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CARDIAC DOSES IN LEFT SIDED BREAST CANCER RADIOTHERAPY TREATED WITH BI-TANGENTIAL CONVENTIONAL BEAMS: DATA FROM REGIONAL CANCER CENTRE (RCC) IN NORTH EAST INDIA

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ABSTRACT: *Radiation induced cardiac adverse events are the significant reasons for morbidity and mortality in long term survivors of breast cancer. We are reporting the cardiac doses in patients receiving radiotherapy for breast cancer at our centre treated with computed tomography (CT) simulation based bi-tangential conventional beams plans. The main purpose of this study was to determine the radiotherapy doses received by heart and correlate the data with published literature. The values obtained will be used to improve the cardiac doses further at our centre.*
KEYWORDS: *Breast Cancer, Radiotherapy, Cardiac doses*

INTRODUCTION

With the increase in overall survival rates oncologists around the world are trying to reduce the possible adverse effects to the long-term survivors of breast cancer. Radiotherapy regimens and techniques for breast cancer have evolved over the decades resulted in lesser and lesser doses of radiation to heart. Despite the efforts, heart still receives doses of 1 to 5 Gy as reported in literature. [1-7]. For women with left-sided breast cancer, there is risk of potential cardiotoxicity from the radiation therapy [8]. Increased risk of death from heart disease due to breast cancer radiotherapy has been proven in long-term follow-up of data of randomised trials [9].

One of the largest analysis involving 34,825 women who received radiotherapy for breast cancer has shown significant increase in risk of developing ischaemic heart disease, pericarditis and valvular disease and the incidence was significantly higher for the left sided breast cancer patients compared to right sided patients [10]. Several studies have suggested that radiation exposures can cause ischemic heart disease starting within 5 years of Radiotherapy [11-13]. Linear increase in rates of major coronary events by 7.4% per gray mean heart dose (95% confidence interval, 2.9 to 14.5; $P<0.001$), with no apparent threshold is reported [14]. The increase started within the first 5 years after radiotherapy and continued into the third decade after radiotherapy. The magnitude of the risk after any given dose to the heart is uncertain, as are the time to the development of any radiation-related disease and the influence of other cardiac risk factors. Long term follow up data is needed for exact estimation of risk for women irradiated today. Various strategies have also developed to reduce the dose of radiation to the heart without compromising radiation doses [15}. Considering the recent reports, we analysed the cardiac doses in breast cancer patients treated with radiotherapy at our centre.

MATERIAL AND METHODS

Between October 2016 to February 2017, 12 patients of left sided breast cancer who underwent radiotherapy at our institution were selected for analysis.

CT Simulation: As per our institution protocol all patient with breast cancer are simulated with a proper use of breast board with 3mm slice thickness from mandible up to 5cm below the clinically determined inferior border of bitangential field or 5cm below the opposite inframammary fold in case of chest wall. Patients were simulated in supine position with hands above the head and head turned to opposite side. For the delineation of PTV (Planning Target Volume) metallic wires were kept around the clinically palpable breast tissue (Figure 1). For chest wall tumors, the metallic wires were kept at the clinical field borders of bitangential beams i.e superior, inferior, medial and lateral which will be adequately covering the PTV as per the treating clinician's discretion.

Treatment Planning: The CT simulation images were transferred to CMS XIO planning system (version 4.80). Planning Target Volumes (PTV) and Heart was contoured as per the guideline described by RTOG breast cancer atlas [16] and Mary Feng et al. [17] respectively. During treatment planning, the main aim was to cover 95% of the target volume with 95 % of the prescribed dose for the breast or chest wall. The lead markers kept at the clinical medial and lateral field border was taken as the initial reference for starting the planning. The metallic wires kept at clinical superior and inferior field border at the time of CT simulation were taken as reference for the respective field borders in bitangential beams. For patients with intact breast approximately 1.5-2 cm margins were given to the metallic wire (kept around breast tissue during CT simulation) encompassing breast tissue for adequate coverage with bitangential portals. Bi-tangential Beam arrangements plans with single isocentric beam technique with or without use of wedges to achieve the adequate PTV coverage were generated. All patients were planned with 6MV photons with (Clarkson dose calculation Algorithm) by medical physicist using CMS Xio 4.80 Treatment Planning System (TPS). All treatment plans were modified based on patient's breast and chest wall shape and tumor factors (tumor quadrant location) and approved by a treating radiation oncologist prior to treatment. The prescribed dose was 40.05 Gy in 15 fractions (2.67Gy/#) for all the patients. Dose-volume histograms (DVH) were computed and analyzed. Values like PTV coverage, Mean heart dose and maximum hot spot for PTV were recorded for dosimetric analysis with the help of Dose Volume Histogram (DVH) from planning system i.e. CMS XIO version 4.80. All the patients were treated on Elekta (Synergy) Machine with 6MV photons.

RESULTS

Out of 12 patients 4 were breast conservation procedures and 8 were post mastectomy cases. Final accepted PTV coverage and doses received by Heart are as shown in table 1. The average mean heart dose was 3.59 Gy (Range 0.66 - 8.7). Only two patients had mean heart dose beyond 5Gy. The mean PTV coverage was 94.78% (Range 91.85-98.78). The mean hot spot was 112.74% (Range 109.41-122.42). None of our patient has history of cardiovascular co-morbidity

DISCUSSION

This is the first reported data of cardiac doses in breast cancer patients from North East India. Cardiac irradiation can result in significant pathologic damage to the heart as manifested by microcirculatory damage leading to ischemia, fibrosis, diffuse myocardial interstitial fibrosis, pericarditis, pericardial effusion, fibrous thickening of pericardium, valvular fibrosis, and accelerated atherosclerosis.

