Original Research Article

Dosimetric comparative study of 3DCRT versus VMAT in post mastectomy left sided carcinoma breast patients.

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Abstract:
Background & Method: The aim of the study is to compare dosimetry of 3DCRT versus VMAT in post mastectomy left sided carcinoma breast patient. The plan was created using a mono-isocentric technique. The chest wall was irradiated using two opposing tangential beams in 3DCRT technique. A single anterior field with an angle of 10° away from the spinal cord was used to treat the SCF and axillary apex. Dose prescription was done to isocentre. To ensure adequate PTV coverage and reduce hotspot to less than 107%, the Field-in-Field technique with MLCs was used with multiple subfields. The dynamic weightings used in this study were chosen to maximize PTV dose coverage and homogeneity. The prescription was given at the point for the nodal dose but was normalized to reduce hotspots to less than 107% isodose line. The algorithm used was Collapsed Cone and 6 MV photons with a dose rate of 600 MU/min were used for the chest wall, whereas 10MV energy was used for nodal areas.
Conclusion: VMAT better than the standard method as far dosimetry of high dose volumes was considered. Inverse planning methods that worsened performance were the low dose irradiation of the heart, lung, contralateral breast, and integral dose to the body. It would be prudent to conclude that VMAT was superior to 3DCRT if only target volume and high dose irradiation were prioritized but worse when low dose irradiation was brought into the picture.

Keywords: Dosimetric, 3DCRT, VMAT, mastectomy & carcinoma.

Study Designed: Observational Study.

1. Introduction

Breast cancer is the leading cause of cancer among females in developing countries, with most cases presenting in a locally advanced stage. It constitutes the highest number of patients seen on an outpatient basis in a developing country like India, with 178,361 new cases diagnosed in 2020, constituting 26.3% of all cancer cases [1]. Mastectomy has remained the standard of care for locally advanced breast cancer (LABC).
Even with the myriad options available to oncologists worldwide, radiation plays a pivotal part in multimodality treatment to prevent local recurrences leading to improved overall survival. EBCTCG meta analysis [2] and other trials had demonstrated that post-mastectomy radiotherapy (PMRT) provides a survival advantage to patients undergoing mastectomy even when they had at least one positive lymph node. The MA-20 trial helped determine who would benefit from Comprehensive Nodal Irradiation (CNI) along with chest wall irradiation [3]. The benefit of radiotherapy comes at the expense of the heart [4], lung, and secondary breast cancer risk [7]. The heart is one of the most vulnerable organs for radiation for left-sided breast cancer, with increasing cardiac dose linked to higher mortality. Compared to three dimensional conformal radiotherapy (3D-CRT), intensity-modulated radiotherapy (IMRT) has been widely used in the last decade, allowing optimal dose distribution according to individual anatomy. It improves dose homogeneity within the irradiated breast with heart and lung sparing. A

newer technique called volumetric modulated arc therapy (VMAT) was introduced by Otto [5] in 2008. The intended dose could be delivered in a single gantry rotation and decrease the treatment time compared to IMRT.

2. Material & Method

This observational study was conducted at Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Ambala.The source of study was outpatient and inpatients breast cancer patients registered in the Department of Radiation Oncology between January 2021 to December 2022. Total 50 patient of left sided breast carcinoma post mastectomy were included in this study. Clinical target volume (CTV) contoured as target and ipsilateral lung, heart , LAD, contralateral lung and contralateral breast as organ at risk (OAR) as per guidelines. Dose prescribed 40Gy/15#/ 3weeks. Both plan VMAT and 3DCRT were developed for each patient. Left lung mean, V5, V10,V20 and for heart mean,V20, V25 ,LAD mean, D max and right lung V5 and right breast mean were calculated for each patient and compared between VMAT and 3DCRT technique.

The plan was created using a mono-isocentric technique. The chest wall was irradiated using two opposing tangential beams. Dose prescription was done to isocentre. To ensure adequate PTV coverage and reduce hotspot to less than 107%, the Field-in-Field technique with MLCs was used with multiple subfields. The dynamic weightings used in this study were chosen to maximize PTV dose coverage and homogeneity. A single anterior field with an angle of 10° away from the spinal cord was used to treat the SCF and axillary apex. The prescription was given at the point for the nodal dose but was normalized to reduce hotspots to less than 107% isodose line. The algorithm used was Collapsed Cone and 6 MV photons with a dose rate of 600 MU/min were used for the chest wall, whereas 10MV energy was used for nodal areas.

