One Dose of Radiation Causes 30 Percent Spongy Bone Loss

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Mice receiving just one therapeutic dose of radiation lost up to 39% of the spongy portion of their inner bone, reducing the inner bone's weight bearing connections by up to 64%, researchers reported. The study, which appears in the online edition of the *Journal of Applied Physiology*, has implications for patients receiving radiation therapy and astronauts traveling on long space flights.

"We were really surprised at the extent of bone loss," said lead researcher Ted A. Bateman of Clemson University. "We're seeing bone loss at much lower doses of radiation than we expected." The mice suffered the loss of trabecular bone, the spongy area of bone inside the dense outer area known as the cortical bone.

"It's interesting that the trabecular bone, not the cortical bone, suffered the damage," said Bateman, a bioengineer who studies bone biomechanics. The remaining spongy bone must redistribute the load to bear the weight, but this makes the bone support structure less efficient and leaves the bone more vulnerable to fracture.

"A murine model for bone loss from therapeutic and space-relevant sources of radiation," by Sarah A. Hamilton, Neil D. Travis, Jeffrey S. Willey, Eric R. Bandstra and Ted A. Bateman, Clemson University; and Michael J. Pecaut, Daila S. Gridley and Gregory A. Nelson, Loma Linda University and Medical Center, appears in the online edition of the *Journal of Applied Physiology*, published by The American Physiological Society.

Mouse model applies to humans

The results of a mouse study cannot be directly applied to humans. However, both mice and humans lose bone after radiation exposure, so the results raise a red flag. Bateman noted that a recent clinical study of 6,000 cancer patients reported in the Journal of the American Medical Association found that post-menopausal women who received pelvic radiation for cervical and colorectal cancer increased their bone fracture risk by 60%. Radiation following anal cancer increased the risk of fracture by 200%, he said.

Astronauts lose 2% of bone mass for each month they are exposed to the effects of microgravity. So far, astronauts have not been exposed to the increased radiation of outer space, but that will change when they undertake a proposed 30-month trip to Mars, Bateman said. NASA has focused on radiation's cancer-causing properties and its ability to compromise the central nervous and immune systems. But the effect on bone health is an unexamined concern.

The murine (mouse) model such as the one in this study provides a way to study the physiological effects of radiation using controlled experiments. Clinical studies of people who undergo radiation to treat cancer are limited because of the complicating factors of the illness itself and the chemotherapy which often accompanies it. "You can't study this in people, so having a well-defined animal model is important," Bateman said.

Study focuses on four types of radiation

In the current study, the mice received a single 2 Gray (Gy) dose, which is comparable to the single dose of 1-2 Gy that human cancer patients receive. However, cancer patients receive a series of doses over the

course of therapy, totaling 10-70 Gy. (The amount of radiation in a Gy varies, because it is calculated based on the recipient's weight.)

The mice were divided into five groups. The control group received no radiation. Each of the remaining four groups received a different type of radiation: gamma, proton, ion or carbon. Those exposed to the carbon radiation suffered 39% spongy bone loss; proton, 35%; ion, 34%; and gamma, 29%. The loss of spongy connections in the four groups ranged from 46-64%, he said.

Cancer patients typically receive either gamma or, less commonly, proton radiation. Astronauts on a Mars mission are expected to receive extended periods of low-dose radiation of multiple types, including protons and heavy ions, Bateman said.

Source: American Physiological Society