URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Environmental EMF Evaluation for Mobile Communication Base Stations

Ae-Kyoung Lee*(1) and Hyung-Do Choi(1)
(1) Radio Technology Research Department, 218 Gajeong-ro, Yuseong-gu, Daejeon, 34129, KOREA,
https://www.etri.re.kr/

Abstract

Environmental EMF assessment for epidemiological studies is important. It obviously differs from the measurements for compliance test with the safety limits. We live by moving or in different postures in environments are surrounded by EMF sources radiated with different frequencies. This paper calculates SAR distributions in the brains of a 6-year-old child and an adult under an environment with spatially uniform incidences of plane waves. The results are expressed in W/kg/(V/m)^2 and would be used as an SAR efficiency at the corresponding age for cumulative exposure assessment.

1 Introduction

Many epidemiological studies have looked for an association between brain tumors and mobile phone use [1-3]. We can choose whether or not to be exposed to radiation from our own mobile phone. Nowadays, environmental exposure of EMF is getting more complex, which is not a matter of individual choice and lasts at any time and the level differs depending on a living environment or a region. Therefore, environmental exposure needs to be investigated and integrated into the overall exposure estimate.

In this paper, the whole-body models of a 6-year-old child and an adult were used to calculate the brain SAR distribution for environmental EMF exposure. It may be effective when we consider cumulative exposure, integrated with the exposure of mobile phones.

2 Human Models and Methods

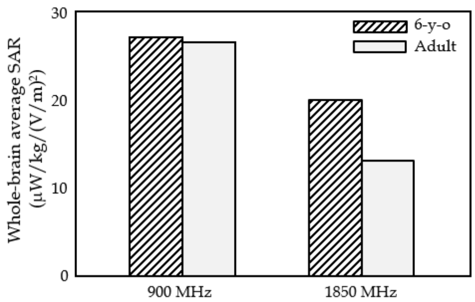
Anatomical dimensions related to the human brains were measured using magnetic resonance image data of hundreds of Korean children and adults and the average head models for a few age groups were implemented [4-5]. Therefore, the head models are representative of Korean males. In this paper, the 6-year-old child and the adult head models of them were used to calculate the brain SAR distribution.

The postures of the live human body are ceaselessly changed and at the same time, various electromagnetic waves exist around the body. The purpose of the study is to determine a typical SAR distribution at a specific age and a specific frequency of environmental EMF radiated from base stations. It was considered by assuming plane waves uniformly incident to the human body.

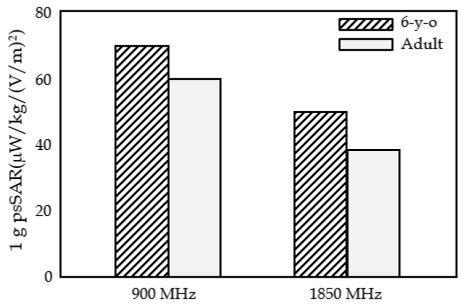
To simulate spatially uniform plane waves, total 60 plane waves with different incident directions and polarizations were used. The number of incident directions is twelve and the directions accord with those to the vertices from the origin of an icosahedron. The number of polarizations at each vertex is five. The head parts of the whole-body models of [6] have been replaced with the two head models of [5] and the outer dimensions were modified. A voxel size of 2 × 2 × 2 mm^3 was employed for the whole-body simulations using the finite-difference time-domain (FDTD) technique.

3 Results

After the 60 SAR simulations for each whole-body model, the SAR values at each voxel of the brain were averaged. Figure 1 compares the whole-brain average SAR and 1 g psSAR of the brain between the child and the adult for the incident electric field strength of 1 V/m.



(a) Whole-brain average SAR



(b) 1 g psSAR of the brain

Figure 1. SAR comparison between the child and adult models.

