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Dosimetry for the Treatment of Bone Metastases with Radionuclide Therapy

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The skeleton is a complex tissue consisting of bone, bone marrow and cartilage. The bone can be divided into two entities: cortical and trabecular bone. The trabecular bone is a fine, intricate structure of bone cavities that contains the red marrow. The trabecular bone and the red marrow are together named spongiosa. The skeleton contains two tissues considered radiation sensitive: the red marrow (haematological toxicity) and the osteogenic cells, also called bone surfaces, (cancer induction). The total weight of the skeleton for a 70 kg man is 10 kg, or 14.5% of the body weight.

A historical overview of the development of models for estimation/calculation of S values (the absorbed dose per decay) for bone will be given. The development was begun by Spiers and co-workers, who determined distributions of mean chord lengths for both the cavities and the trabeculae within the spongiosa. The refinement of the models and the Monte Carlo simulation of S values for normal bone on both macro and microscopic scale is still ongoing. Dosimetry for bone tumours can be performed by rescaled S values for unit density spheres. Another possibility for bone dosimetry on a macroscopic scale is image based 3D-dosimetry.

Radionuclide therapy for bone metastases is commonly given as a palliative treatment, although it also can be given with a curative intent. ICRP53 has published the mean absorbed dose per injected activity for ^{89}Sr. However, published results show wide ranges of absorbed doses for a given administered activity, both for normal bone and tumours. The possibilities for quantitative imaging, enabling patient specific dosimetry for the currently most common radiopharmaceuticals will therefore be reviewed.

The microscopic activity distribution and its implications for dosimetry and toxicity for different radiopharmaceuticals will also be discussed.

References

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