Heating of lead electrodes disconnected from sacral stimulator during routine lumbar and pelvic MRI at 1.5T with receive-only coil

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Target Audience: MR safety researchers, researchers interested in MR scans with sacral stimulation implants

Purpose:

Sacral nerve stimulation is a type of electrical stimulation therapy to treat voiding dysfunction, in which a subcutaneously placed programmable stimulator sends low amplitude electrical stimulation to the sacral nerve via a lead. If subjected to an MRI procedure, the electrode contacts of the lead and the IPG case can be subjected to RF induced heating. MRI scans of the head under certain conditions is allowed to be safely performed for patients implanted with Medtronic InterStim II model 3058 stimulator, while all other scans are contraindicated. We performed RF heating testing during pelvic and lumbar scans of Medtronic Interstim II (Model 3058) implantable pulse generator (IPG) connected to Medtronic Quadipolar Nerve Stimulator Lead (Model 3889) at 1.5T. In addition, to understand real-world situations such as scenarios where (i) the lead had snapped or (ii) the stimulator is left disconnected from the lead, we repeated the study with the lead only (no stimulator) for the scan with the highest Specific Absorption Rate (SAR).

Methods:

MR scans were performed using a 1.5 Tesla Siemens Magnetom Aera scanner (Erlangen, Germany) with a Siemens 18 channel receive-only body phased array coil (Body 18) for pelvic scans. The IPG connected to the lead with 4 electrode contacts was inserted in the pelvic area of a head and torso phantom filled with polyacrylic gel[1]. The lead and the IPG were set up in the phantom similar to where it would be in a human (Fig. 1). Four fluoroptic temperature sensors (model m3300, LumaSense Technologies, Santa Clara, CA, USA) were used for temperature measurement. The points of contact of the probes were (i) the proximal contact, (ii) the contact next to the distal contact, (iii) on the IPG case, and (iv) the gel as a control. The probe from case was connected to a contact in the open end in the IPG disconnected configuration. Prior to immersion into the gel the IPG was turned off. A pelvic MRI protocol was performed that consisted of 11 scans. SAR values were recorded for each scan from the console. A coronal Half-Fourier Acquisition Single-shot Turbo spin-Echo (HASTE) (TR/TE/FA = 900 ms/86ms/180^0, turbo factor = 256) had the highest SAR (whole body / exposed body / head / time averaged RF power = 1.7 W/kg / 2.7 W/kg / 2.4 W/kg / 229.3 W). The HASTE scan was then repeated after disconnecting the IPG lead from the lead and removing the IPG from the phantom.

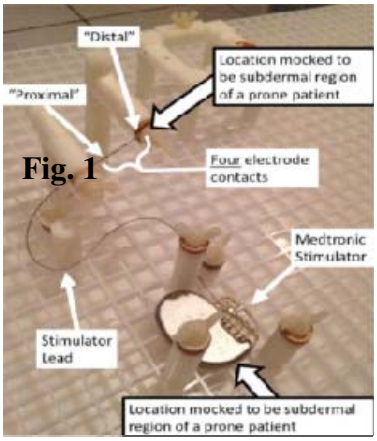

Fig. 1

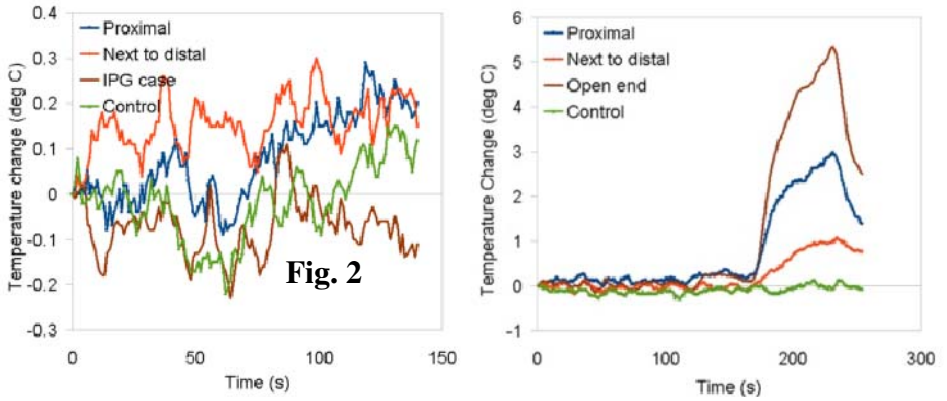

Fig. 2

Results and Discussion:

No electrode heating was observed when the lead was connected with the IPG in any of the scans, while considerable heating was observed during HASTE scan when the IPG was disconnected and taken out of the phantom. Heating during HASTE scan during both configurations is shown in Fig. 2. The maximum heating observed at the open end, proximal, distal and reference point during HASTE with lead only configuration were 5.35^0, 2.98^0, 1.08^0 and 0.14^{0}C respectively. The results provide evidence that the risk of heating is low for pelvic or lumbar MRI in the setting of an intact Medtronic InterStim II (Model 3058) and lead (Model 3889) system at 1.5T. However, MRI of pelvis or lumbar spine in the presence of a lead disconnected from the IPG can result in electrode heating. It should be noted that these results do not necessarily generalize and individual centers should validate safety of performing MR scans in presence of such implants before scanning patients with implants.

Conclusion:

Patients with Medtronic lead (Model 3889) not connected to InterStim II (Model 3058) should not be scanned with pelvic or lumbar protocol at 1.5T with a receive-only body-array coil. In the event of surgeons deciding to leave the lead only for subsequent implantation of an IPG, the patient should not be scanned during that time. We also recommend routine checks for broken leads (by impedance testing with the programmer) prior to scans to avoid excessive tissue heating.

Acknowledgements: Medtronic, Inc.

References: 1.Baker, J Magn Reson Imaging, 2006, 1236-42