AbstractID: 3941 Title: Bone marrow and bone endosteum dosimetry methods comparison for external photons

Purpose: To compare and verify different bone endosteum and bone marrow photon dosimetry methods through the use of a high-resolution micro CT-based radiation transport model.
Method and Materials: Two different Monte Carlo dosimetry algorithms for bone endosteum and bone marrow were compared to a high-resolution microCT image-based radiation transport model developed in our laboratory. Bone marrow dosimetry methods are (1) the dose response function method by Eckerman (DRF), and (2) the mass energy absorption coefficient ratio method (MEAC). Bone endosteum dosimetry methods include (1) DRF method and (2) homogeneous bone dose approximation (HGB). Each method was compared to results obtained from the microCT-based paired-image radiation transport (PIRT) model. Two ex-vivo bone samples of a 66-year male (lumbar vertebrae and cranium) were chosen for the comparison because of their distinctively different microstructures. Simple mono-energetic parallel photon beams were simulated from 0.01 to 4.0 MeV.
Results: For the bone marrow dose, the DRF method shows good agreement with PIRT result in the lumbar vertebra, but showed over estimates of bone marrow dose in the cranium, while the MEAC method shows good agreement with PIRT in both bone sites. For the bone endosteum dose, the DRF method shows closer results to the PIRT model at lower energies, but shows significant over-estimates of endosteum dose in higher photon energies. This can be explained by the fact the Eckerman model assumes that secondary electrons are followed through an infinite expanse of trabecular spongiosa, with no loss of energy to the bone cortex at high energy.
Conclusion: For the bone marrow dose assessment, the MEAC method seems to be the best choice among the methods considered, while for the bone endosteum dose, the HGB method shows better agreement with PIRT than is seen with the DRF method, especially at higher photon energies.