ABSTRACTS (PH D THESIS)

Study on RF Safety by Using Human Cells in Vitro under Magnetic Resonant Coupling Wireless Power Transfer

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Wireless power transfer (WPT) technology using the resonant coupling phenomenon has been widely studied. However, possible relationships between WPT exposure and human health have not been experimentally evaluated. In this study, we developed a new in vitro exposure system to evaluate the biological effects of magnetic resonant coupling WPT (Fig.1). The WPT was carried out using a self-resonant helical coil, which was designed to transfer the power with 85.4% efficiency at a 12.5 MHz resonant frequency. The magnetic field at the positions of the cell culture dishes is approximately twice the reference level for occupational exposure as stated in the International Commission on Non-ionizing Radiation Protection (ICNIRP) guidelines. The specific absorption rate (SAR) at the positions of the cell culture dishes match the respective reference levels stated in the ICNIRP guidelines. In this paper, the coil design for magnetic resonant coupling in the in vitro exposure system and characteristics, such as power transfer efficiency, electric field and magnetic field distributions and SAR of the exposure system, are described.

Next, we investigated whether exposure to magnetic resonant coupling WPT has genotoxic effects on WI38VA13 subcloned 2RA human fibroblast cells. WPT exposure was performed using a helical coil-based exposure system designed to transfer power with 85.4% efficiency at a 12.5-MHz resonant frequency. The magnetic field at the positions of the cell culture dishes is approximately twice the reference level for occupational exposure as stated in the International Commission on Non-ionizing Radiation Protection (ICNIRP) guidelines. The specific absorption rate at the positions of the cell culture dishes matches the respective reference levels stated in the ICNIRP guidelines. For assessment of genotoxicity, we studied cell growth, cell cycle distribution, DNA strand breaks using the comet assay, micronucleus formation, and hypoxanthine–guanine phosphoribosyltransferase (HPRT) gene mutation, and did not detect any significant effects between the WPT-exposed cells and sham-exposed cells. Our results suggest that WPT exposure under the conditions of the ICNIRP guidelines does not cause detectable cellular genotoxicity.

A dosimetric evaluation has also been discussed to evaluate the potential health risks of the electromagnetic field from this WPT technology based on the ICNIRP guidelines. However, there has not been much experimental evaluation of the potential health risks of this WPT technology. In this study, to evaluate whether magnetic resonant coupling WPT induces cellular stress, we focused on heat shock proteins (Hsps) and determined the expression level of Hsps 27, 70 and 90 in WI38VA13 subcloned 2RA human fibroblast cells using a western blotting method. The expression level of Hsps under conditions of magnetic resonant coupling WPT for 24 h (Tab.1) was not significantly different compared with control cells, although the expression level of Hsps for cells exposed to heat stress conditions was significantly increased. These results suggested that exposure to magnetic resonant coupling WPT did not cause detectable cell stress (Fig.2).

Acknowledgements

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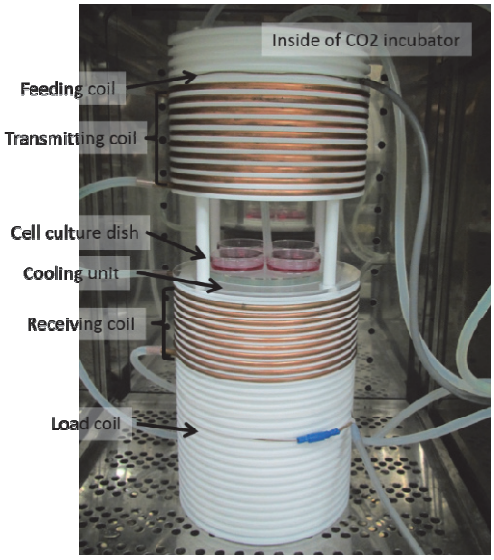

Fig. 1. Photograph of coils for magnetic resonant coupling WPT within the CO_2 incubator.

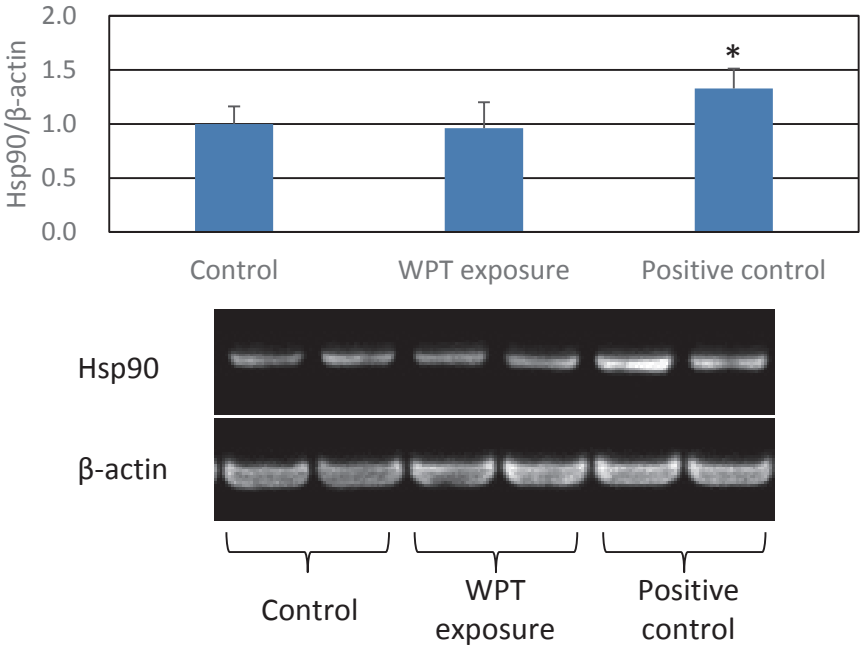

Fig 2. The expression of Hsp 90 in WI38VA13 subcloned 2RA human fibroblast cells exposed to WPT and control cells for 24 h, or heated at 43 °C as positive control. The expression of Hsp 90 was standardized to that of β-actin. Data are presented as means ± SD from three separate experiments. Photograph shows the typical results of Western blotting. * $p < 0.05$ compared with control.