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Medical linear accelerator mounted mini-beam collimator: transferability study

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Background: In place of the uniform dose distributions used in conventional radiotherapy, spatially-fractionated radiotherapy techniques employ a planar array of parallel high dose 'peaks' and low dose 'valleys' across the treatment area. A group at the Saskatchewan Cancer Agency have developed a mini-beam collimator for use with a medical linear accelerator operated at a nominal energy of 6MV.
Purpose: The goal of this work was to characterize various attributes of the mini-beam collimated dose distribution and assess consistency of those attributes across a set of medical linear accelerators.
Materials and Methods: Three "beam matched" Varian iX accelerators were used in this study. All measurements were made using a PTW scanning water tank set with a 100 cm source to surface distance. Dose profiles perpendicular to the plane of the mini-beam collimator were measured at a depth of 10.0 cm for a square field of side 4.0 cm. Percentage depth dose (PDD) curves along the central peak dose were made for a square field of side 4.0 cm. Relative point dose measurements were made at a depth of 10.0 cm along the central peak dose using two different diode detectors (PTW TN60017 and IBA stereotactic field diode (SFD)). A collimator factor (CF), defined as the ratio of the collimated point dose to that of the open field point dose, was determined at a depth of 10 cm for each linac for square field sizes of side 2.0, 3.0, 4.0 and 5.0 cm.
Results: When normalized to the central peak dose, the profile data revealed a variation in the relative valley dose across the three linacs. However, the PDD data was consistent indicating no variation in beam energy across the three linacs. As previously determined, the measured CF did differ as a function of detector. This results from the active volume of the detectors being different. The measured CF also differed across the set of linacs. The PTW diode measurements showed an average difference of 2.65% across accelerators, and the SFD showed an average difference of 5.6% across accelerators. The difference in CF and valley dose is believed to result from differences in the electron source width incident on the Bremsstrahlung target for each of the accelerators.
Conclusion: The dose profile and collimator factors of the mini-beam collimated dose were not found to be consistent across a set of medical linear accelerators.

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