Magnetic Resonance Imaging-induced heating on patients with Implantable Cardioverter-Defibrillators and Pacemaker: Role of Lead Structure

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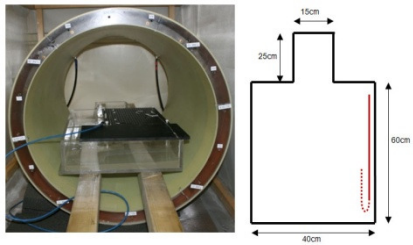
Magnetic Resonance Imaging (MRI) induced heating on patients with metal implants can pose severe health risks and careful evaluations are needed for pacemaker (PM) or implantable cardioverter-defibrillator (ICD) leads to be labeled as 'MRI conditionally'.

Experimental studies in this field have shown a great variability in results and revealed that several aspects can affect the amount of heating induced at the lead tip. The structural parameters of the lead are one of these.



RF coil and human trunk simulator and sketch of the lead positioning inside the phantom

In this study we performed in-vitro temperature measurements of PM/ICD leads inside a human trunk simulator exposed to the RF field of a 1.5T MRI scanner. Aim of these measurements is to investigate the role of the lead structure on the induced heating at the lead electrodes (tip and ring). The exposure system was a 64 MHz birdcage coil delivering a whole-body SAR on 1W/kg and temperature was measured by fluoroptic® porbes. The trunk simulator was filled with a gelled saline solution that minimized the heat transfer by convection, as described in the international standards ASTM F2182–02a.

A total of 26 commercial leads from 7 manufacturers were tested (23 PM leads, 3 ICD leads) and the temperature increases induced by the RF field ranged from 2.1°C to 15.0°C. Significant heating was observed not only at the lead tip, but also at the ring (as high as 4.2°C), even if not in all the bipolar leads tested. Active-fix leads showed higher temperature increases than passive-fix ones (4.7°C versus 7.4°C).

In conclusion, the lead structure plays an important role in the MRI-induced heating. It must be carefully considered to interpret the widely varying results reported in literature and to define safe conditions to extend MRI to patients with metal implants.