

## Digital Autoradiography of $^{241}\text{Am}$ Spatial Distribution within Trabecular Bone Regions

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The ionizing-radiation Quantum Imaging Detector (iQID) is used at the United States Transuranium and Uranium Registries (USTUR) for imaging  $\alpha$ -emitters:  $^{241}\text{Am}$ ,  $^{239}\text{Pu}$ , and  $^{226}\text{Ra}$ . The iQID allows visualizing the distribution of  $\alpha$ -particle events and differentiating between the surface-seeker (Am, Pu) and bone volume-seeker (Ra) radionuclides and their activity quantification. In this study, spatial distribution of metabolized  $^{241}\text{Am}$  within trabecular bone regions was investigated using USTUR Case 0846 (voluntary donor). For this individual, initial  $^{241}\text{Am}$  whole-body deposition was estimated to be 66.6 kBq. Post-mortem radiochemical analysis indicated that 29.6 kBq were retained in the skeleton 40 years post exposure. Bone specimens were sampled from humerus proximal end, humerus proximal shaft, and clavicle acromial end. These specimens were embedded in methyl methacrylate plastic and processed to produce multiple 100- $\mu\text{m}$ -thick sections. Bone sections were polished to a fine surface and anatomical structure images were taken with a digital microscope. All bone sections were imaged at 35  $\mu\text{m}$  resolution for at least two weeks. In order to evaluate the radionuclide distribution and corresponding histology precisely, iQID images were co-registered and superimposed with the anatomical structure images. The  $^{241}\text{Am}$  activity distributions were visualized and quantified in cortical bone and trabecular spongiosa. These two bone regions are well represented within the humerus proximal end. High activity concentration of  $^{241}\text{Am}$  was measured in trabecular bone region. Activity concentration ratio was used to represent radionuclide distribution within different bone regions. The cortical bone-to-trabecular spongiosa activity concentration ratio of 1:0.7 was calculated for the humerus proximal end. This is in agreement with ratios obtained from radiochemical analysis – 1:0.7 and ICRP biokinetic model predictions – 1:0.5. The cortical-to-trabecular bone activity concentration ratio of 1:2.7 was in agreement with that of 1:3 obtained from radiochemical analysis. This quantitative digital autoradiography imaging approach is proven to be an effective method for micro-scale heterogeneous distribution studies, where traditional counting methods do not apply.

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