Analysis and development of transcranial magnetic stimulation devices

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Abstract

Transcranial magnetic stimulation (TMS) is an emerging technique to stimulate neural tissue non-invasively by inducing electric field in the brain with pulsed high-intensity magnetic field. The advantages of stimulating neural tissue in this way have resulted in the technique being rapidly adopted for research and clinical purposes. Advances in the depth and localization of stimulation that TMS can achieve will allow new applications to be established and replace surgical alternatives.

To evaluate the performance of coils used for TMS it is necessary to understand how pulsed magnetic field interacts with neural tissue. To model this phenomenon, numerical methods and anatomically realistic human head models have been employed to accurately determine where neural stimulation will occur. The results of this analysis reveal the simplified homogeneous head models used in earlier studies are unable to correctly predict the distribution of induced electric field at depth in the brain.

This method has subsequently been applied to develop novel coil designs to facilitate stimulation of deep-lying brain regions. Additionally, the mechanical stress experienced by TMS coils has been investigated to support further development of combined neuromodulation and neuroimaging systems.