Microbeam evolution: From single cell irradiation to preclinical studies

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Purpose: This review follows the development of microbeam technology from the early days of single cell irradiations, to investigations of specific cellular mechanisms and to the development of new treatment modalities in vivo. A number of microbeam applications are discussed with a focus on preclinical modalities and translation towards clinical application.

Conclusions: The development of radiation microbeams has been a valuable tool for the exploration of fundamental radiobiological response mechanisms. The strength of micro-irradiation techniques lies in their ability to deliver precise doses of radiation to selected individual cells in vitro or even to target subcellular organelles. These abilities have led to the development of a range of microbeam facilities around the world allowing the delivery of precisely defined beams of charged particles, X-rays, or electrons.

In addition, microbeams have acted as mechanistic probes to dissect the underlying molecular events of the DNA damage response following highly localised dose deposition. Further advances in very precise beam delivery have also enabled the transition towards new and exciting therapeutic modalities developed at synchrotrons to deliver radiotherapy using plane parallel microbeams, in Microbeam Radiotherapy (MRT).

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