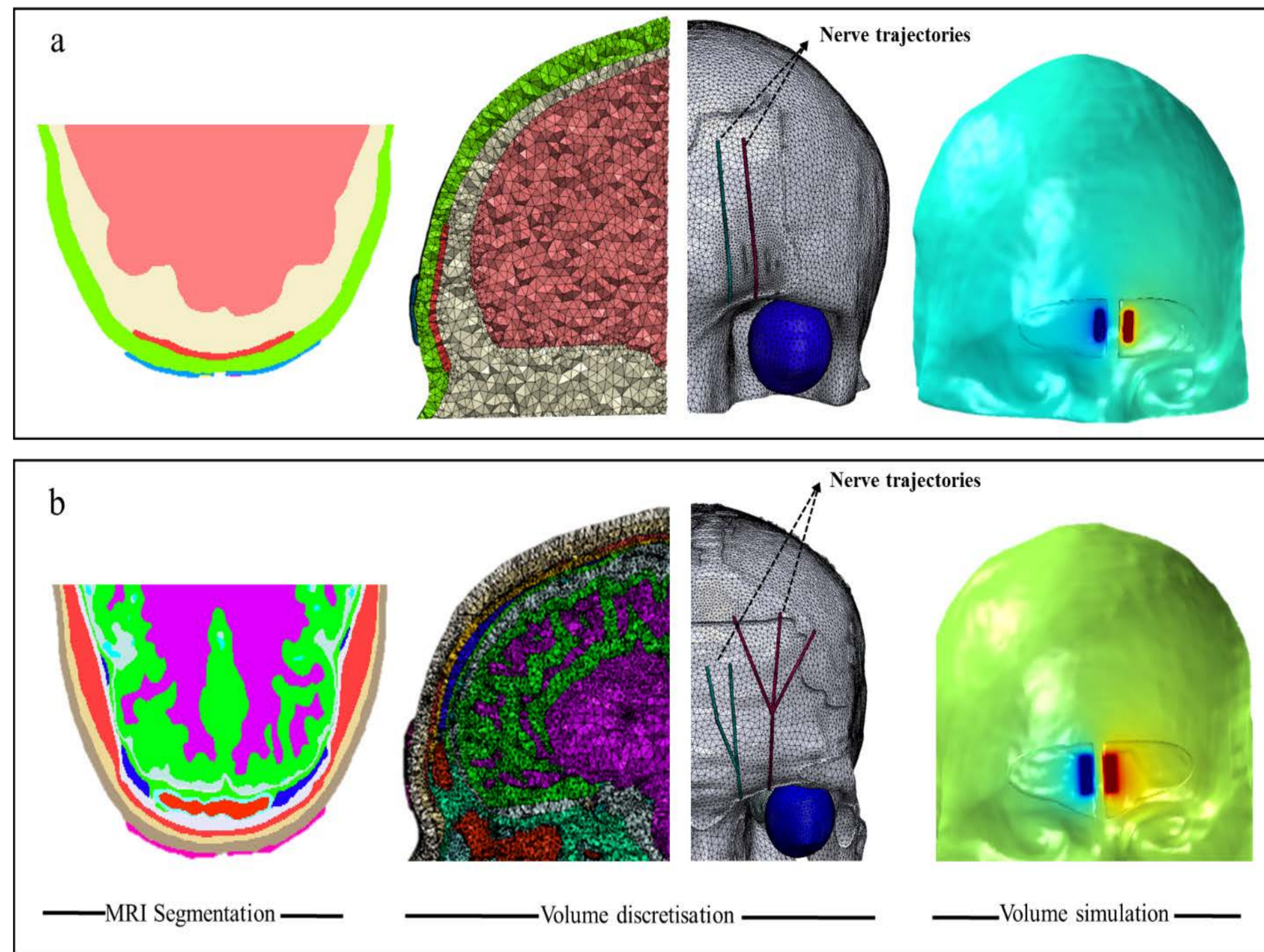


Figure 2. Showing simplified (a) and realistic (b) human head volume conductor

Results:

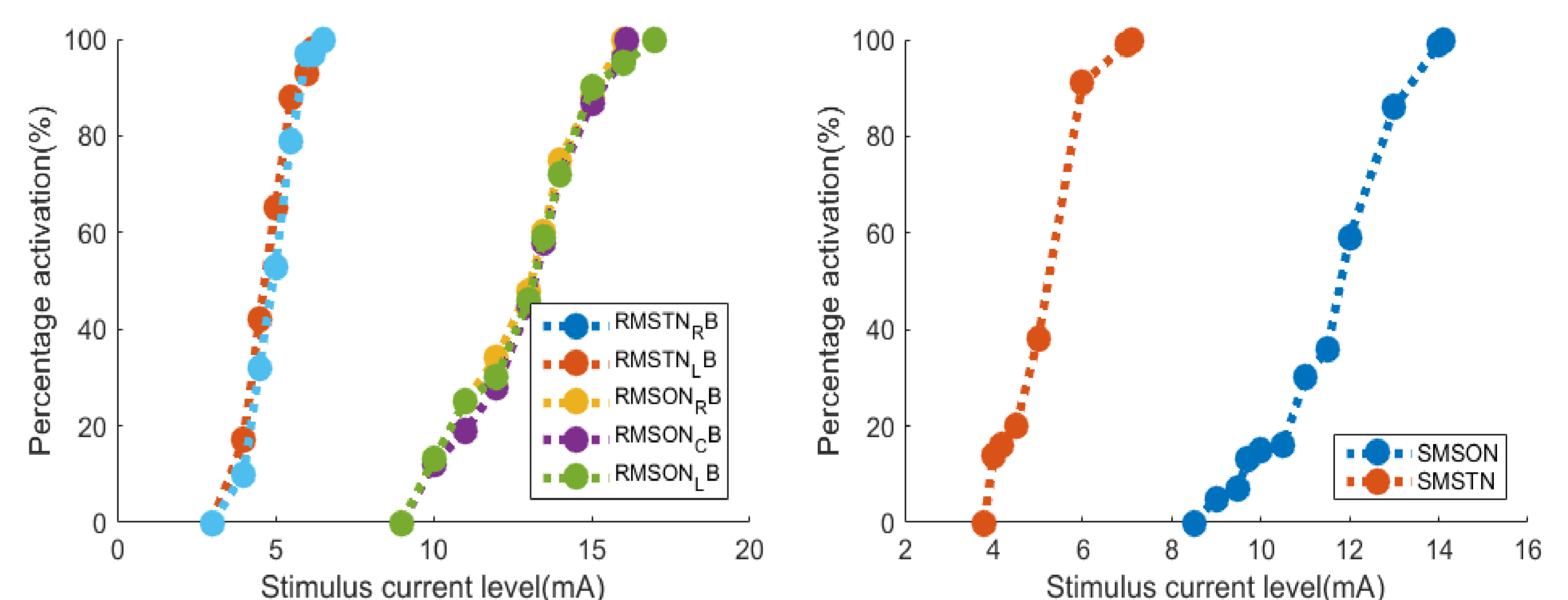


Figure 3. The PAs of nerve fibers versus stimulus current levels

Conclusion:

The difference between two models in terms of stimulus threshold level may be due to the mesh size in the model **b**. This is a limitation of this study which should be rectified to generate variations of this model

References:

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