BE-32

FAR-FIELD MICROWAVE DOSIMETRY IN A RHESUS MONKEY MODEL

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ABSTRACT

Microwave dosimetry at 1.29 GHz was conducted in a full-size rhesus model in the sitting position. The phantom model was composed of muscle-equivalent material supported by a polyurethane foam mold. Far-field irradiations were conducted in a microwave-anechoic chamber illuminated with pulsed microwave energy from a type AN/TPS-1G radar set.

Several kinds of temperature probes were used in the calorimetric determination of specific absorption rate (SAR) at eight locations of the phantom. These probes included the liquid crystal optical fiber (LCOF) device and a 4 lead, high resistance thermistor. Thermographic imaging techniques were also employed to produce two-dimensional records of the microwave absorption in the monkey model.

Results of the initial dosimetry show a front-surface heating for several measured locations similar to the initial measurements in a man-size model. Some locations in the sitting primate model, however, showed a different heating pattern such as an internal "hot-spot" effect where the embedded region of high absorption exhibited an SAR of approximately three times the observed front-surface value.

The objective of these experiments is the determination of the locus and level of far-field microwave absorption in a rhesus primate model. This absorption data is required in the correlation of primate electromagnetic (EM) bioeffects with the quantitative dosages of microwave energy producing the effects. Absorption information has also been used directly in the extrapolation from primate to man on the basis of size and morphological similarity. The rhesus is often used in biomedical research, and it is important to obtain dosimetric results in more detail than has been previously accomplished.

The phantom model was developed as a rhesus-shaped void contained within a two-part mold of foamed polyurethane. This void was filled with simulated muscle tissue composed of water, salt, gelling agent, and polyethylene powder. A photograph of the rhesus phantom is shown in Figure 1.

A microwave-anechoic chamber was illuminated from one side with a feed-horn irradiator. Pulsed microwave energy at 1.29 GHz was obtained from a military radar set type AN/TPS-1G. The phantom/mold assembly was placed on a foamed polystyrene support in the far field of the horn, facing the horn and exposed to an average power density of approximately 30 mW/cm^2 in each irradiation.

Nonperturbing temperature probes, inserted from the rear of the mold, were used to record the temperature rise (ΔT) of the phantom front surface at eight locations throughout the body. Care was taken to avoid any nonlinearity in the recorded ΔT values. To obtain more dosimetric information, the phantom was thermographically imaged from the front following microwave exposure. The initial thermal image yielded the ΔT distribution of the irradiated front surface. A time-sequence of thermograms obtained immediately following an irradiation provided qualitative information as to subsurface heating. Subsurface heating was also obtained using temperature probes.

Figure 1. Photograph of the rhesus monkey phantom model and mold shown with the front mold member removed. Small, white discs mark measured locations.

Results of these experiments include not only dosimetric data about the sitting rhesus model but also much practical information regarding the laboratory use of the nonperturbing temperature probes in a phantom model of this size and type. The liquid crystal optical fiber probe tended to be sensitive to the pushing and pulling required in positioning the device in the model; whereas, the 4 lead, high resistance thermistor electronics package required some filtering at the output terminal to reduce microwave-induced noise.

Figure 2 shows the dosimetric results obtained in the head region of the phantom. A distinctive "hot spot" appears that has been characteristic of the results of many theoretical analyses of an isolated spherical model. Dosimetric results obtained in the other locations typically show absorption to be highest at the front surface or near the front surface and lack the "hot spot" observed in the head.

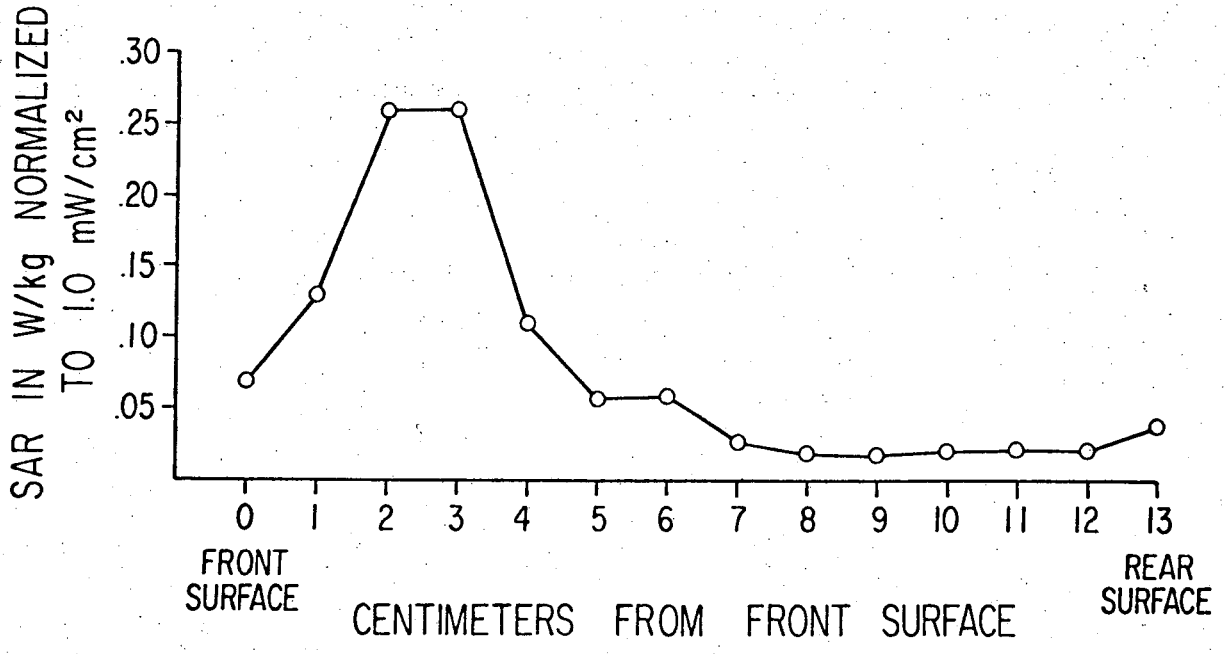

Figure 2. Measured SAR in primate phantom model at 1.29 GHz. All points were located in the saggital plane on a horizontal line at eye level.

This study is the first experimental, far-field dosimetric analysis of an often used subject in bioelectromagnetics, the rhesus monkey in an upright, sitting position. Results obtained from these experiments include a calculated whole-body, average SAR and location-specific absorption profiles, which information can be used in the correlation of bioeffects with absorbed electromagnetic dose.