INDUCED ELECTRICAL FIELDS ON A HUMAN BODY BY VARIOUS MAGNETIC FIELD TOPOLOGIES IN THE LIGHT OF PERIPHERAL NERVE STIMULATION THRESHOLDS

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INTRODUCTION: Induced electrical fields inside the human body trigger peripheral nerve stimulation (PNS), if they exceed a frequency dependent threshold [1]. For magnetic particle imaging (MPI), studies using magnetic fields which are almost homogeneous in one direction have been carried out [2-5]. In order to extend those results to other magnetic fields and coil topologies, notably for field free line and single sided scanners, and to allow the optimization of coils to limit the triggering of nerves, a boundary element method model of the induced electrical field has been implemented in Matlab.

METHODS: The surface of a person is meshed in 3D and is placed inside or on a surface carrying a current density. The coil surface is either a cylinder with an inner diameter of 0.63 m or a circle with a diameter of 0.5 m. Then, the induced electrical field over the body surface is calculated according to Faraday's law [6]. For the cylindrical model, points having a value greater than 5 or 6 times the standard deviation of the results were set to zero, in order to address the mesh inconsistency (at the back of the hand, elements reached unrealistic values). The coil surface is then translated along the z axis to find the relative position where the highest maximal induced electrical field (HMIEF) is reached. The induced electrical field due to the translation movement is not taken into account. The HMIEF values are then divided by the main spherical harmonic coefficient and the frequency, to facilitate any further scaling.

RESULTS: The relative position between the two surfaces leading to the HMIEF is calculated and displayed in Fig. 1. The coil is always positioned as in Fig. 1 a) and b) when the HMIEF is reached.

CONCLUSION: A set of HMIEF values have been calculated. This will facilitate the approximation of PNS limits for different MPI scanners. Comparing those results with the thresholds proposed in [1], an FFL scanner with a gradient perpendicular to the line of 1 T/m may induce PNS if the frequency applied to the quadrupoles goes above 100 Hz.

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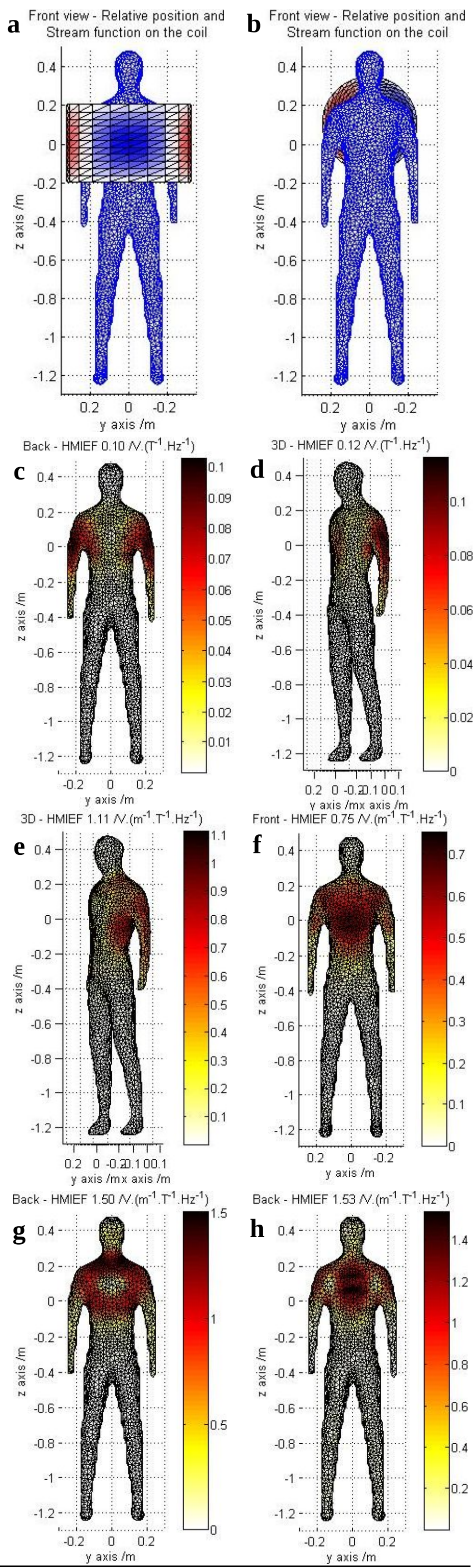

Figure 1: **a, b)** Used patient and coil surfaces. The coil surfaces are translated along the z-axis to find the position inducing the HMIEF. The model a) is used for the results c to f. The model b) is used for the results g and h. The subsequent subfigures show the induced electrical fields: **c)** by the quadrupole shown in a), **d)** by a quadrupole rotated around the z-axis by 45° in comparison to the one in a), **e)** by an x-drive coil, **f)** by a y-drive coil, **g)** by an x-drive coil, **h)** by a y-coil.

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