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## Improved Overall Efficacy in Transcranial Magnetic Stimulation of Human Brain with Semi - ellipse Coil Pair

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Transcranial magnetic stimulation (TMS) is a modern technology for non-invasive modulation of the cortical tissue excitability in specific brain regions. Because of better focalization, planar Figure of Eight (FOE) coil is most widely used in magnetic stimulator nowadays, whereas it has two negative peaks besides the positive peak of interest and the ratio of peak value to negative peak value (RPN) is low. In order to obtain stronger induced electric field intensity and higher RPN without weakening focalization, a coil pair of innovative geometric structure is proposed in this paper based on the idea of special-shaped magnet. Projected onto a plane parallel to objective target, the two adjacent coils are in semi-ellipse shape. From the top view, the semi-ellipse coil pair (SEP) is bended along two mutually perpendicular axes with a range of radians which matches more with human head. The Finite-Element Method (FEM) is adopted to analyze the 3D spatial distributions of the induced electromagnetic field produced by SEP coil and the conventional FOE coil (mean diameter of 82mm) under the same excitation condition. A comparison function is constructed to analyze the new design's feasibility from therapeutic effect. The heating problem during a typical psychiatric treatment is discussed considering medical safety. Comparing to FOE coil, the geometry optimization of SEP coil with 60° radian can enhance the peak of induced electric field by 18.7%, raise RPN by 74.2% while improving the overall efficacy by 47.9%. A real human head modeled as homogeneous and isotropic is occupied in this paper to verify our method.

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