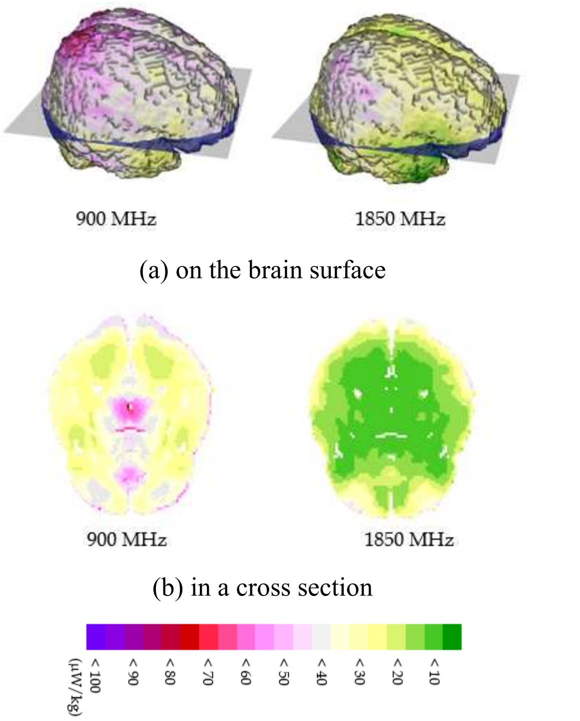


Figure 2. SAR distributions of the adult brain when the electric field strength is 1 V/m.

Both the whole-brain average SAR and the psSAR are higher at 900 MHz due to a deeper penetration than at 1850 MHz. At 900 MHz, the SAR differences between the child brain and the adult brain are not significant but at 1850 MHz, the SAR of the child brain is about 30% (1g psSAR) and 50% (whole-brain average SAR) increased than the adult brain.

The SAR distributions on the surface and cross-sectional views at the middle height of the adult brain are given at 900 and 1850 MHz are shown in Figure 2.

In Figure 2, it is observed that the SAR distributions between the two frequencies are very different; at 900 MHz, hot spots created in the center of the brain such as thalamus but at 1850 MHz, SAR level at each voxel is lower than those at 900 MHz except for partial areas and is getting higher as it goes to the edge of the brain. Because the SAR patterns and levels in the brain are different with the frequency, it is important to distinguish frequencies when measuring environmental EMF.

4 Conclusions

In studies on the association between EMF exposure and brain tumors, exposure assessment has been generally devoted on radiation from mobile phones and thereby researchers are particularly interested in tumors on the right or left side of the brain. However, it is found that the energy absorption due to environmental EMF at 900 MHz could concentrate in regions deeper of the brain. The time of individual using a mobile phone held against the ear is usually limited, but base stations are a source of continuous exposure. The exposure from base stations is less intense than that from a mobile phone, but occurs whether a mobile phone is being used or not. Therefore, in terms of cumulative exposure of EMF, the exposure level from base stations will vary depending on the region, but the result cannot be ignored when compared with the exposure level of the mobile phone.

As is well known, transmitting and receiving power levels of a mobile phone are inversely related. Those data of mobile phones are being extensively collected in real environments. In the near future, the collected results will be analyzed and the exposure level from base stations will be estimated and compared with that from a mobile phone.

5 Acknowledgements

This work was supported by the ICT R&D program of MSIT/IITP. [2019-0-00102, A Study on Public Health and Safety in a Complex EMF Environment]

6 References

1. E. Cardis, L. Richardson, B. Armstrong, M. Feychting, C. Johansen *et al.*, "The INTERPHONE study: design, epidemiological methods, and description of the study population," *Eur. J. Epidemiol.* **22**, 2007, pp. 647–664, doi: 10.1007/s10654-007-9152-z

2. D. Aydin, M. Feychting, J. Schüz, T. Tynes, T.V. Andersen *et al.* "Mobile phone use and brain tumors in children and adolescents: a multicenter case-control study," *J. Natl Cancer. Inst.,* **103**, 16, August 2011, pp. 1264–1276, doi: 10.1093/jnci/djr244

3. S. Sadetzki, C.E. Langer, R. Bruchim, M. Kundi, F. Merletti *et al*. "The MOBI-Kids study protocol: challenges in assessing childhood and adolescent exposure to electromagnetic fields from wireless telecommunication technologies and possible association with brain tumor risk," *Frontiers Public Health*, **2**, 124 September 2014, doi: 10.3389/fpubh.2014.00124

4. M. Han, A.-K. Lee, H.-D. Choi, Y. W. Jung, and J. S. Park, "Averaged head phantoms from magnetic resonance images of Korean children and young adults," *Phys. Med. Biol.* **63**, 3, 2018, 035003, doi: 10.1088/1361-6560/aaa1c7

5. A.-K. Lee, J. S. Park, S.-E. Hong, M. Taki, K. Wake, J, Wiart, and H.-D. Choi, "Mobile phone types and SAR characteristics of the human brain," *Phys. Med. Biol.* **64**, 4, 2019, 045004, doi: 10.1088/1361-6560/aafcdc.

6. A.-K. Lee and H.-D. Choi, "Determining the influence of Korean population variation on whole-body average SAR," *Phys. Med. Biol.* **57**, 9, 2012, pp. 2709-2725, doi: 10.1088/0031-9155/57/9/2709.