



Investigation on Heating of the Implant Metal Exposed to HF-EMF due to Wireless Power Transfer

Shinto Son ^{*(1)}, Emi Matsuda ⁽¹⁾, Takashi Hikage ⁽¹⁾, and Toshio Nojima ⁽¹⁾

(1) Graduate School of Information Science and Technology, Hokkaido University,
Kita14, Nishi9, Kita-ku, Sapporo, Hokkaido, 060-0814 Japan
e-mail: hikage@wtmc.ist.hokudai.ac.jp

With regard to the electromagnetic field (EMF) emitted from wireless communication devices, international radio radiation protection guidelines for human exposure to EMF have been established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [1] and the Institute of Electrical and Electronic Engineers (IEEE) [2]. These guidelines provide no quantitative discussions about their relevance to humans with metallic objects embedded in their bodies. It is very important to estimate the amount of exposure that users with metallic implants will experience. Some papers regarding interaction of radio frequency (RF) EMF and metallic implants have been published, and studies on the EMF exposure of users with passive metallic implants have reported measurements and numerical estimations [3], [4].

The main objective of this study is to assess whether implant metal, such as osteosynthesis plates, screws, and wires in the treatment of fractures, could be expected to cause temperature increase at HF-band Wireless Power Transfer (WPT) frequency band. Numerical simulation that can treat electromagnetic and thermal analyses are carried out to estimate the characteristics of temperature elevation due to HF-band WPT. In addition, by using thermograph, temperature elevation distribution is measured on the implant metal. Here, we estimate loop-shaped metallic objects exposed to HF-band EMF.

From our results, temperature increase on implant metal due to HF-EMF was clearly observed. Future works include evaluating the temperature elevation while changing the size or shape of the implant metal and other types of metallic objects.

1. ICNIRP Guidelines, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)," *Health Phys.*, vol.74, no.4, pp.494–522, 1998.
2. ANSI/IEEE C95.1-1999, "IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz"
3. McIntosh RL, Anderson V, McKenzie RJ., "A numerical evaluation of SAR distribution and temperature changes around a metallic plate in the head of a RF exposed worker," *Bioelectromagnetics*, vol.26, no.5, pp.377-388, 2005.
4. A. Kyriakou, A. Christ, E. Neufeld, and N. Kuster, "Local Tissue Temperature Increase of a Generic Implant Compared to the Basic Restrictions Defined in Safety Guidelines," *Bioelectromagnetics*, vol.33, no.5, pp.366–374, 2012.