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LETTERS TO THE EDITOR

Significant differences in motor threshold between figure-8 and double-cone coils for repetitive transcranial magnetic stimulation in patients with refractory depression

To the Editor,

The figure-8 (Fo8) coil offers superficially focal transcranial magnetic stimulation (TMS), while the double cone (DC) coil allows less focal stimulation but can reach deeper brain structures. This design also allows superficial cortical stimulation, albeit at lower intensities, as a trade-off.[1] Another study already compared the Fo8 coil to another type of deep TMS device, the H-coil, concluding to a higher absolute electric field, a more efficient activation of deeper cortical regions, as well as lower motor thresholds (MTs) with the latter[2]. In our TMS clinic, we had similar observation regarding MTs difference between the Fo8 and DC coils, which we decided to test experimentally in vivo in patients with refractory depression.

Nine patients referred to our clinic for refractory depression (five men, mean age of 54, in the range 32–89) were recruited. We used a MagVenture Cool B70 (Fo8) and D-B80 (DC) with a MagVenture X100 stimulator. The visualization of hand movement method by stimulation of the contralateral primary motor cortex was used to determine MTs.[3] MTs of each patient was measured with both coils during the same session and a counterbalancing design was used to avoid any inhibitory effect on cortical excitability when determining the MT with the second coil. Differences between coils were tested using a paired *t*-test, with significance level set at $p < 0.05$. Procedures were carried out after obtaining informed consent from patients and ethical approval.

A significant difference was found between MTs with the Fo8 coil ($M = 57.9\%$, $SD = 17.2$) and the DC coil ($M = 39.7\%$, $SD = 9.9$) ($t(8) = 6.68$, $p < 0.0001$). The average difference in MTs between both coils was 17.1%, that is an average MT 31.5% higher for the Fo8 coil compared to the DC coil. Also, a significant positive correlation is seen in Fig. 1, as the MT with the Fo8 increased, the difference between coils capacity to elicit cortical activation also increased ($r = 0.939$, $n = 9$, $p < 0.00001$), the DC coil evoking lower MTs. Finally, no impact was seen depending on the order in which the coils were tested.

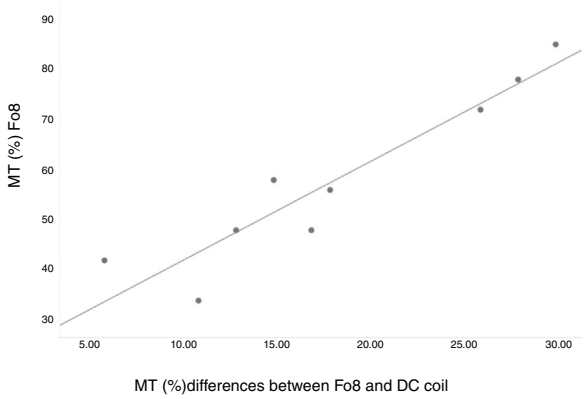

Figure 1 Differential cortical excitability based on MTs between the Fo8 and DC coils.

This is the first study highlighting a significant difference in MTs between Fo8 and DC coil for rTMS in patients with refractory depression. In accordance with physiological theory[1] and preliminary results[4], our data demonstrate that the MT is consistently and significantly higher with the Fo8 coil than for the DC coil in every patient, and this effect becomes larger at higher MTs.

Interesting findings arise from our results. First, the significant difference in MT averages for the two different coil designs leads us to believe that if we use one coil design to determine a patient's MT while using a different coil for treatment, the intensity of the stimulation during treatment will be grossly different if the same type of coil was used, that is, around 30% more for patients receiving treatments with the DC coil. This could represent an important safety issue, as clinicians need to realize that the MT determined with the Fo8 coil cannot be used for the DC coil. Secondly, there was an important difference between the MTs of the two coils at all intensity levels. This difference increased at higher MTs. This could be explained by the fact that the DC coil, with its different magnetic field geometry, is less sensitive to precise positioning over the motor cortex and can probably recruit a larger volume of cortical gray matter and deeper cortical structures. This is in line with a previous study stating that MTs are influenced by skull to cortex distance and corticospinal tract direction, over which the DC coil has advantages.[5] For patients who experience treatment tolerability issues at higher MTs, this finding could be of interest, as a switch to the DC coil could reduce scalp pain.

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With these hypotheses in mind, more reliable and tolerable rTMS treatments could be expected with the DC coil, and thus offer an alternative to the Fo8 coil in certain cases. This would merit further investigations with additional patients and possibly electrical field measurement in a head model.

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Conflicts of interest

The corresponding author states on behalf of all authors that there are no conflicts of interest.

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