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Clinical synchrotron radiotherapy programs from a medical physicist point of view

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Therapeutic applications of synchrotron x-rays are becoming a reality. The first phase I/II clinical study of Synchrotron Stereotactic Radiation Therapy (SSRT), in place at the European Synchrotron Radiation Facility (ESRF) since 2012, consists of a dose escalation protocol to show the feasibility and safety of the technique. 13 patients have been treated using 80 keV high-flux quasi-parallel monochromatic x-ray beams, in the presence of iodinated compounds injected immediately before irradiation, for radiation dose enhancement purposes1,2. Even if the technique is still in its infancy, these promising technical results are allowing the clinical transfer of other synchrotron radiation therapy modalities for an improved healthy tissue sparing effect combined with an increased tumoricidal effect. One realistic option is the use of high dose rate arrays of synchrotron microbeams (Microbeam radiation therapy, MRT) for treating isolated small lesions3.

MRT is based on the spatial fractionation of the dose using an array of parallel microbeams having a width comparable to that of a human hair (~50 micrometres) and being separated by regions of almost zero radiation. Pre-clinical studies have demonstrated that MRT significantly improves the treatment outcome compared to conventional radiotherapy4,5. This is the result of preferential damage to cancer cells and high tolerance of healthy tissues within the irradiation pattern. Although MRT is currently confined to synchrotron radiation facilities because of the very high radiation dose rate required (5,000 times higher than clinical radiotherapy), clinicians and medical physicists are collaborating closely with synchrotron scientists to spearhead its development towards clinical trials.

Extensive methodological developments and rigorous medical physics codes of practice are required for its implementation in clinics. Such protocols are well established in conventional clinical radiotherapy but are not applicable to MRT due to the x-ray spectrum, high dose rates and radiation detector limitations. Recently, absolute real time dosimetry methods have been successfully benchmarked using a microdiamond detector6 or spectrometry techniques7. Moreover, rigorous and reproducible preclinical studies are now possible with the DynMRT system available at the Australian Synchrotron medical beamline. This is mandatory to strengthen the biological data available on healthy tissue tolerances and tumour responses to MRT.

Keywords or phrases (comma separated)

Are you a student?

No

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No

Are you an ECR? (<5 yrs</br>since PhD/Masters)

No

What is your gender?

Male

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