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Sat-Mo-Po.02-03: A multi-parameter overlapping coil with a ring-shaped shielding for improving the deep brain transcranial magnetic stimulation

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As a non-invasive and painless treatment method for neurological diseases, transcranial magnetic stimulation has shown great potential in the diagnosis and treatment of central nervous system diseases and mental disorders. To improve the accuracy of stimulation in specific brain areas and reduce side effects during the treatment, the geometric structural design of the stimulation coil has become a hot topic in the TMS field. To solve the problem of unsatisfied stimulation focalization when traditional TMS is applied to deep brain regions, a new design of the multi-parameter overlapping coil (the MPO coil) is proposed in this paper. The MPO coil consists of two vertically placed stimulation coils and the crossing angle between two coils is adjustable. To further improve the stimulation performance of the MPO coil, a ring-shaped shielding plate which is made up of laminated sheet silicon steel material was placed around the MPO coil. The ring-shaped shielding plate can effectively reduce eddy current losses within the coil and decrease magnetic energy loss, thereby enhancing the stimulation focalization of the MPO coil. The finite element analysis method is adopted to obtain the stimulation characteristics of the MPO coil. Results show that compared with the conventional FOE coil, the MPO coil with the shielding plate can effectively increase the stimulation depth, and narrow down the focusing area while ensuring the stimulation intensity. The optimized MPO coil can achieve a stimulation depth of 3 cm below the scalp, which is more advantageous in deep brain stimulation compared to traditional stimulation coils with a depth of 1.5cm to 2cm. Under the same constraints, the MPO coil can improve the stimulation focalization by 10.4% and stimulation depth by 28.3% when compared to the FOE coil. A real human head model is used in this paper to verify our method.
Keywords: Coil; shielding plate; transcranial magnetic stimulation; multi-parametric; eddy current losses

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