Title: Preventing cardiotoxicity in breast cancer radiation treatment: deep inspiration breath hold proves to be superior modality.

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Purpose/Objective(s): As breast cancer survivorship continues to increase, the need to minimize long term side effects of radiation such as heart disease and lung fibrosis becomes more pertinent. Respiratory-induced heart and lung motion in whole breast irradiation (WBI) can lead to changes in dose distribution across target volumes. Therefore, we sought to compare dosimetric variance using four different treatment schemes: 4DCT average intensity projection (AVEIP), 4DCT maximal intensity projection (MIP), deep inspiration breath hold (DIBH) and prone breast setup.

Materials/Methods: Patients with left sided early stage breast cancer, planned to undergo WBI to 50Gy in 2Gy fractions using tangents without nodal radiation were retrospectively selected. During the time of simulation, the patients were positioned in the supine position to acquire both a 3DCT during DIBH and a 4DCT acquired during free breathing, and in the prone position for a 3DCT. Contours were delineated on the prone, DIBH, all 10-phases of the 4D, the AVEIP and the MIP. The whole breast, ipsilateral (IPSL) and contralateral lungs (CTRL) and heart were contoured. IPSL dosage was analyzed using Dmean, and the volume receiving ≥ 5, 10 or 20Gy. CTRL dosage was evaluated for volume receiving ≥ 5Gy. Heart dosage was evaluated using Dmean and the volume receiving ≥ 5, 10 or 15Gy.

Results: Sixteen separate plans were analyzed. Analysis of 4D volumes showed no variation for MIP and AVEIP, while two distinct phases of end inspiration and end inspiration could be identified based on volumetric changes in each patient. Analysis of 4D data was done by combining values obtained from both MIP and AVEIP as they were comparable. Plans using DIBH and 4DCT had greater breast volume coverage when compared with prone setup; V50Gy for DIBH, 4DCT and prone were 77.1% +/- 1.68, 79.3% +/- 5.07 and 68.7% +/- 0.90 respectively (p=0.03). Prone setup significantly reduced the Dmean to IPSL: 60cGy +/- 13 compared with 425cGy +/- 43.7 for DIBH and 452cGy +/- 65.5 for 4DCT (p<0.01). IPSL V20Gy was significantly decreased with prone setup at 0.40% +/- 0.1 as compared with 6.95% +/- 0.6 for DIBH and 7.18% +/- 1.8 for 4DCT (p=0.003). In analyzing V5Gy to the heart, DIBH had significantly less tissue receiving 5Gy at 0.6% +/- 0.3, while prone setup was 5.28% +/- 0.1 and 4DCT was 3.49% +/- 0.4 (p<0.01).

Conclusions: From recent literature, it is now clear that the heart is vulnerable to radiation toxicity and steps must be taken to prevent this. Plans devised for both prone breast and DIBH provided a benefit to normal tissue dose as seen in treatment planning. While prone breast radiation minimized lung dose, breast coverage was not optimal. DIBH minimized heart dose while allowing for optimal whole breast coverage. We suggest that radiation planning and delivery are crucial to consider especially with young patients with left sided breast cancer and based on our findings, DIBH may be the optimal technique for radiation delivery in this population.