

AbstractID: 9496 Title: Modeling the dose rate effect on High Dose Rate (HDR) Accelerated Partial Breast Irradiation (APBI) Treatment

Purpose: The objective of this study is to quantify the loss of radiobiological effect during a protracted Partial Breast Irradiation treatment using HDR interstitial brachytherapy and the MammoSite balloon applicator.

Method and Materials: Given the relatively short half-life of Ir-192, a range of dose rates are employed clinically. The position and size of target relative to radiation source differs for MammoSite and an interstitial implant thereby affecting the treatment time. Two treatment plans (one for each modality) were used to simulate the treatment delivery with variable source strengths (3-9 Ci) and treatment times (250-1,000 s). The radiobiological effect was quantified using the Biologically Effective Dose (BED) formalism for each voxel of the target. These values were then aggregated, thereby removing the dose non-uniformity contribution, into an Equivalent Uniform Dose (EUBED). Two models were employed: BED_0 that simply takes into account the total dose, fraction size and α/β ratio, and BED_1 which accounts for repair and the delivery time sequence. The PTV for the MammoSite applicator was 86.3 cc, and that of the interstitial implant was 120.5 cc (16 catheters).

Results: While the $EUBED_0$ for both modalities, assuming uniform dose distributions is 62.9Gy ($\alpha/\beta=4$ Gy, fraction size=3.4Gy), the effect of non-uniform distributions raises the $EUBED_0$ to 74.6Gy and 76.0 Gy for the interstitial case and the MammoSite applicator, respectively. When repair and the delivery time sequence is considered, $EUBED_1$ drops dramatically to 54.5Gy, 39.5Gy and 36.4Gy, for treatment times one, two and three times longer than the actual treatment time. Similar results were noted with the MammoSite treatment.

Conclusion: There appears to be a significant loss of radiobiological effect with protracted HDR treatments. We are advocating recording of treatment times along with other dosimetric parameters as these may impact the clinical outcome.