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Cell Phone Radiofrequency Radiation Exposure and Brain Glucose Metabolism

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The majority of the radiofrequency energy emitted by a cellular telephone is absorbed by the hand and head of the user. The total energy absorbed is a function of the specific absorption rate, duration of use, and the manner in which the phone is used. In addition to concerns about potential harmful effects of such exposure, such as the issue of risk of brain cancer, change in brain function related to cell phone radiofrequencies also is of concern. Studies have been conducted to investigate the effect of cell phone use on brain electrical activities, neurophysiology, and behavior. The study by Volkow and colleagues in this issue of JAMA is the first investigation in humans of glucose metabolism in the brain after cell phone use.

The investigators placed cell phones on the left and right ears of 47 healthy participants and used positron emission tomography with injection of (^{18}F) fluorodeoxyglucose to measure brain glucose metabolism twice, once with the right cell phone activated (but with sound muted) for 50 minutes ("on" condition) and once with both phones deactivated ("off" condition). The study reported 2 important findings. First, exposure to radiofrequency radiation emitted from a cell phone for 50 minutes increased glucose metabolic rate in select cortical regions of the brain. Second, a significant linear correlation was observed between enhanced neural metabolic rate and the estimated rate of radiofrequency energy absorption expected in brain regions.

Even though the health consequences of these effects on brain glucose metabolism are unknown, the results point to a conclusion that cell phone use can possibly affect brain function, and specific effects may depend on the regions of the brain affected. An important question is whether the effects observed are mediated by an increase in temperature. Temperature of the skin on the head in contact with the cell phone can increase by more than 2°C after less than 10 minutes of cell phone use. That increase in temperature is mainly attributable to the heat generated by the operating phone and only to a lesser extent by the radiofrequency energy emitted. Diffusion of this heat energy into the brain is not expected to be high. In the study by Volkow et al, brain areas that showed an increase in glucose metabolism were quite distant from the contact area. Thus, it is not likely that the effects observed were caused by heating.

Also important is that during the on condition, “the cell phone was receiving a call (from a recorded text). . . .” Cell phones in the receiving mode simply maintain a connection with nearby base stations and thus typically emit less energy. Therefore, in this study the cell phone was actually emitting less radiofrequency radiation than is the case when a user is speaking into a phone, and the effect observed could thus potentially be more pronounced in normal-use situations.

The results by Volkow et al add to the concern about possible acute and long-term health effects of radiofrequency emissions from wireless phones, including both mobile and cordless desktop phones. Although the biological significance, if any, of increased glucose metabolism from acute cell phone exposure is unknown, the results warrant further investigation. An important question is whether glucose metabolism in the brain would be chronically increased from regular use of a wireless phone with higher radiofrequency energy than those used in the current study. Potential acute and chronic health effects need to be clarified.

Much has to be done to further investigate and understand these effects. Do these effects occur from use of cell phones of different frequencies and waveforms? In a series of studies carried out in the 1980s, Sanders et al reported that the effect of radiofrequency radiation on energy metabolism in the rat brain was dependent on carrier frequency as well as pulse modulation frequency; ie, the wave characteristics of the radiofrequency radiation are important determinants of energy metabolism responses in brain tissues. Can the increase in glucose metabolism explain the increase in responsiveness in psychological tests observed in humans after exposure to cell phone radiation? Furthermore, an operating cell phone also generates low frequency and extremely low frequency electromagnetic fields. The biological effects of these fields emitted by cell phones have received little attention. However, many studies have indicated that these fields, at much lower frequency than the radiofrequency field, are biologically active. Can these fields also affect neural tissue metabolism?

Could the findings of Volkow et al be a marker of other alterations in brain function from radiofrequency emissions, such as neurotransmitter and neurochemical activities? If so, this might have effects on other organs leading to unwanted physiological responses. Further studies on biomarkers of functional brain changes from exposure to radiofrequency radiation are definitely warranted.