Occupational exposure to TMS treatment: variability among human anatomical models

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Transcranial Magnetic Stimulation (TMS) is a neurostimulation and neuromodulation technique used as a neuro-investigation and diagnostic tool [1], as well as in the clinical practice for therapeutic purposes.
In TMS applications, the stimulating coil, placed over the patient's head, generates a high intensity pulsed magnetic field, up to 2 T, spread in the space around the stimulating coil.
One issue related to occupational exposure lays on the importance of the manual skills of the clinician that require healthcare personnel to operate in the vicinity of the patient, often holding the coil with their hand. Clinicians can use TMS for several hours a day and for many days, with the result that she/he remains exposed for a long time to the magnetic field produced by the source (Figure 1). It is worth to note that characterization of such an exposure cannot be unique due to different anatomical characteristics of the operators implying different electromagnetic (EM) exposure conditions.
The purpose of this work is to carry out a comparative numerical evaluation of the EM exposure assessment among different human anatomical models representing medical staff during TMS treatment.
The study is based on an exposure scenario, derived from real working environments and the EM exposure is evaluated using virtual human body models male and female with different anatomical characteristics (e.g. height, body fat, age, size etc.) and considering as a source of TMS a circular coil. The 99th percentile of induced electric field inside the operator's body tissues has been evaluated by means a post-processing tool, and afterwards compared with the limits reported both in the 2013/35 European Directive [2] and the ICNIRP 2010 guidelines [3]. Results of the induced electric field in the human models show that in the cases here analyzed the exposure limits can be exceeded, but also indicate that the exposure appears to be slightly influenced by the gender and body shape of the operator. This study could be a useful starting point for future risk assessment studies and for providing general safety guidance, since to date there are no standardized requirements for the conformity assessment of TMS [4].

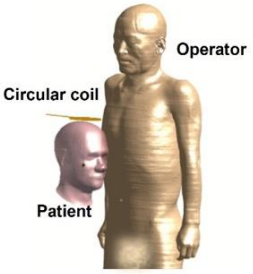

Figure 1: Scheme of an occupational exposure condition during TMS treatment

References

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[2] Directive 2013/35 / EU of the European Parliament and of the Council of 26 June 2013 on the minimum safety and health provisions relating to the exposure of workers to the risks deriving from physical agents (electromagnetic fields) (twentieth particular directive pursuant to article 16 , paragraph 1, of Directive 89/391/EEC) and which repeals Directive 2004/40 / EC. *Official Journal of the European Union*, **L179/1**, 2013, pp. 1-21.
[3] International Commission on Non-Ionizing Radiation Protection "Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz)", *Health Physics*, **99 (6)**, 2010, pp: 818-836.
[4] I. P De Sousa,. & E. Costa Monteiro, "Transcranial magnetic stimulation conformity assessment". *XXI IMEKO World Congress Measurement in Research and Industry*, **1/3**, 2015, pp 1297–1300, ISBN: 978-1-5108-1292-5.
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