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On Seeking the *Worst Case* of Human Exposure to the External EMF Radiation

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Introduction

Electromagnetic field (EMF) radiation is very controversial issue. For one hand, many therapeutic and diagnostic applications are proved effective; on the other hand, excessive exposure may cause adverse biological effects. In order to prevent the over-exposure, the worst results are frequently discussed for the safety limits. The basis of the issue is to establish the relationship between the external radiation field and the dose (SAR) distribution in the whole body and the specified tissues. External sources, dosimetric methods and the digital human models are the key elements which could determine that relationship. Because of lack of the non-invasive measurement techniques, numerical methods such as FDTD, FEM and MoM are frequently utilized to qualify the in-body dose distribution. Variability introduced for the numerical methods are insignificant. Given the external radiation field are fixed; the influential factors were include the tissue dielectric properties, postures/statures, anatomical structures, physique features and etc. Practically, they are often interwoven to each other. Many studies were focusing on the surrogate models and the morphing was available in order to find out the *worst case* with a certain external exposure.

Present Trends

Surrogate models

During the past two decades, several realistic digital human models (phantoms) were generated by MRI/CT, sliced photo and the specialized software. They were represented different races and physique characters. The SAR of whole body was mainly depended on the stature and resonant frequency. Based on this conclusion, surrogate models were proposed to approximate the physique effect (body mass index, body surface area) and to the internal dose distribution. This is a commitment dosimetric evaluation method of the whole body which was combining with the statistical analysis.

Morphing

The target of morphing is investigating the internal dose distribution caused by postured effect. The current morphing work was made mainly about the information technology and available 3D deformation platform. It could be utilized to assess the internal power distribution for the designed scenarios such as sitting, supine, prone, standing and even more complicated poses.

The insufficiency of the surrogate model and the present morphing technique were the incapability to mimic the deformation of the internal tissues. Admittedly, heterogeneous human models on many postures were generated and published. One thing to mention was that the deformation emphasized to the profile approximation and with less anatomical validation for the internal organs or tissues. Current deformation approaches either simply deformed the internal organs with the same extent with the outer layers or left them untouched. Volumetric variation and displacement could cause the gravity effect contributed to the realistic organ deformation due to statures and postures, which in return, affected the power absorption on the tissues.

Conclusion

The clinical imaging method should be systematically applied to investigate the realistic deformation extent for the internal tissues and organs by the typical postures and statures. If any coefficients could be confirmed, the question of *worst case* with the whole body and the tissues would be answered better.

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