Abstract

Background: The use of hypofractionated intensity-modulated radiation therapy (IMRT) ensured the safe application of internal mammary lymph node area (IMN) in the treatment field as well as protect organs at risk such as the heart and lungs in cases of left breast cancer; however, little is known about the effect of respiratory motion on regional node irradiation IMRT for advanced breast cancer. We analyzed the effect of intra-fractional and inter-fractional motion during IMRT of left-side breast and regional lymphatics by calculating dose distribution based on four-dimensional computed tomography (4D-CT).

Materials and Methods: Twenty patients diagnosed with left breast cancer were enrolled. Three-dimensional (3D)-CT along with ten phases of 4D-CT were collected for each patient, with target volumes independently delineated on both 3D-CT and all phases of 4D-CT. IMRT plans were generated based on 3D-CT (43.2Gy in 16 fractions). The plan parameters for each segment were split into phases based on time duration estimates for each respiratory phase, with phase-specific dose distributions calculated and summated (4D-calculated dose). The procedure is repeated for 16 fractionations by randomly allocating starting phase using random-number generation to simulate inter-fractional discrepancy caused by different starting phase. Comparisons of plan quality between the original and 4D-calculated doses were analyzed.

Results: There was a significant distortion in 4D-calculated dose induced by respiratory motion in terms of conformity and homogeneity index compared to those of the original 3D plan. Mean doses of the heart and the ipsilateral lung were significantly higher in the 4D-calculated doses compared to those of the original 3D plan (0.34Gy, p=0.010 and 0.59Gy, p<0.001), respectively). The mean IMN dose was significantly greater in the 4D-calculated plan, compared to the original 3D plan (1.42Gy, p<0.001).

Conclusions: DIBH may help in reducing dose increment caused by free-breathing motion in heart and lung. IMN doses should be optimized during the dose-calculation for the free-breathing left breast IMRT.

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