Section: Radiation Oncology

Research

ASSESSMENT OF CONTRALATERAL BREAST RADIATION DOSE DURING THREE-DIMENSIONAL CONFORMAL RADIOTHERAPY IN CARCINOMA OF BREAST AFTER BREAST CONSERVATION SURGERY

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Abstract

Background: Regardless of a country's socioeconomic standing, breast cancer is the most common cancer among females globally. The aim is to determine the mean, median and maximum radiation dose received by contralateral breast during three-dimensional conformal radiotherapy in carcinoma of the breast after breast conservation surgery. **Materials and Methods:** A cross-sectional study was conducted at the Department of Radiation Oncology, Government Medical College Hospital, Kozhikode, from January 2016 to December 2019. Forty patients with carcinoma of the breast who underwent breast conservative surgery and were treated with three-dimensional conformal radiotherapy were included in the study. **Result:** The meduan age of participants was 47.1 (11.5) years. 55% of patients had left sided breast cancer and 45% had right sided breast cancer. More than half (52.5%) of patients had comorbidities at the time of treatment. TNBC was the most frequent type (40.0% of patients), followed by Luminal A (32.5%). 62.5% of patients received 40 Gy/15 fractions and 37.5% received 42.5 Gy/16 fractions. 42.5% of patients had their supra-clavicular fossa treated. There was a significant positive correlation between the contralateral breast volume and the maximum radiation dose. The median dose of mean radiation to the contralateral breast was significantly higher when the inner quadrant radiation was given than the outer quadrant's radiation (172 cGY vs 65.5 cGY; p=0.001). **Conclusion:** People who underwent BCS followed by three-dimensional conformal radiotherapy showed a significant increase in contralateral breast dose when the tumour site was in the inner quadrants of the breast, compared to those who had tumour in the outer quadrants. This highlights the importance of contouring the contralateral breast as an organ at risk during breast cancer radiation therapy planning.

INTRODUCTION

Cancer of the breast is the most prevalent kind of malignancy found in women worldwide, regardless of whether they live in a developing or developed country. Breast cancer in contrast to other types of cancer, may be efficiently treated if diagnosed early. Because of advances in diagnosis and therapy, it is becoming a disease that more and more people can survive. Over the past several decades, there has been a worldwide rise in the incidence of breast cancer, with a particular emphasis on the rise of the disease in Asian nations. In India, the premenopausal age group accounts for fifty percent of the breast cancer cases diagnosed yearly.[1]

Radiotherapy is an essential part of breast cancer care for patients who have had breast-conserving surgery (BCS). Only the tumour is excised during breast-conserving surgery with a pathologically clear margin. Radiotherapy administered after lumpectomy attempts to enhance local control in the affected breast. Following breast-conserving surgery, usually whole breast irradiation is given followed by boost dose to the primary tumour site.[2]

The most common treatment technique used is three-dimensional conformal radiation or 3D CRT. Most treatments in 3D CRT are carried out using radiation beams with an intensity consistent across the field. However, wedges or compensators are employed in certain circumstances to adjust the intensity profile of offset contour abnormalities and generate a more uniform composite dose distribution. Intensity modulation is the technique of altering the intensity profile of a beam to fulfil the requirements of a composite design.

Radiation dose to the contralateral breast is concern due to its potential long term carcinogenic effects. This is a particular cause for worry for younger women (under 45 years old) undergoing breast cancer radiotherapy. Dosimetric studies have shown that scattered dose received by opposite breast is mainly from the collimator and accessories of accelerator. The Early Breast Cancer Trialists Collaborative meta-analysis found that individuals who underwent radiation therapy for breast cancer were more likely to develop breast cancer in the contralateral breast than those who underwent mastectomy alone.[3] Our study aims to determine the contralateral breast dose during radiotherapy in post-BCS breast cancer patients in our institute.

AIM

To determine mean, median and maximum contralateral breast radiation dose received during three-dimensional conformal radiotherapy in carcinoma of the breast after breast conservation surgery.

MATERIALS AND METHODS

A cross-sectional study was conducted at the Department of Radiation Oncology, Government Medical College Hospital, Kozhikode, from January 2016 to December 2019. Forty patients with invasive breast cancer treated with breast-conserving surgery and who received whole breast irradiation followed by boost to tumour bed using 3D conformal technique were included in the study. Patients who had undergone MRM, patients who received palliative radiotherapy, and patients with contralateral breast lesions at presentation were excluded from the study.

