Purpose: Microbeam radiotherapy (MRT) is a preclinical therapy that has been shown in animal experiments to have a selective ability to eradicate tumor cells while sparing normal tissue. However, potential MRT clinical application is hindered by the lack of understanding of the biological mechanisms involved. To study DNA damage and repair mechanisms and cell survival under MRT irradiation, our objective is to integrate a carbon nanotube field emission technology-enabled high dose rate (100's Gy/s) electron microbeam with a micropallet array technology-enabled cell retrieval and analysis system. The focus of this presentation is a feasibility demonstration of the integrated system for MRT cellular irradiation.

Methods: We have upgraded our carbon nanotube field emission-based prototype cell irradiator system to produce a single or multiple ~40 micron wide electron MRT beams at a dose rate range of several hundred Gy per second. Dosimetry is measured using GAFCHROMIC HD-810 film. SW480 colon cancer cells are plated on individual square micropallets of 60 or 100 micron in size, placed in a customized culture dish. Cells can be collected from each individual micropallet while remaining adherent to their growth surface for further analysis.

Results: We have demonstrated the MRT cellular irradiation using gamma-H2AX, a nuclear histone protein that becomes phosphorylated in proximity to IR-induced DNA double strand breaks. The MRT radiation beam profile shown by staining fixed cells post-IR for phospho-H2AX was consistent with calculation.

Conclusions: We have developed an integrated MRT cellular irradiation and analysis system using carbon nanotube field emission technology and micropallet array technology. We have characterized the dosimetry and demonstrated the feasibility of MRT beam irradiation in cellular irradiation for future mechanistic research on microbeam therapy.

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