

## **Improvement of transcranial magnetic stimulation (TMS) coils for psychiatric applications**

### **Results:**

Two improved versions of a TMS coil designed for stimulation of deep neuronal structures, the new H1 and H2 coils, were built and tested for safety on 31 normal volunteers. Treatments were conducted with H1-coil, H2-coil, Standard (superficial) figure-8 coil and Sham coil at 1, 10 and 20 Hz. Analysis of short clinical assessments protocols and additional safety measurements revealed that TMS stimulation was well tolerated with no major side effects. Overall, the changes were not differential for the four treatment groups and no evidence was found for a possible deterioration in cognitive performance due to the TMS treatments. In some tests transient cognitive improvement were observed, but only with deep TMS.

The H-coils were then used in a clinical study to test for effectiveness and safety on 50 depressed patients, who received daily TMS treatment 5 days per week for 4 consecutive weeks. Stimulation with these coils was well tolerated, with no major side effects or adverse physical outcomes. Compared with the value prior to the start of TMS therapy,  $31.3 \pm 5.0$ , the average HAM-D scale dropped significantly to  $16.2 \pm 9.9$  on the day after completion of the therapy. There was no significant difference between the coils, but the H1 coil tended to induce greater antidepressant effects. The CANTAB performed before, during and after the study indicated selective improvement in cognitive functions, especially spatial memory and executive function.

We also showed, using computer models, that an effective way to improve the performance of the H-coils is to combine them with iron cores. Their presence contributes to an overall increase in stimulus intensity in the vicinity of the core, which is more pronounced in deep regions.

### **Published work:**

Roth, Y., A. Amir, Levkovitz, Y., Zangen, A. (2007). "Three-dimensional distribution of the electric field induced in the brain by transcranial magnetic stimulation using figure-8 and deep H-coils." *J Clin Neurophysiol* 24(1): 31-8.

Levkovitz, Y., Y. Roth, Harel, E. V., Braw, Y., Sheer, A., Zangen, A. (2007). "A randomized controlled feasibility and safety study of deep transcranial magnetic stimulation." *Clin Neurophysiol* 118(12): 2730-44.

R. Salvador, P. C. Miranda, Y. Roth, and A. Zangen, "High permeability cores to optimize the stimulation of deeply located brain regions using transcranial magnetic stimulation," *Phys Med Biol*, vol. 54, pp. 3113-28, May 21 2009.

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