

Investigation of MRI RF-induced Heating of Lead Wire by Different Thickness of Cap

Satoshi Yatsushiro^{*(1,2)}, Takashi Yokawa⁽¹⁾, and Kagayaki Kuroda⁽²⁾

(1) BioView, Inc., Tokyo, Japan; e-mail: yatsushiro@bioview.co.jp; yokawa@bioview.co.jp

(2) Department of Human and Information Science, School of Information Science and Technology, Tokai University, Kanagawa, Japan; e-mail: kagayaki@keyaki.cc.u-tokai.ac.jp

Introduction

Application cases of magnetic resonance imaging (MRI) for patient with implantable medical device (IMD) are recently increasing.[1] It is important for understanding of electromagnetic interference between MRI and IMD, in particular that induces tissue heating by radiofrequency electromagnetic wave of MRI, called as radio frequency (RF) induced heating. It has reported that the capped abandoned lead of MR-conditional pacemaker generates heat more than the uncapped lead. In this study, to investigate the heating effect by the difference of cap thickness, as a basic step, we have conducted electromagnetic field simulation of an insulated lead wire in the absence/presence of cap, including with different thickness.

Methods

The simulation was performed using a finite difference time domain (FDTD) method on commercial software (Sim4Life, Zurich Med Tech AG, Zurich, Switzerland). The lead wire has 260 mm length and 1.6 mm diameter with 0.45 mm insulation. The length of the bare parts of the wire was 20 mm. The thickness of the cap was 0.45 and 1.00 mm. The lead wire was immersed in polyacrylic acid gel of ASTM phantom denoted in ASTM F2182. The RF magnetic field at 64 MHz of 1.5-T MRI was created by the lowpass-typed 8-elements birdcage coil. Local specific absorption rate (SAR) was defined as SAR in 1 mm³ cubic region.

Results

Figure 1 shows the lead wire configurations, each SAR distribution, and the maximum local SAR for each configuration. The local SAR in presence of 1 mm cap was relatively lower than that of 0.45 mm cap, although that is considerably high against the uncapped wire. This result indicated that RF-induced heating for the insulated lead wire may be reduced by cap with sufficient thickness.

Conclusion

In conclusion, this study demonstrated RF-induced heating of the lead wire by in the absence/presence of cap as well as the difference of the cap thickness. Further investigation for the effect of the cap property such as thickness and relative permittivity will be conducted.

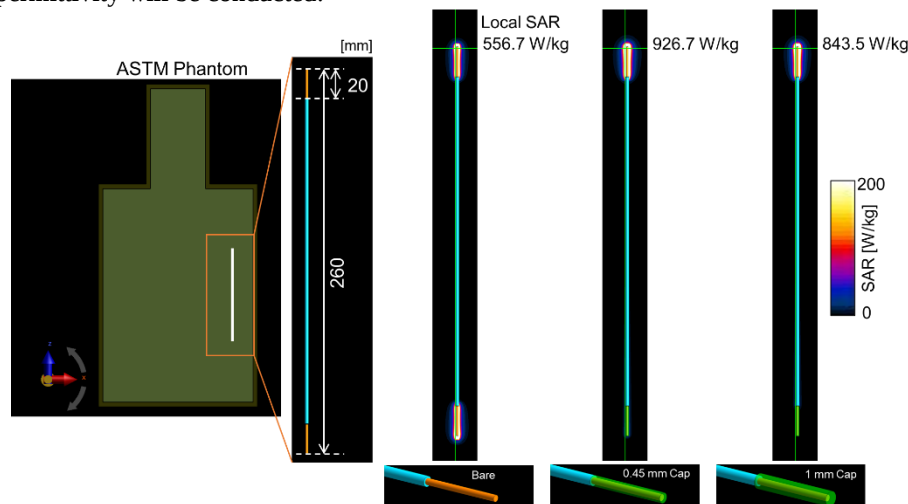


Figure 1. ASTM phantom, the lead wire configurations, and SAR distribution for each configuration. Maximum local SAR observed at the intersection of green lines in the distribution was shown in the top-right of each distribution.

References

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