The Different Types of Nuclear Radiation in Radionuclide Therapy

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In nuclear medicine, pharmaceuticals labelled with unsealed radioactive sources, are administered to the patients for diagnostic or therapeutic purposes. This form of therapy includes treatment of both cancer and non-malignant conditions. The purpose of radionuclide therapy is to achieve a selective high concentration of the radionuclide in the target tissue compared with that present in the surrounding tissues, yielding a therapeutic effect in the malignant tissue while sparing the normal tissue. With systemic radionuclide therapy it is possible to treat also disseminated cancer.

When the ionizing radiation emitted from the radionuclide during the radioactive decay is absorbed by the tissues, various biological effects occur. Several different parameters influence the biological effect, such as the type of radiation and its energy, the physical half life of the radionuclide, the dose rate, the absorbed dose etc. But also the physiological behaviour of the radiopharmaceutical has an effect on the therapeutic outcome and on the radiation exposure of the surrounding tissues.

The biological consequences from photons (X-rays or gamma rays) compared to those from charged particles (i.e. alpha particles or electrons) can vary markedly, mainly due to different ranges in tissue. For example a high energy alpha particle has a range in same magnitude as the diameter of a normal cell and deposit the radiant energy densely, yielding a severe biologic effect to the cell. The photons on the other hand deposit the radiant energy sparsely with fewer damages per cell resulting in a higher survival fraction.

Optimization of radionuclide therapy includes selection of appropriate radionuclides. Different malignancies require radionuclides with different properties, e.g. for therapy of large tumours it is suitable to use a radionuclide emitting radiation with larger ranges, while a small tumour is best treated with short-range radiation, provided that the radionuclide is concentrated in the tumour.

Although photons may not contribute directly to the therapeutic effect it may rise value to the therapy since it can be used for imaging of the radionuclide distribution in the body. Furthermore, it contributes to patient-specific knowledge of the absorbed dose to the pathological tissue which is essential for a successful treatment and to the normal tissue for an accurate evaluation of the risk of adverse acute and chronic tissue effects as well as for a second cancer.

References:

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