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Challenges in the evaluation of the biophysical effects of electromagnetic exposure in the palms of a surgical treatment team

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The stream of high-frequency current across the human body causes thermal load in tissues, and when one high voltage electrode attached to the body is large and a second one is small, it is possible to create very localized strong thermal effects near the small electrode, and to use this during surgical treatments to reduce the blood lost in patients by coagulating soft tissues, or even cutting them. This treatment is performed using surgical diathermy devices (SDD), in particular using the manually operated active electrode of an SDD (sometimes recognized as an electric knife). During the treatment, all members of treatment team (usually a group of 2-10 medical personnel involved in the patients treatment) are exposed to an electromagnetic field (EMF) emitted by the SDD electrode and cables connected with the high voltage potential at the SDD generator.

The results of performed studies (EMF and limb current measurements, and numerical simulations of EMF spatial distribution near SDD and patient), both in our project and elsewhere, showed a high level of localized exposure to EMF emitted during the treatment from the active electrode and SDD cables. The highest exposure is received by the hand of the operator, or other personnel who grasping the handle of the active electrode or the cable. However in some exposure situations, other highly exposed parts of the body may also suffer from EMF exposure (the profile of exposure is determined in principle by the complex conditions, such as patient's health, the spatial organization of the treatment room, the organization of the work of the treatment team – e.g. the number of personnel assisting with the patient and their location, as well as the location of other nearby objects, such as lamps or tables, the location of the SDD cables, the way the handle of active electrode or cable are grasping, and even the electrical grounding of particular devices and objects in the treatment room).

However, the results of EMF and limb current measurements showed clearly, that in many realistic exposure situations, the level and spatial distribution of SAR and induced current need evaluation in the palm of the surgeon (or other person) who is exposed to EMF while grasping the handle of the active electrode or cable – the results of this evaluation of EMF exposure effects in the workers' body are very sparse. Our experience in this challenging field of numerical modeling showed that the SAR and induced electric field values obtained in the models of palm are very sensitive to the dimensions of the palm and the spatial configurations of the palm during EMF exposure caused by using a SDD. The reports from the treatment teams showed clearly that at least two main cases need to be taken into considerations: (i) "pencil-like" grasping – typical when the handle of the active electrode is managed by the surgeon; and (ii) "toothbrush-like" grasping – typical when the cable connecting the electrode with the diathermy generator needs to be managed by the assisting personnel. Our experience showed that the available human body posable models allow the relevant geometrical models of these exposure situations to be created, but the internal structure of palms is still far from anatomic. In addition, the dimensions of the palms in the available posable models do not cover the anthropometric spectrum of workers' palms (which need attention in light of the results of our simulation studies performed using small set of numerical body models). Further studies in that direction are needed, because the EMF exposure on SDD may reach levels exceeding exposure the limits provided by standardization bodies such as IEEE/ICES and ICNIRP.

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