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Theranostics in particle therapy

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Particle therapies with protons, helium or carbon ions are emerging treatments enabling precise targeting of pathological cancer tissues due to inverted depth-dose distribution (Bragg peak) offering improved dose conformity with respect to conventional radiotherapy by X-rays. In addition to their dosimetric advantages, protons and heavier ions penetrating patient tissue undergo scattering and nuclear interactions and produce secondary radiation of different type, i.e., radioactive isotopes, ions, photons, and neutrons at varying energies. The secondary radiation induced by primary ions, which is not present in conventional X-ray therapy, can be detected and used to image therapeutic dose in the patient and gain information about patient anatomy simultaneously with the radiation therapy. I will review the ongoing research and development of imaging methods based on secondary radiation induced by particle beams, focusing on the underlying potential of particle therapy to be considered as theranostic approach to radiation therapy.

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