SAR distributions in a child head phantom in the vicinity of recent mobile phones

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Abstract

There are growing concerns about possible health effects of electromagnetic field (EMF) by cellular phones. Epidemiological studies have been in progress in order to evaluate the hypothetical relationship between RF exposure by cellular phones and brain tumor risk in children [1][2]. SAR (Specific Absorption Rate, [W/kg]) is one of the important factors to evaluate RF exposure for epidemiological studies on cellular phones. The purpose of our study is to characterize SAR inside a child head due to the use of mobile phones. SAR inside an adult head have been characterized for INTERPHONE study [3][4]. Child heads differ in size from adult heads. Moreover, the antenna structures have been changing with times and embedded in the body of the phones in recent years. Therefore, we measured SAR distributions inside a child and adult head phantom for several cellular phones commercially available in recent year.

1. Introduction

In the exposure assessment for INTERPHONE study, phones were categorized into a discrete number of classes based on the SAR distribution and the SAR at the location of the brain tumors have been estimated for all cases based on the measured data for compliance testing [3][4][5]. For the case of children, it is important to consider the difference of head size and antenna structure of the recent phones. In this study, we measured SAR distribution on flat phantom for over hundred conditions and examined the categorization of phones. SAR distribution on the child phantoms were measured for several phones.

2. Materials and Methods

SAR distributions on flat surface were measured using immediate SAR scanner (SPEAG, iSAR) for over hundred cases. Phones are on the Japanese market. SAR distributions in the child-head phantom were measured with an electric-field probe (SPEAG, ET3DV5R) with the method similar to the standard procedure for the compliance testing [6]. The child-head phantom was developed to be similar in size to average Japanese children. Table 1 shows the size of the child and adult (SAM) phantom. Developed child phantom was shown in figure 1.

Table 1: Size of the child and adult (SAM) phantom (unit: mm)

	Total head height	Head length	Head breadth
Child	205.4	176	145
Adult (SAM)	246.7	206	158.4

Figure 1: Child head phantom

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3. Results

Figure 2 shows the example of measurement on flat phantom. SAR distributions on flat surface were compared for over hundred cases. The distance between the maximum SAR and the ear position (speaker position) in the longitudinal axis varies as shown in figure 3. This variation is due to the difference of antenna position embedded in the phone. Here, we categorized phone into 3 groups with their maximum SAR position (or antenna position). Then the SAR distributions in the child and adult head phantom were measured for 3 different type of phone (Phone A, B and C). Figure 4 show SAR distributions in the child and adult phantom at 800 MHz band with left hand and cheek position. Reflecting the position of antenna, SAR distribution varies among phone type. Ratio of 10g SAR values between child and adult was shown in figure 5. Though the difference between child and adult head phantom is small for Phone A, values differ for Phone B and C. The antenna position is relatively lower for Phone B and C. The difference between the result of child and adult phantom is due to the antenna position which likely to protrude from child head smaller than adult.