Inclusion Criteria: 1.Histopathologicaly proven carcinoma breast patient.
2.Post Mastectomy.
3. Irradiation site: Chest wall, axilla and SCF.

Exclusion Criteria: 1. Irradiation site chest wall only.
2.Post BSC.

Fig 1: VMAT 95% COVORAGE

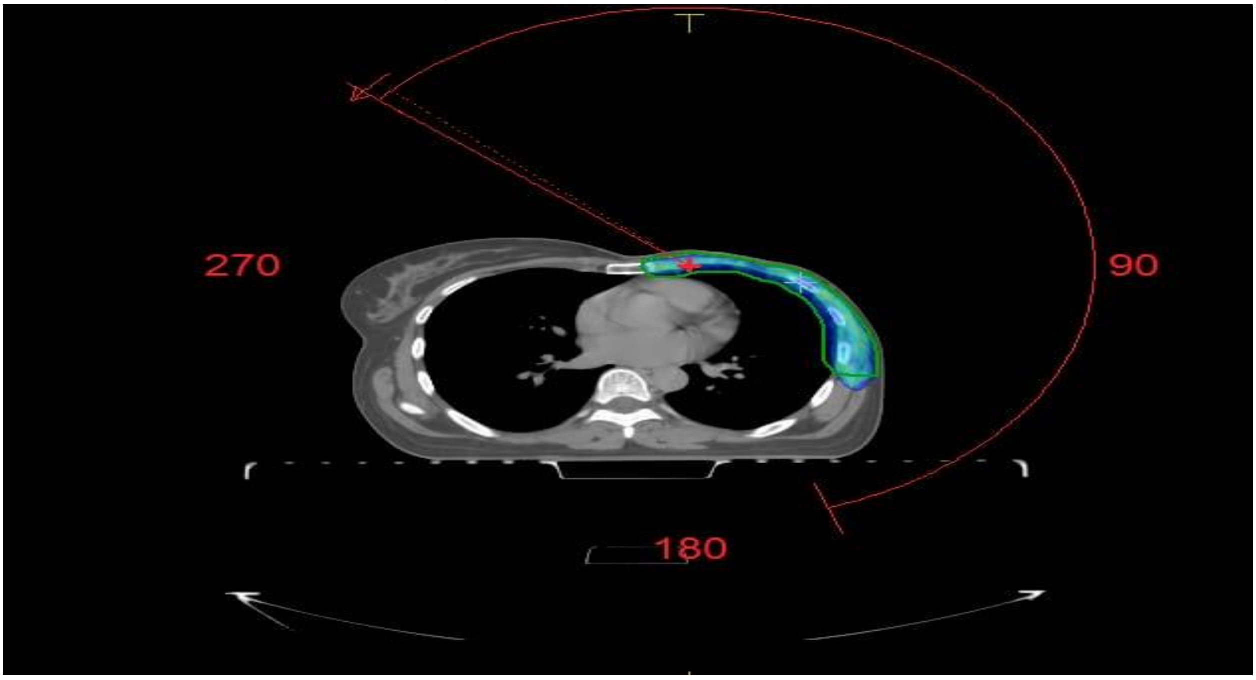

Fig 2: 95% 3DCRT COVERAGE

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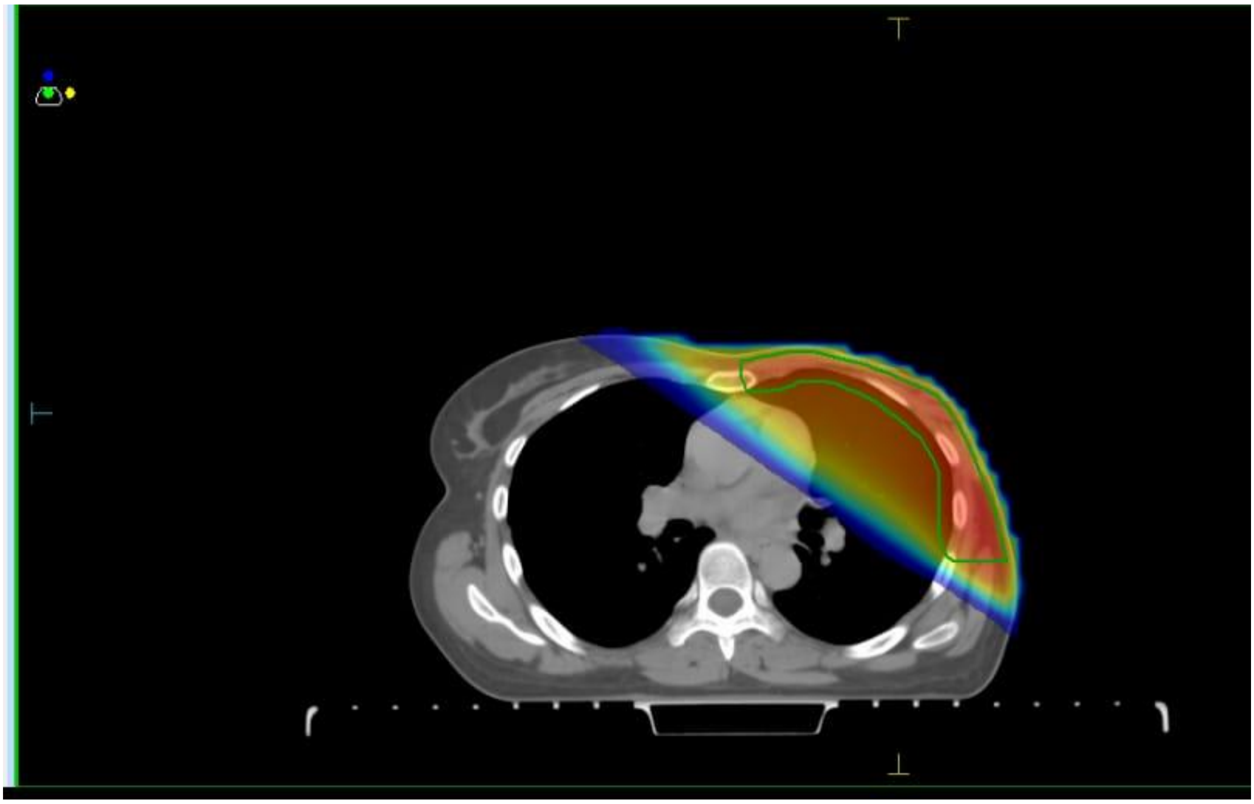

3. Results

Table No. 1:

Parameters		**VMAT**	**3DCRT**	**P Value**
PTV V95% (%)		91.44 ± 6.15	74.55 ± 14.72	<0.001*
Conformity Index (CI)		0.92 ± 0.14	0.78 ± 0.09	<0.001*
Homogeneity Index (HI)		0.205 ± 0.05	0.132 ± 0.08	<0.001*
	D_{MEAN}	15.18 ± 9.56	28.37 ± 6.79	<0.001*
Left lung	V_5 (%)	84.62 ± 15.77	58.13 ± 9.32	<0.001*
	V_{10} (%)	49.15 ± 9.64	34.22 ± 7.19	<0.001*
	V_{20} (%)	31.69 ± 4.50	51.74 ± 8.67	<0.001*
Right lung	V_5 (%)	41.95 ± 18.75	5.77 ± 3.16	<0.001*
Heart	D_{MEAN}	15.42 ± 4.92	13.76 ± 5.24	0.1057#
	V_{25} (%)	13.68 ± 7.55	31.56 ± 9.84	<0.001*
LAD	D_{MEAN}	15.09 ± 3.79	24.56 ± 5.91	<0.001*
	Dmax(Gy)	27.57 ± 7.62	33.93 ± 5.73	<0.001*
Right Breast	D_{MEAN}	5.74 ± 2.18	3.05 ± 1.75	<0.001*
Spinal cord	Dmax(Gy)	21.46 ± 4.57	39.78 ± 6.95	<0.001*

