Development of Wideband Local Exposure Antenna for Laboratory Small Animal Study

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In recent years, next-generation mobile communication system is developed. In this system, higher frequency band such as over 10 GHz will be used. On the other hand, mobile devices such as smartphone are usually used in the vicinity of a head, therefore, an exposure to a human head will be localized exposure. In order to simulate local exposure during mobile phone use, radio wave energy absorption should be focused on a head region of laboratory small animals. To realize local exposure for laboratory small animals, we propose local exposure antenna. International guidelines which developed by WHO (World Health Organization) identify a SAR (Specific Absorption Rate) as a measure of exposure to radio wave fields, taking into account the thermal effects (Health Physics 74(4): pp.494-522, 1998), as a following expression

$$\mathbf{SAR} = \frac{\sigma|\boldsymbol{E}|^2}{\boldsymbol{\rho}} [\frac{\mathbf{W}}{\mathbf{Kg}}] \qquad (1)$$

where E, ρ and σ denote electric field, density of tissues, and conductivity respectively. In this study, SAR is used to estimate local exposure for laboratory small animals. In this days, international safety standards have been developed by IEEE to protect against health effects . The exposure limits of peak SAR on any mobile phone user to be lower than 2 W/kg for any 10-g tissue in the head or body (IEEE C95.1-2005, IEEE Standaerd). In this study, local exposure antenna is developed. The developed antenna is based on a monopole antenna. The shape of radiation element is a disk. This disk has small hole to observe radiation area. Experimental result shows that reflection index s_{11} is lower than -10dB from 6GHz to 14GHz. Therefore, the antenna can radiate wave power in wide-band frequency range. The local exposure performance of developed antenna is indicated as follow. We carefully analyzed SAR distribution inside of small animals by using the developed antenna. The analyzing method is an FDTD method. The local exposure performance is estimated by using ratio of target area SAR (TA-SAR) and whole body SAR (WB-SAR). In this study, rat is used as laboratory small animal. The rat models using this study are 2-week-age and 8-week-age rat model. The analyzed frequency was 8GHz and 10 GHz. The ratios of TA-SAR/WB-SAR using 2-week-age rat model were 321 at 8GHz and 314 at 10GHz. The ratios of TA-SAR/WB-SAR using 8-week-age rat model were 531 at 8GHz and 509 at 10GHz. Therefore, the proposed wideband antenna that realized localized exposure in wide-band frequency range to laboratory small animal such as rat. The ratio of TA-SAR/WB-SAR of proposing antenna is higher than 300 in any case.

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