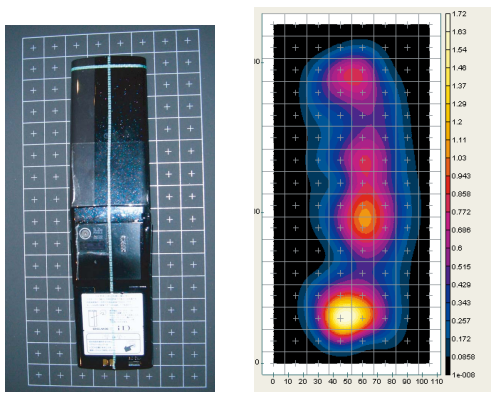


Figure 2: Example of SAR data on flat phantom

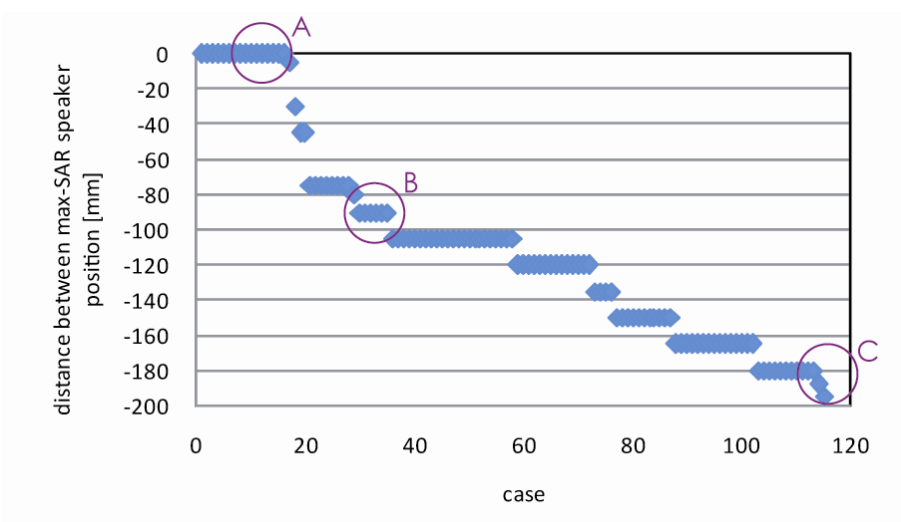
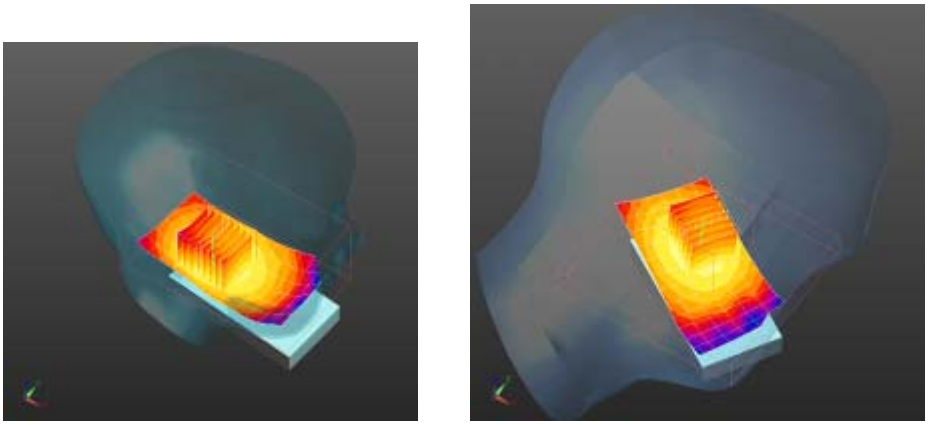
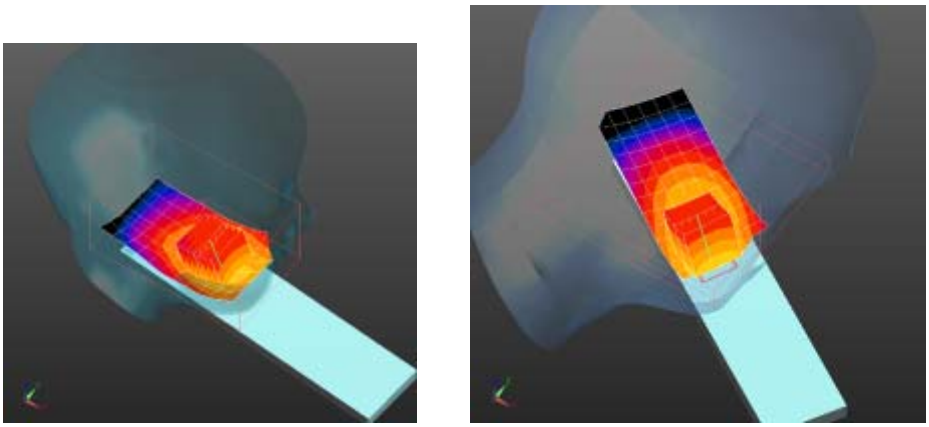


