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Synchrotron Radiation: therapeutics and imaging

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Abstract

Synchrotron generated cortical and hippocampal transections are an extremely interesting novel experimental tool for the treatment of epilepsy and other functional brain tumors as well as brain tumors. Microscopic arrays of X-ray beams (microbeams) originating from a synchrotron source and delivering to the brain incident doses up to 600 Gy induce the equivalent of a microsurgical incision. Neurons, glia, and axons along the penetration path receiving the peak doses succumb instantly while the immediately adjacent tissue is exposed to much lower valley doses (less than 4 Gy) which do not induce histologically evident tissue damage. In essence, synchrotron-generated cortical transections provide a microradiosurgical equivalent of multiple subpial transections (MST), a non-resective surgical technique developed to treat patients with medically refractory epilepsy involving eloquent cortex. The MST treatment involves the placement of vertical incisions through the epileptic cortex in order to cut the horizontal axons responsible of the propagation of seizures while preserving the vertical axons responsible for critical neurological functions. The vertical columns working as the basic unit of cortical function are disconnected but not injured by MST, allowing the treatment of epileptic foci located over sensorimotor or language cortex that are not amenable to surgical resection. Microbeam transections equivalent to MST have been performed over an epileptogenic focus located in rat sensorimotor cortex, with fast abolition of seizures and preservation of motor function(Romanelli et al., PlosONE) . Further studies, recently published by Dr Romanelli and colleagues on Nature Scientific Reports, have been performed on rat eloquent cortex and hippocampus, showing that microbeam transections do not induce neurological deficits otherwise caused by ablative procedures . The ability to control seizures through a non invasive procedure inducing microradiosurgical transections of selected cortical or hippocampal targets offers a novel experimental approach to treat drug-refractory epilepsy with wide potential clinical applications. Synchrotron-generated microbeams have been also used to develop a novel modality of brain imaging , offering details down to the subcellular scale.

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