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Identifying optimal clinical scenarios for synchrotron microbeam radiation therapy

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Background: Synchrotron Microbeam Radiation Therapy (MRT) is a pre-clinical modality characterised by a periodically alternating peak-valley dose-distribution. Dosimetry studies using clinical datasets have not yet been conducted. Our aim was to identify optimal settings for a future Phase I trial from a range of clinical scenarios refractory to standard treatments.

Materials and methods: Seven clinical scenarios were chosen for MRT planning. A hybrid algorithm which combines Monte Carlo and convolution-based approaches was used for dose-calculation. The objective of MRT plans was to ensure the valley dose to organs at risk (OARs) was within the tolerance doses achieved in the corresponding clinical plans. We then assessed the corresponding peak doses and peak-to-valley dose ratio (PVDRs) at the tumour target volume.

Results: Tumours with small and shallow volumes could receive peak doses greater than 80 Gy in a single fraction with PVDRs greater than 10. These scenarios included recurrent glioblastoma, head and neck tumours, and select loco-regionally recurrent breast cancer sites. Treatment volume was a more important factor than treatment depth in determining the PVDR. The mean PVDR correlated strongly with the size of the target volume ($r = -0.70$, $p = 0.01$).

Conclusion: In the context of the current physical limitations of a horizontal beam-line, our findings suggest that intra-cranial and head and neck sites will be optimal scenarios for a future trial of MRT.

Primary author(s) : SMYTH, Lloyd (University of Melbourne, ICON Cancer Centre); DAY, Liam (Royal Melbourne Institute of Technology); Ms WOODFORD, Katrina (Alfred Hospital); ROGERS, Peter (University of melbourne); CROSBIE, Jeffrey (RMIT University); Dr SENTHI, Sashendra (Alfred Hospital)

Presenter(s) : SMYTH, Lloyd (University of Melbourne, ICON Cancer Centre)

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