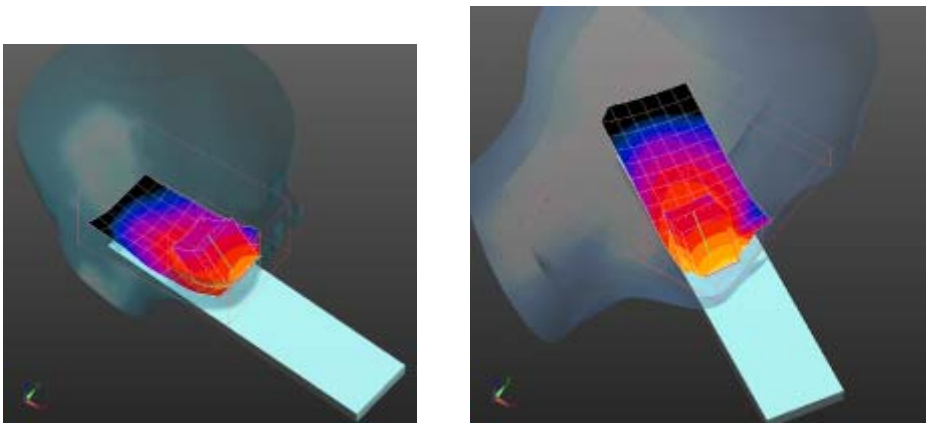
Figure 3: Distance between max-SAR and speaker position in longitudinal axis



Phone A



Phone B



Phone C

Figure 4: SAR distributions in child and adult phantom at 800 MHz band (left: child. right; adult)

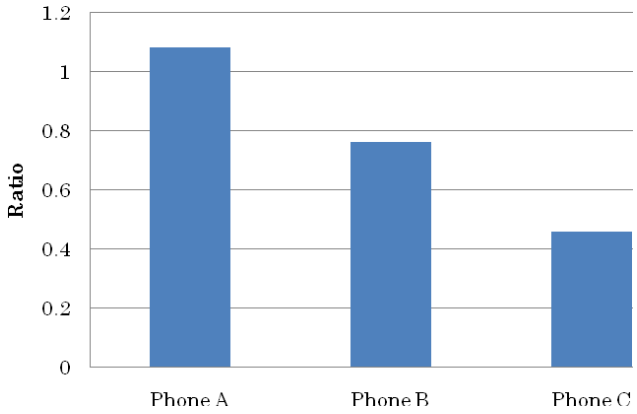


Figure 5: Ratio of 10g SAR between child and adult for each phone

Summary and Conclusions

We investigated SAR distributions inside the child-head phantom by recent mobile phones. The position of the maximum SAR and the SAR distribution vary due to the antenna position. There are possibilities to classify phones considering SAR distribution. For the phone whose antenna is in lower position, SAR in child head tends to differ from adult.

Acknowledgments

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References

1. M. Feychting, "CEFALO-A Case-Control Study of Brain Tumors in Children and Adolescents and Mobile Phone Use", Epidemiology, vol. 17, pp. Issue 6, p. S74, 2006.
2. mobi-kids, http://www.mbkds.net/news/press-release-11052009
3. E. Cardis *et. al*., "Distribution of RF energy emitted by mobile phones in anatomical structures of the brain", Physics in Medicine and Biology, vol. 53, pp. 2771-2783, 2008.
4. K. Wake *et. al.*, "Estimation of 3-D SAR distributions in a human head from mobile phone compliance testing data for epidemiological studies", Physics in Medicine and Biology, vol. 54, pp. 5695-5706, 2009.
5. N. Varsier *et. al.*, "Categorization of Mobile Phones for Exposure Assessment in Epidemiological Studies on Mobile Phone Use and Brain Cancer Risk", IEEETrans. on Microwave Theory and Techniques, vol. 56, no. 10, 2008.
6. International Electrotechnical Commission (IEC), "Procedure to measure the specific absorption rate (SAR) for hand-held mobile wireless devices in the frequency range of 300 MHz to 3 GHz", ICE 62209-1 Standard, 2005.