Calculating SARs: A Little Arithmetic

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The bone marrow of young pigs has a higher water content than adult bone marrow and, as expected, Peyman and Gabriel found that it has a higher conductivity. A little math might help understand why a higher water content in tissues this leads to higher SARs. Start with the basic equation for calculating the SAR:

$$SAR = \sigma E^2 / \rho$$

where σ = conductivity of the tissue; E = electric field, ρ = density of the tissue

More simply, this means that the SAR is proportional to the conductivity:

$$SAR \propto \sigma$$

and therefore as the conductivity increases, so does the SAR.

Christ and Kuster only estimated the relative increase in SAR, which is proportional to the ratio of the conductivity of a child's bone marrow to an adult's:

$$\text{Relative SAR} \propto \sigma \text{ (children)} / \sigma \text{ (adults)}$$

Actually, it's somewhat more complicated than this. Looking at the SAR equation, we can see that there are two other variables to consider: the electric field (E) and the density (ρ) of the sample. The electric field in the bone marrow depends on the permittivity (ε) of the tissue. Peyman and Gabriel showed that the permittivity of a child's bone marrow, like its conductivity, is also higher than an adult's. The net effect of this change is to further increase the SAR. As for the density of the tissue, there's no indication that it changes much with age, so, for our purposes, we can ignore it.

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