

ABSTRACT FINAL ID: 1061;

TITLE:

Comparison of Three Partial Breast Irradiation Techniques: Treatment Effectiveness Based Upon Biological Models

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ABSTRACT BODY:

Purpose/Objective: To evaluate the equivalence of partial breast irradiation (PBI) to whole breast irradiation (WBI) for Stage 0-II breast cancer, a phase III trial NSABP-B39/ROG 0413 has opened which randomizes patients after lumpectomy to standard WBI or to one of three PBI arms: Multi-catheter brachytherapy (MCT) (3.4Gy BID), Mammosite[®] brachytherapy (MST) (3.4Gy BID), or 3-D conformal (3DCRT) PBI (3.85Gy BID) delivered over 5-10 days. The rationale for the higher dose for 3DCRT PBI is the anticipated large dose inhomogeneity in the two brachytherapy PBI modalities. This raises a question whether the three PBI modalities are equivalent if considering realistic dosimetry. Using a linear-quadratic (LQ) model with the consideration of realistic dose inhomogeneity, we compared the relative merits of three PBI modalities in terms of equivalent uniform dose (EUD), Tumor Control Probability (TCP), and Normal Tissue Complication Probability (NTCP).

Materials/Methods: Treatment plans from five patients treated by each PBI modality (a total of 15 patients) were retrospectively selected from an institutional database. Dose-volume-histograms (DVH) for clinical target volume (CTV), ipsilateral breast, and ipsilateral lung for each plan were generated. The CTV was excluded from the breast volume. In the case of MST, the balloon was not considered as part of the CTV. The patients had comparable age and tumor stage. Breast volumes ranged from 402cc to 2570cc. CTV volumes ranged from 56cc to 213cc. The LQ parameters $\alpha = 0.3 \text{ Gy}^{-1}$ and $\alpha / \beta = 10 \text{ Gy}$, as well as other LQ parameters found in the literature for breast cancer were used to carry out the calculations. A computer code (*AutoEUD*) was utilized to perform the calculations based on the individual DVH.

Results: The largest DVH variation between PBI modalities was for CTV. A comparison of DVHs for CTV averaged over five patients for each PBI modality is shown. The dose inhomogeneity is different for the three PBI modalities, which may result in different treatment effectiveness. The average EUD (normalized to 3.4Gy BID) for the MCT, MST, and 3-DCRT PBI was 35Gy, 37.2Gy, and 37.6Gy, respectively. When normalized to a standard 2 Gy fractionation these become, 42.2Gy, 46.4Gy, 46.9Gy, respectively. Average TCP for MCT, MST, and 3-DCRT PBI was 94.8%, 99.14%, and 99.17% respectively. The breast and lung DVH variation between treatment plans within a given PBI modality was very small. The NTCP values for both breast and lung are found to be very low for the cases considered.

Conclusions: The three PBI modalities demonstrate variation in anticipated effect as assessed by EUD, TCP, and NTCP based on realistic dose distributions. As evidenced by the EUD and TCP calculations, the MST and 3DCRT PBI may result in different clinical outcomes as compared to MCT. Clinical data are needed to confirm these findings.

(No Table Selected)

