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CENTER FOR HUMAN RADIOBIOLOGY

Fact Sheet on

Radium Distribution and Dosimetry

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The bones and epithelial tumors which appear in radium cases are believed to result from dose delivered to cells which lie near the bone surfaces. Estimates of target tissue dose rates are usually based on measurements of radium concentration or alpha particle energy release from bone surfaces. Two complementary methods for collecting such data on the microscale are autoradiography and alpha particle spectrometry. Autoradiography permits measurements to be made anywhere in the skeleton but lacks in spatial resolution. Alpha spectrometry provides nearly perfect spatial resolution but can only be used where bone surfaces are nearly flat.

Beside providing data on distribution and dose, autoradiography provides a powerful tool for the study of bone remodeling. Remodeling rates are important as an indicator of radiation damage and as input to dose-response models.

Remodeling rate

Radium is deposited in intense, localized hotspots and throughout bone in a much less intense diffuse deposit. At long times after uptake the diffuse specific activity should exceed the average specific activity as a result of the removal of radioactive bone by resorption and its replacement by bone which is nearly free of radioactivity. The ratio of diffuse to average specific activity can be used to determine the average remodeling rate experienced by the bone (or bones) examined. Studies of 10 radium cases have shown that the remodeling rates are usually less than 1% per year, a low value compared with the 2.5% per year rate which is typical of normal adults.

Quantitative autoradiography

Photographic darkening in contact autoradiograms is produced by alpha-particle emission from a layer of bone approximately 50 μm thick. Quantitative interpretation of the image has required the assumptions that, in this layer, the concentrations of radium and its daughter products are constant as a function of depth, the radon retention is equal to the retention in large samples of bone or in the entire skeleton and the ratio ^{210}Po activity/^{226}Ra activity can be computed from the Norris function. Alpha

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spectroscopy is being used to test the first assumption and to measure the radon retention and $^{210}Po/^{226}Ra$ ratio.

Alpha spectrometry of bone surfaces

Alpha spectra may be used to determine the radium concentration as a function of depth below the bone surface. This can then be used to compute the surface dose rate. The method has been applied to dog bone obtained 24 hours after injection. There the radium was found to be deposited in uniform concentration to a depth of about 5 μm and then to drop to very low levels by 6.5 μm. It is now being used to determine if a depleted layer exists near the endosteal surface in radium cases with long-standing burdens.

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