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# Planning and Delivery of Spatially Fractionated Minibeam Treatment

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## Abstract

OBJECTIVES: Spatial fractionation of radiation using arrays of narrow parallel beams, is a concept with many unknowns specifically within the underlying biology of cell death. A tungsten collimator was designed to produce minibeams with a linear accelerator for translational animal research into the effectiveness of spatial fractionation minibeam radiotherapy (MBRT). The following work presents the treatment planning technique and radiotherapy workflow for the application of MBRT treatments within a 16 patient clinical study comparing outcomes between conventional radiotherapy and MBRT.

METHODS: MBRT plans were created using static fields at various gantry angles. The collimator and couch angles were kept at zero degrees to superimpose the minibeam peaks and valleys. Careful consideration was made to ensure the radiological depth was equivalent between the static fields to minimize peak broadening. A multileaf collimator was used to conform the aperture shapes to the PTV volume with a margin of 1.5 mm. For patient dose calculations, the MBRT collimator was incorporated into a Monte Carlo based treatment planning system. MUs per field were determined by normalizing the prescription dose to the PTV volume. The dosimetry of the plan was revived by the physician and the calculated plan was used for patient treatment. Prior to treatment, a delivery verification plan was created on a SoildWater phantom and treatment field outputs were measured. For radiotherapy delivery, patients were anesthetized and positioned within a vaclock bag lying prone. A bite block and thermoplastic mask further immobilized the head.

RESULTS: Patients were planned with two static fields expect one where three fields were used. Equivalent field weighting was used for all plans. For the eight patient treated with MBRT, the mean percentage difference between calculated and planned output was -0.2%, and the standard deviation was 1.6%.

CONCLUSIONS: The presented MBRT planning technique and workflow was followed to plan the first series of linac based MBRT patients within a clinical study. Field outputs results were within our experimental uncertainty and provided reassurance in our Monte Carlo beam model. Depending on the clinical outcome results, the planning technique and radiotherapy workflow could be applied to human MBRT treatments.

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