Indirect Radiation Therapy of Cancer with Synchrotron Radiation at the K-Edges of Heavy Metal Complexes and Target-Nanoparticles

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Indirect radiation therapy of cancer IRT inactivates tumors cells by secondary products evolving from an incorporated target upon specific absorption of therapeutic radiation, which is depicted as photon activation therapy PAT by K-edge target absorption of synchrotron radiation (fig.1). We apply biocompatible heavy metal complexes of Lanthanides, e.g. Gadolinium- to Lutetium-DTPA in target-nanoparticles and in keyformulations breaking the blood-brain barrier (BBB). The novel cancer therapy is optimised towards minmal body dose Q_b (demage) at maximal healing dose Q_t , specifically absorbed at the local target material. With our materials using the heaviest Lanthanide Lutetium ($E_K = 63.31$ keV) the relative therapeutic absorption $A_t b = Q_t/Q_b$ can be up to 10%, as calculated for an 1 cm target area covering a brain tumor in a human head (12 cm path); with Gadolinium an effect of $A_t b=6.3\%$ is possible at $E_K = 50.24$ keV. This lead to the imaging- therapy postulate for indirect radiation therapy: "An effective (adjuvant) cancer therapy target should be visible by in vivo contrast imaging (therapeutic imaging)." In animal tests with rats the imaging-therapy postulate was successfully verified. First therapy trials with rats bearing brain tumors are running.

Photon activation therapy PAT: <u>PAT / PXT</u>: Lu, Gd + $\gamma \implies n \cdot e^{-}$ Auger-electrons (secondary radiation) \implies DNA inactivation @ tumor Lutetium photon absorption Photon activation therapy PAT A) inactivates cancer cells by absorption of X-ray photons at the target K-edge [Cm and subsequent local production of toxic products, e.g. free radicals. Absorption cross section The photon absorption spectrum B) of Lutetium is the key for research and medical applications. During indirect radiation therapy IRT photons of 63.3 keV are absorbed at K-electrons (1:1). In the direct radiation therapy RT the compton effect of 8 MeV photons Photon energy [keV] IRT ct RT produces some compton electrons.

Abb. 1: Principles of indirect radiation therapy IRT, i.e. photon activation therapy PAT, and direct radiation therapy RT with an incorporated Lutetium target.

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