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Temperature elevation during back skin exposure to 28 GHz wave in human volunteer

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The use of millimeter waves (MMW) such as 5th generation wireless systems (5G) and WiGig (IEEE 802.11ad) is now expanding. However, there is concern that exposure to radio frequency (RF) waves may have adverse health effects on the human body. Several studies have investigated the biological effects of local exposure to 5G-MMWs.

However, these have mainly focused on the effects on the eyes and cultured cells, but not on the whole human body. In particular, a few studies reported temperature changes in the human body, which is the most important parameter to evaluate biological effects. The aim of this study was to evaluate how much temperature increase was detected during MMW exposure on the back skin of human volunteers.

To investigate the biological effects of MMW exposure on skin temperature, we designed the systems, consisting of a signal generator, an amplifier, and a lens antenna, to expose the human back extensively to 28 GHz waves and to measure the skin temperature by infrared thermography camera under exposure. The antenna input power was set at 22.5 W, which corresponds to an absorbed power density (APD) of 248 W/m^2 at the target back skin.

Adult volunteers (over 20 years of age) were recruited, and informed consent was obtained for this study. The experiment was performed in a room maintained at 24.5±0.3℃ temperature and 47.4±3.6% relative humidity. Subjects were seated on a chair in the room at least 30 min before the measurements and were at rest.

A circular area (310 mm in diameter) of the back skin was defined as the target area for exposure and positioned 500 mm in front of the lens antenna. The 28 GHz wave was irradiated from the antenna to the target skin for 30 min. Before and during the exposure, the temperature of the target skin was measured by infrared thermography. The core temperature was measured simultaneously with an ear thermometer. This experiment was approved by the ethics committee of Kurume University (Japan).

The skin temperature increased immediately after the beginning of exposure within the irradiated area and reached the steady state in about 20 min. The value of the increase was 4.3℃ at the end of the 30-min exposure. In contrast, there was little change in core temperature during exposure. According to the ICNIRIP guideline [1], it is defined that the MMW exposure (< 30 GHz) at APD of 200 W/m^2 could increase the temperature by about 5℃ in type I tissues. Our finding in human back skin could help to consider the validation of the guideline.

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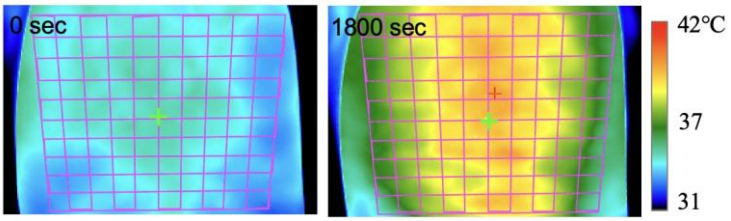

Figure 1. Temperature changes in the human back skin under 5G-MMW exposure. In the beginning of the exposure, the skin temperature was 33.8±0.6℃.

References

[1] "Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)," *Health Phys.*, vol. 118, no. 5, pp. 483–524, May 2020.