

From Mapping to Quantification Digital Autoradiography of ^{226}Ra in Human Skeleton

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The United States Transuranium and Uranium Registries (USTUR) studies actinide biokinetics and tissue dosimetry by following up occupationally exposed individuals. Currently, the USTUR employs the ionizing radiation quantum imaging detector (iQID) to map the micro-distribution of alpha-emitting radionuclides in human tissues. This research aims to expand upon the capabilities of the iQID, primarily focusing on quantifying the activity concentrations of ^{226}Ra in bone samples. In this study, two plastic-embedded bone sections were selected from the middle shaft of a left femur and the left side of the thoracic vertebra of a radium dial painter (RDP). These samples were obtained from the National Human Radiobiology Tissue Repository (NHRTR), an integral component of the Registries. The NHRTR preserves an extensive collection of tissue materials from a variety of radium worker studies, including histological bone slides and tissue blocks from RDPs. In this study, the ^{226}Ra micro-distribution was mapped in bones of a female who had worked as a dial painter for 6 years, had an estimated ^{226}Ra uptake of 58.9 MBq, and passed away at age 24. Regions of interest for both cortical bone and trabecular bone were segmented. A computational model was developed to simulate the geometric efficiencies unique to the geometry of each sample, enabling the estimation of volumes and sample masses. This simulation utilized alpha particle transport models based on the particle interactions within the images of individual bone samples. The activity concentrations derived using iQID measurement were compared to results from the radiochemical analysis of these samples. The iQID imaging technique proves not only effective in studying micro-scale heterogeneous radionuclide distributions but also in accurately estimating activity concentrations of alpha-emitting radionuclides.

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