Radionuclide Distribution Measurement Within Anatomical Bone Structures Using Digital Autoradiography

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The ionizing-radiation Quantum Imaging Detector (iQID) is a radiation camera originally developed for gamma-ray imaging applications such as scintigraphy and single-photon emission computed tomography. Recently, the detector's response was extended to a broader range of ionizing radiation, including: neutrons, spontaneous fission, conversion electrons, alpha and beta-particles. The iQID digital autoradiography imager allows for real-time quantitative autoradiography at a resolution up to 20 µm when imaging alpha particles. With conventional autoradiography technique, imaging may take up to several months without knowledge that a sufficient number of decays has occurred to visualize the spatial distribution of alpha emitters. Quantification of the activity can also be difficult or impractical. The iQID allows studying radionuclide microdistribution in the anatomical bone structures, such as cortical and trabecular bone volumes and surfaces at sub mBq levels. The initial feasibility imaging experiments were performed using bone samples from individuals exposed to radium (Ra-226), plutonium (Pu-239), and americium (Am-241). The bone samples are available at the National Human Radiobiology Tissue Repository (NHRTR), which is a part of the U.S. Transuranium and Uranium Registries (USTUR). For the internally deposited Ra-226, Pu-239, and Am-241, activity distribution was visualized and quantified in various bone sections. Radionuclide activity distribution ranged between 0.002 and 0.003 mBq mm^{-2} for Pu-239, 0.1 and 0.7 mBq mm^{-2} for Ra-226, and 1.0 and 10.0 mBq mm^{-2} for Am-241. The initial feasibility studies are promising and prompt for additional sample imaging, especially those with small-scale heterogeneous distributions where traditional counting methods do not apply.

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