SARs and Temperature Increase Induced by MRI Fields in a Model of the Human Head with Retinal Implants

Zhengxin Tong*[(1)] and Gianluca Lazzi[(1)]
(1) NC State University, Raleigh, NC, USA

While Magnetic Resonance Imaging (MRI) is a routinely used medical imaging technique, its application in cases where patients carry implants is often discouraged, unless specific safety testing demonstrate that a given implant does not carry a risk of injury for the patient. On of the main concerns, in the case of implants, is the presence of metal and leads which carry under certain condition large currents as well as potentially result in significant temperature increase when exposed to the RF fields of the MRI equipment.

A epiretinal implant has been under investigation and development since over a decade by several groups. The epiretinal implant consists of an implanted telemetry coil to receive power and data, an implanted microchip, and an electrode array position on the surface of the retina. At this stage, encouraging preliminary results show that patients affected by retinal degeneration diseases such as Retinitis Pigmentosa (RP) and Age-Related Macular Degeneration (AMD) can gain some form of vision. Results with 16 electrode array have been reported – recent evidence suggests that a higher electrode count can result in improved, higher resolution, restored vision.

In this presentation, we focused on determining the potential of thermal injury of patients with an epiretinal prosthesis implant that are exposed to the fields of a MRI system. Both a uniform-grid Finite-Difference Time-Domain (FDTD) and Expanding Grid FDTD techniques have been used for computational modeling of the MR fields induced in a model of the human head with implant at 64, 128 and 256 MHz. Particular attention was given to the computation of the Specific Absorption rate (SAR) and temperature increase in regions proximal to the implant and the telemetry coil with respect to patients that do not carry the implant. It is observed that, as the frequency increases, the homogeneity of the induced radio-frequency (RF) magnetic fields decreases due to enhanced electromagnetic interactions with the human tissues as well as higher induced currents in the implant. However, the peak 1-g SAR values computed at aforementioned frequencies are well within safety limits published by IEEE and other organizations. Temperature elevations resulting from the SAR distribution as well as the induced currents in the implant, evaluated using the bio-heat equation, are also computed at these frequencies. Results show that, for the particular epiretinal implant considered, neither induced SAR or thermal increase are likely to be a concern.