Our overall average radiation mean heart dose was 3.59 Gy and similar values are reported in published literature [7,18]. In woman with no preexisting cardiac risk factors, a mean heart dose of 3 Gy would increase risk of death from ischemic heart disease before the age of 80 years from 1.9% to 2.4% (i.e., an absolute increase of about 0.5 percentage points) and all our patients were below 65 years of age.

In our study although mean heart doses are well below 5Gy and only one patient has mean heart dose of 8.7Gy. The reason for this was heart lying near thoracic cage and the other important reason was medial quadrant tumor location with extension of surgical scar up to midline. The medial tangential field border was taken across midline to address this issue (Figure 2). For the left sided breast cancer patients, the mean heart doses vary and the published literature shows wide variation. But it should also be noted that the variation in the cardiac doses is mostly dependent on the distance of heart to the thoracic wall and it also depends on the irregular shape of chest wall after surgery. Because of unique shape of breast and chest wall and its proximity to underlying organs like heart and lung, some portion of these organs gets included in the tangential portals to achieve adequate target coverage. The individual anatomical variation in shape of the thoracic cage and the need for internal mammary node irradiation might affect the cardiac doses substantially. Deep Inspiratory Breath Hold (DIBH) technique described by some authors [19] will help to reduce cardiac doses in such cases. The pushing of heart away from the thoracic cage will reduce cardiac doses in some of our cases (Figure 3). Due to lack of DIBH facility at our center we couldn't give benefit of this technique to our patients.

We accepted the PTV coverage of more than 90% in some patients as adequate and the reason being the irregular shape of target and undue hot spots in bitangential beam plans (Table1). Also we have beam data for 6MV only at our center and use of high energy photons beam like 10-15MV might benefit in some patients with large separation between medial and lateral body edges (Figure 1).

We have used Hypofractionation (40Gy in 15 fractions) schedule for our patients which has become a standard of care. Apprehension was raised by few clinicians regarding the cardiac adverse events in these group of patients as majority of trials have provided data on cardiac toxicity for conventionally fractionated RT. Hypofractionation with fraction sizes >2 Gy was introduced to lessen the burden of treatment, for convenience of patients, and moreover to have efficient use of resources. The 10 years follow up data of two hypofractionation trials (START A & START B) from United Kingdom has shown incidence of cardiac complications less than 1% for left sided irradiation [20]. Although we need to follow up our patients over a period to get results on cardiac complications.

CONCLUSION

Mean heart doses reported in our data are comparable with published data. Appropriate techniques of breast radiotherapy should be used whenever possible to reduce the cardiac doses. Documentation of cardiac dose and dose-response relationships and their variations with different radiotherapy techniques and dose fractionation regimens should be rigorously followed in conjunction with long-term follow-up data.

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Table1: Values for Mean Heart Dose, PTV Coverage and Hot spot for all patients

Patient Number	PTV COVERAGE (%)	HOT SPOT (%)	MEAN HEART DOSE (Gy)
1	92.35	111.2	4.2
2	92.1	114	3.71
3	95.54	115.31	2.41
4	96.62	122.42	4.69
5	96.47	109.6	0.66
6	96.38	111.7	1.52
7	92.4	109.41	5.5
8	93.37	110.76	3.9
9	96.16	110.01	0.74
10	98.78	109.61	3.81
11	95.44	115.28	8.7
12	91.85	113.66	3.32

Figure 1. CT Simulation Procedure

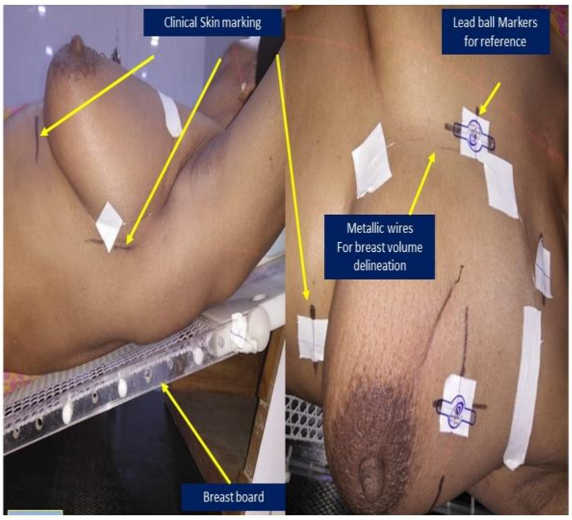

Figure 2. Patient with surgical scar extending across mid line

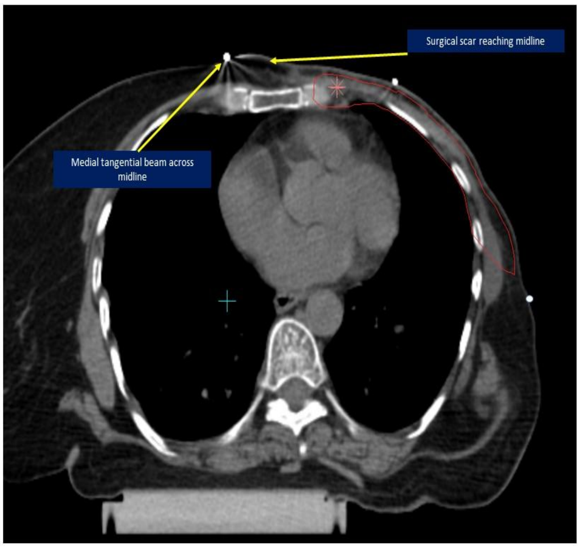

Figure 3. figure showing position of heart with respect to chest wall and separation method between medial and lateral; tangential beam