The following data were collected: name, age, menopausal status, parity, presence of comorbid illness, pathological stage and chemotherapy received. The radiotherapy planning was reassessed, and the contralateral breasts were contoured. In addition, a dose-volume histogram was collected from individual patients' treatment plans.

Each patient had a virtual CT simulation while lying supine with both arms flexed and abducted to greater than 90 degrees. The hand grip on the board above the head was designed to be held with both hands. If there was an indication to treat supraclavicular fossa, the head was turned to the opposite side of the diseased site to aid in patient position reproducibility.

The patient was scanned from the level of the sixth cervical vertebra down to the level below the diaphragm while in the treatment posture. Participants got either 40Gy in 15 fractions or 42.5Gy in 16 fractions. The AAA (Anisotropic Analytical Algorithm) technique was applied to the three-dimensional CT density data with lung correction to determine the dose distribution.

Data were analysed using SPSS V21 for Windows. Categorical variables like parity and age categories are expressed as frequency and percentages. Continuous variables like age, mean, median, minimum and maximum dose are expressed as mean (SD) or median (range) depending on the type of distribution. Mann Whitney U test was used to determine the association between the mean dose with the quadrant of radiation and supraclavicular fossa radiation. Spearman correlation was used to determine the correlation between the breast volume and the radiation doses.

RESULTS

The mean age of the patients was 47.1(11.5) years. Youngest patient was 23-year-old and oldest patient was 77 years old, with the median age being 47.0 (40.0-54.25) years. More than half of the patients were between the ages of 46 and 60. Three patients were 30 years or below, and five were older than 60. Breast cancer was on the left side among 55% of patients and on the right in 45% of patients.

More than half (52.5%) of patients had comorbidities during treatment. 18 patients had diabetes, and nine patients had hypertension. There was a co-existence of diabetes and hypertension among nine patients. Coronary artery disease/Cerebral vascular accidents, asthma and old pulmonary tuberculosis was present among four, two and one patient.

The majority (60%) of the patients were multiparous women. A family history of cancer was present among nine (22.5%) patients. Of the nine patients with positive family history, five had a family history of breast cancer, two had a family history of gastrointestinal tract malignancy, and a family history of lung and ovarian carcinoma was present among one patient each. In addition, 37.5% of patients were post-menopausal women.

TNBC was the most frequent type in 40.0% of patients, followed by Luminal A (32.5%). The composite stage of cancer among patients was Stage I in 21, Stage II in 16, and Stage III in 3 patients. In addition, 42.5% had their supra-clavicular fossa treated. AC-T3 weekly was given as chemotherapy to most (60%) patients. No chemotherapy was given to the two patients. The inner quadrant was treated among 35% of the study participants (Table 1).

The range of breast volume was 248 cm3 to 1942 cm3. The mean and median dose range was 6.0 cGY

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– 300.0 cGY and 0.4 cGY – 390.0 cGY, respectively. Similarly, the minimum and maximum doses range was 0-197.0 cGY and 90.0-500.0 cGY. There was no correlation between the breast volume and the mean radiation dose (r=0.089; p=0.583). Likewise, there was no correlation between the breast volume and the median radiation dose (r=-0.241; p=0.134).

Table 1: Demographic data of the study

		Frequency	Percentage
Age	<30	3	7.5%
	31-45	12	30%
	46-60	20	50%
	>60	5	12.5%
Side	Left	22	55%
	Right	18	45%
Parity	Nulliparous	5	12.5%
	Primiparous	11	27.5%
	Multiparous	24	60%
Molecular subtype	Luminal A	13	32.5%
	Luminal B	8	20%
	TNBC	16	40%
	Her 2 enriched	3	7.5%
Dose of radiation	40/15	25	62.5%
	42.5/16	15	37.5%
Chemotherapy	No	2	5%
	FAC	4	10%
	AC-T 3 weekly	24	60%
	AC- weekly Paclitaxel	2	5%
	Others	6	20%

Table 2: Correlation between the breast volume and maximum dose

	Correlation coefficient (r)	P-value
Breast volume (cm3) vs median dose (cGY)	0.346	0.029

There was a significant positive correlation between the breast volume and the maximum radiation dose (r=0.346; p=0.029). The mean dose of contralateral breast radiation decreased with the increase in age of the patient (r=-0.251) but was not significant (p=0.118) [Table 2].

