Effects on Fluoroptic Temperature Probes on Heating Measurements for MRI Implantable Devices

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When patients with medical implantable devices are undergoing MRI procedures, the energy induced from the MRI RF coil can exhibit focusing near the tips of these implantable devices. As a result, higher temperature rises are expected in the vicinities of these medical implants. To determine the maximum heating of a family of medical devices, extensive electromagnetic simulations are often required to capture the surface heating patterns of complex medical implantable devices. Once the electromagnetic simulations are finished, measurements are performed near the maximum heating location to determine the worst-case heating.

However, during actual measurements, the temperature probe may interfere with the original energy deposition near the tips of various devices. To investigate this effect, a temperature probe CAD model is developed and included in the original numerical simulations. The effect of the temperature probe on device heating for three different implants is studied in this paper: 1) a spinal basis system, which is used to represent implanted orthopedic devices; 2) an external fixation device with two connection bars and two insertion pins, which is used to represent external fixation devices; and 3) a 20 cm long coaxial lead, which is used to represent the lead structure in pacemaker leads. Experimental studies are also performed using different relative positions between the probes and the devices.

The results indicate that the potential effect of the fluoroptic probes cannot be ignored. For thin and long medical devices such as pacemaker leads, the existence of fluoroptic probes could lead to a 51.2% temperature measurement error. This study also indicates that a perpendicular relative position can minimize the measurement error to 20%. Good agreement between simulation and experiment is found.