Dosimetric comparison of Intensity-Modulated Radiation Therapy (IMRT) vs. 3D Conformal Radiotherapy (3D-CRT) in operable breast cancer

Salah El-Mesidy[1]; Amr El-Kashif[1]; Nader El- Sherbini[2]; Khaled Thabet[1]

1. *Department of Clinical Oncology, Faculty of Medicine, Cairo University*
2. *Physics Unit, Faculty of Medicine, Cairo University*

PAJO, December 2011, 4(4): 20-27

Abstract

Purpose: To compare target dose distribution, homogeneity and doses received by organs at risk (OAR); lungs, heart, and contralateral breast using 3D conformal radiotherapy (3D-CRT) and intensity-modulated radiation therapy (IMRT) planning in patients with operable left breast cancer. Calculated tumor control probability (TCP) and normal tissue complication probability (NTCP) for OAR were also compared.

Patients and Methods: Sixty female patients with operable left breast cancer either post mastectomy or breast conservative surgery (BCS) underwent 3D-CRT and IMRT planning. Target coverage and target dose distribution as well as doses received by OAR (lungs, heart) were evaluated in both techniques. The TCP for target volumes, the NTCP for late excess cardiac mortality and radiation pneumonitis and estimated excess relative risk of right breast cancer incidence (EERRRBCI) were calculated.

Results: Dose coverage for left breast and chest wall planning target volume (PTV) was better in IMRT (D90% 4883.70 ± 166.09 cGy and D95% 4820.70 ± 142.05 cGy) compared with 3D-CRT (D90% 4780.8 ± 119.04 cGy and D95% 4630.80 ± 108.06 cGy) P=0.001, while dose homogeneity was better in 3D-CRT vs. IMRT with homogeneity index (H.I) 0.1570 ± 0.02437 vs. 0.1857± 0.02417 (P=0.001). TCP was also better in 3D-CRT compared with IMRT (68.34 ± 4.74% vs. 66.24 ± 4.89% with P=0.006). Target dose coverage and dose homogeneity in internal mammary chain (IMC) PTV were better in IMRT than in 3D-CRT with D90% 4735.48 ± 114.29 cGy and 4678.87 ± 209.65 cGy (P=0.059) and D95% 4707.80 ± 291.36 cGy and 4562.93 ± 230.73 cGy (P=0.001), respectively. Larger volumes of the left lung and heart were exposed to higher radiation doses in 3D-CRT than in IMRT technique. V20Gy for left lung was 17.40 ± 2.47% and 26.77 ± 5.53% with P=0.001 for IMRT and 3D-CRT, respectively. V30Gy for the heart was 5.22 ± 3.05% and 13.18 ± 5.86% with P=0.001 for IMRT and 3D-CRT, respectively. There was a significant difference in the NTCP for late pulmonary and cardiac toxicities in favor of IMRT. These significant differences were also maintained whether IMC was included or not in the planning and when the chest wall geometry was more curved (more than the normal ratio of AP/lat = 5/7). Radiation doses to right breast were also significantly higher in IMRT than 3D-CRT with EERRRBCI of 2.29 ± 0.62% vs. 0.93 ±0.43% with P=0.001.

Conclusion: IMRT planning improves target coverage and decreases irradiation of the OAR at the expense of increased target heterogeneity and more radiation doses to contralateral breast compared with 3D-CRT. IMRT technique should be offered to patients with more curved chest wall or when IMC is included due to significant sparing of left lung and heart.