CAN NON-UNIFORM TREATMENTS USING LINAC MLCS MIMIC MICROBEAM IRRADIATION RESULTS?

Claridge E¹², Suchowerska N¹², Zhang M¹, Ebert M³⁴, McKenzie DR²
¹ Royal Prince Alfred Hospital, Sydney, Australia
² University of Sydney, Sydney, Australia.
³ Newcastle Mater Misericordiae Hospital, Newcastle, Australia.
⁴ University of Newcastle, Newcastle, Australia.

Introduction
Results from microbeam irradiations suggest that there is clinical advantage in treating with non-uniform beams. The increased cellular tolerance observed following these irradiations is attributed to the small size of the beams and the migration of cells to repair damaged capillaries²³. Radiotherapy treatments such as IMRT are constrained by ICRU recommendations of dose uniformity to the target volume¹. We have performed strategically designed experiments to determine if the increased tolerance evident in microbeam treatments is observable in irradiations of non-uniform fields created with clinical MLCs.

Method
Clonogenic cell survival assay of Melanoma cells (MM576) was used as a measure of radiosensitivity. After incubation at 37°C overnight, the cells were irradiated with a single dose of 3 to 20 Gy on a Varian 6EX linear accelerator with a 6MV photon beam. The accelerator’s 120 leaf multileaf collimator (MLC) was used to produce different spatially modulated radiation fields. These fields shielded 75% of the cells and exposed the remaining 25% using different dose patterns. After radiation exposure, the cells were incubated for 10 days at 37°C. These colonies were then fixed and stained with Methene Blue / Ethanol. The colonies containing more than 50 cells were counted using a novel technique coupled with computer software [freeware], calibrated to identify colonies larger than 50 cells.

Results
The resulting survival fractions for the non-uniform irradiations were compared to the control unirradiated and the uniformly irradiated survival fractions for the same cell line. Our experimental results show significant differences in survival fraction for the same dose, between uniform and non-uniform irradiations.

Discussion
This work provides important evidence supporting a radiobiological response model that incorporates non-local response effects. This is consistent with previous publications in this area, including those suggesting cellular communication⁴. Similarities in the survival fraction are observed between our results and published microbeam results providing insight into the potential underpinning mechanisms.

References
¹ ICRU (1993) Prescribing, Recording and Reporting Photon Beam Therapy, ICRU report 50

Acknowledgements: NSW Cancer Council Grant RG-06-02