

Biomag2006_ ABSTRACT

Title: "A study of the activating functions for neuronal stimulation by TMS"

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The purpose of this work is to investigate the distribution of the activation functions near or within a cortical sulcus and to hypothesize about the location and extent of the possible stimulation sites. The component of the electric field normal to the cortical surface, E_n , and the gradient of E_n along the same normal, $\partial E_n / \partial n$, appropriately scaled by the axon's length constant λ , were assumed to be the relevant parameters for neuronal stimulation [1]. The physical model consisted of a volume conductor with three layers (CSF, cerebral cortex with a single sulcus and white matter) with realistic thicknesses and electrical conductivities, and a circular magnetic coil (with realistic radius, current and frequency), lying 0.01 m above and parallel to the surface of the volume conductor. The distribution of the induced electric field was calculated using the Electromagnetics Module of the Comsol Multiphysics finite element software. The activation functions were then evaluated in a small volume around the cortical sulcus and directly under the coil winding using Matlab. This information allows us to determine the influence and the preponderance of each of the activation functions within specific cortical areas. For example, in a region such as the hand area of the motor cortex, the cells that are most probably directly stimulated by TMS are intracortical interneurons and short axon cells from adjacent association areas [2] whose length constants λ are about 2 mm. In this case, the results obtained so far indicate that along the vertical wall of the sulcus, the magnitude of λE_n is larger than that of $\lambda^2 (\partial E_n / \partial n)$.

[1] Nagarajan, S. S. et al. (1993), "Effects of Induced Electric Fields on Finite Neuronal Structures: A Simulation Study", IEEE Trans. Biom. Eng., Vol. 40, No. 11;

[2] Terao, Y., Ugawa, Y., "Basic Mechanisms of TMS", J. Clin. Neurophys., 19 (4): 322-343, 2002;