4. Discussion

The management of invasive breast cancer has changed substantially over the past few decades. A larger proportion of such patients, especially in developed nations, is now treated with breast-conserving surgery rather than mastectomy, with increasing numbers of patients receiving systemic therapy[6]. Two different postoperative radiotherapy techniques are used for patients after breast-conserving surgery and radical mastectomy. Patients undergoing breast-conserving surgery are at earlier stages and need only whole breast irradiation, whereas patients with locally advanced stages typically require modified radical mastectomy and irradiation of the ipsilateral chest wall and supraclavicular region[7]. In our study, to manage the dose uncertainty of mega-voltage beams in the build-up region, as well as the CTV displacement resulting from intrafraction movements and setup errors, we added a 1.0-cm thick tissue equivalent compensator to the surface of the chest walls in order to cover the farthest

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CTV displacement border[8]. A “skin flash” could be avoided because a tissue equivalent compensator that was at least 0.3 cm thick was maintained on the surface of the chest wall despite the CTV displacement.
We found that 5F-IMRT plans exhibited advantageous dosimetry compared with the 3DCRT-FinF and 2P-VMAT plans in PMRMRT for left-sided breast cancer. The PTV coverage, dose homogeneity and conformity of IMRT were enhanced compared with the 3DCRT-FinF plans. Moreover, the 5F-IMRT plans exhibited better heart and ipsilateral lung sparing compared with the 2P-VMAT plans[9]. However, whether the dosimetric advantages of 5F-IMRT leading to significant clinical benefit remains unclear and warrants further study. The IMRT plans had an average MU number per fraction equal to 1021 (corresponding to 10.21Gy), which was more than 5 times the number for a 2 Gy/fraction prescription. These plans would require longer periods for treatment and for pre-treatment dosimetric verification compared with the 3DCRT-FinF and 2P-VMAT plans[10].

5. Conclusion

VMAT better than the standard method as far dosimetry of high dose volumes was considered. Inverse planning methods that worsened performance were the low dose irradiation of the heart, lung, contralateral breast, and integral dose to the body. It would be prudent to conclude that VMAT was superior to 3DCRT if only target volume and high dose irradiation were prioritized but worse when low dose irradiation was brought into the picture.

6. References

1. Fuller SA, Haybittle JI, Smith RF, et al: Cardiac doses in post-operative breast irradiation. Radiother Oncol 1992, 25:19–14.
2. Thilmann C, Zabel A, Milker-Zabel S, et al: Number and orientation of beams in inversely planned intensity-modulated radiotherapy of the female breast and the parasternal lymph nodes. Am J Clin Oncol 2003, 26:36–43.
3. Rowbottom CG, Golby C, Atherton S, et al: Investigation into the pinnacle smartarc module for VMAT planning. IFMBE Proceedings 2009, 25:721–724.
4. Rongsriyam K, Rojpornpradit P, lertbutsayanul C, et al: Dosimetric study of inverse-planned intensity modulated, forward-planned intensity modulated and conventional tangential techniques in breast conserving radiotherapy. J Med Assoc Thai 2008, 91(10):1571–1582.
5. Bhanagar AK, Heron DE, Deutsch M, et al: Does breast size affect thescatter dose to the ipsilateral lung, heart, or contralateral breast in primary breast irradiation using intensity modulated radiation therapy (IMRT)? Am J Clin Oncol 2006, 29:80–84.
6. Jagsi R, Moran J, Marsh R, et al: Evaluation of four techniques using intensity-modulated radiation therapy for comprehensive locoregional irradiation of breast cancer. Int J Radiat Oncol Biol Phys 2010, 78:1594–1603.
7. Caudell JJ, DeLosSantos JF, Keene KS, Fiveash JB, et al: A dosimetric comparison of electronic compensation, conventional intensity modulated radiotherapy, and tomotherapy in patients with early-stage carcinoma of the left breast. Int J Radiat Oncol Biol Phys 2007, 68(5):1505–1511.
8. Douglas WA, Monica MM, Frank AV, Nesrin D: Breast IMRT. In Image-Guided IMRT. Edited by Thomas B. Berlin: Springer Berlin - Heidelberg; 2006:371–381.
9. Darby SC, Ewertz M, McGale P, Bennet AM, et al: Risk of ischemic heart disease in women after radiotherapy for breast cancer. N Eng J Med 2013, 368:987–998.
10. Cavendish JJ, Berman BJ, Schnyder G, et al: Concomitant coronary and multiple arch vessel stenoses in patients treated with external beam radiation: pathophysiological basisi and endovaascular treatment. Catheeter Cardiovase Interv 2004, 62:385–390.