Table 3: Comparison of a quadrant of breast radiation and supraclavicular fossa treatment with the mean dose of radiation of the contralateral breast.

		Mean radiation		P-value
		Median	IQR	
Quadrant	Outer	65.5	21-125	0.001
	Inner	172	104-215	
Supraclavicular fossa treatment	Yes	56	18.5-161	0.149
	No	121	42-175	

The median dose of mean radiation to the contralateral breast was significantly higher when the tumour was located in inner quadrants compared to outer quadrant tumours (172 cGY vs 65.5 cGY; p=0.001). However, there was no significant difference in the median of the mean dose of radiation to the contralateral breast depending on the treatment of the supraclavicular fossa (p=0.149) [Table 3].

DISCUSSION

In our study, the average age of participants was 47.10 (11.5). Our study showed that the mean breast volume was 801.6 (301.5) cm3, and the range of the breast volume was 248 cm3 to 1942 cm3. The range of the mean and the median dose was 6cGY – 300 cGY and 0.4 cGY – 390 cGY, respectively. Similarly, the minimum and maximum dose ranges were 0-197 cGY and 90-500 cGY, respectively. There was a significant positive correlation between the breast volume and the maximum radiation dose (r=0.346; p=0.029). However, there was no correlation between breast volume with the mean and median dose of the contralateral breast.

A study by Tolia M et al,[2] has concluded the average dose of breast implants given to patients undergoing breast augmentation surgery varied from 45 to 70 cGy, and between 29 and 47 cGy was the median dosage. In addition, the patients had an average breast capacity of 856 ± 327 cm3.

The contributions to the contralateral breast dosage greatly rely on the patient's primary breast size; Bhatnagar et al,[4,5] determined 7.2% of the primary breast dose (5000 cGy). This is especially problematic for young women with protuberant breasts and breast cancer.

Our study also showed that the mean dose of contralateral breast radiation decreased with the increase in age of the patient (r=-0.251), but it was not found to be statistically significant (p=0.118).

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However, the lack of statistical significance could have been due to a smaller sample size.

According to a study by Tercilla et al,[6] the median dose to the main breast was 325 cGy during half-beam block tangential field treatment and 200 cGy without it, for a total of 5040 cGy distributed across 28 equal size sections. The doses used in our study are higher than those mentioned above. The studies done by Chogule et al,[7] and Muller-Runkel R et al,[8] also reported a slightly lower dosage when compared to our findings. Rather et al,[9] reported that the dose at the contralateral breast for the supraclavicular field was between 1.21 and 1.75 percent, and that the dose at the contralateral breast for the tangential field was between 5.34 and 6.40 percent.

Patients younger than 45 years old who got radiation for initial breast cancer had a considerably increased chance of developing a second malignancy in the contralateral breast, as reported by Boice et al,[10] Younger women are at more risk of secondary breast cancer indirectly due to the increased radiation dose due to dense breast tissue.

Gao et al,[11] and Obedian et al,[12] found the risk of developing contralateral breast cancer after radical mastectomy in patients under the age of 45 who got a total dosage of 46-54Gy to the afflicted breast was greater than in individuals over the age of 45.

Cancer of the breast (CBC) is more common in young patients who have breast carcinoma and who get tangential breast irradiation, according to findings by Hooning et al,[13] This is especially true for those who have a significant history of cancer. The results of our study show that the median dose of mean radiation to the contralateral breast was significantly higher when the inner quadrant radiation was given than the outer quadrant's radiation (172 cGY vs 65.5 cGY; p=0.001). However, the results should be interpreted based on clinical significance, considering the lower power due to the lesser sample size.

CONCLUSION

We conclude that our study highlights the importance of contouring the contralateral breast in all cases of carcinoma breast cancer who underwent BCS followed by three-dimensional conformal radiotherapy and showed a statistically significant increase in contralateral breast dose when the tumour site was in the inner quadrants of the breast.

Limitation

One of the limitations of the study is that the study employed a lesser sample size, hence the issue of external validity and generalizability of the study findings. Furthermore, the study's cross-sectional nature makes it difficult to arrive at a cause-effect relationship; hence, further longitudinal studies with a larger sample size on a multicentric level would help us understand the real effect and add robustness to our study findings.

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