International Journal of Current Research and Modern Education (IJCRME)
Impact Factor: 6.925, ISSN (Online): 2455 - 5428
(www.rdmodernresearch.com) Volume 3, Issue 1, 2018

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

Vikas Jagtap*, Shashank Bansal, Shashi Bhushan Sharma**, Dimpal Saikia***, Ghritashee Bora**, Partha Pratim Medhi** & Apurba Kumar Kalita****

* Department of Radiation Oncology, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya

** Department of Radiation Oncology & Medical Physics, Dr. B. Borooah Cancer Institute, Guwahati, Assam

*** Department of Radiation Oncology, Cancer Hospital, Gauhati Medical College, Guwahati, Assam

Cite This Article: Vikas Jagtap, Shashank Bansal, Shashi Bhushan Sharma, Dimpal Saikia, Ghritashee Bora, Partha Pratim Medhi & Apurba Kumar Kalita, "Cardiac Doses in Left Sided Breast Cancer Radiotherapy Treated With Bi-Tangential Conventional Beams: Data from Regional Cancer Centre (RCC) in North East India", International Journal of Current Research and Modern Education, Volume 3, Issue 1, Page Number 184-187, 2018.

Abstract:

Radiation induced cardiac adverse events are 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 radiotherapy doses received by heart and correlation of data with published literature. The values obtained will be used to improve cardiac doses at our centre.

Key Words: Breast Cancer, Radiotherapy & Cardiac doses

Introduction:

With increase in overall survival rates oncologists around the world are trying to reduce possible adverse effects for long-term survivors of breast cancer. Radiotherapy regimens and techniques for breast cancer have evolved over decades and resulted in lesser and lesser doses of radiation to heart. Despite these efforts, heart still receives doses of 1 to 5 Gy as reported in literature. [1-7]. In women with left-sided breast cancer, there is a risk of potential cardiotoxicity from 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, valvular disease and its incidence was significantly higher for 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 first 5 years after radiotherapy and continued into third decade after radiotherapy. The magnitude of risk after any given dose to heart is uncertain, as are the time to development of any radiation-related disease and 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 been developed to reduce the dose of radiation to heart without compromising target doses [15}. Considering recent reports, we analysed 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 Dr. B Borooah Cancer Institute 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 3-5mm 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 treatment 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 target volume with 95 % of prescribed dose for breast or chest wall. Lead markers kept at clinical medial and lateral field border was taken as initial reference for starting of planning. Metallic wires kept at clinical superior and inferior field border at the time of CT simulation were taken as reference for 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 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 treating radiation oncologist prior to treatment. The prescribed dose was 40.05 Gy in 15 fractions (2.67Gy/#) for all 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 TPS i.e. CMS XIO version 4.80. All patients were treated with 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. Average mean heart dose was 3.59 Gy (Range 0.66 - 8.7). Only two patients had mean heart dose beyond 5Gy. Mean PTV coverage was 94.78% (Range 91.85-98.78). Mean hot spot was 112.74% (Range 109.41-122.42). None of our patient has history of cardiovascular co-morbidity

Discussion:

As per our knowledge 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 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.

Although mean heart doses were well below 5Gy in our study only one patient had 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. Medial tangential field border was taken across midline to address this issue (Figure 2). For left sided breast cancer patients, mean heart doses vary and published literature shows wide variation. But it should also be noted that variation in cardiac doses is mostly dependent on distance of heart to 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. Individual anatomical variation in shape of the thoracic cage and 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. 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 3).

We have used Hypo fractionation (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 less than 1% incidence of cardiac complications for left sided irradiation [20]. Although we need to follow up our patients over a period of time to get results of 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.

References:

1. Schubert LK, Gondi V, Sengbusch E, et al. Dosimetric comparison of left-sided whole breast irradiation with 3DCRT, forward-planned IMRT, inverse-planned IMRT, helical tomotherapy, and topotherapy. Radiother Oncol 2011; 100:241-6.
2. Jagsi R, Moran J, Marsh R, Masi K, Griffith KA, Pierce LJ. Evaluation of four techniques using intensity-modulated radiation therapy for comprehensive locoregional irradiation of breast cancer. Int J Radiat Oncol Biol Phys 2010; 78:1594-603.
3. Lohr F, El-Haddad M, Dobler B, et al. Potential effect of robust and simple IMRT approach for left-sided breast cancer on cardiac mortality. Int J Radiat Oncol Biol Phys 2009; 74:73-80.
4. Ares C, Khan S, MacArtain AM, et al. Postoperative proton radiotherapy for localized and locoregional breast cancer: potential for clinically relevant improvements? Int J Radiat Oncol Biol Phys 2010; 76:685-97.
5. Gulybán A, Kovacs P, Sebestyen Z, et al. Multisegmented tangential breast fields: a rational way to treat breast cancer. Strahlenther Onkol 2008; 184:262-9.
6. Aznar MC, Korreman S-S, Pedersen AN, Persson GF, Josipovic M, Specht L. Evaluation of dose to cardiac structures during breast irradiation. Br J Radiol 2011; 84:743-6.
7. Taylor CW, Povall JM, McGale P, et al. Cardiac dose from tangential breast cancer radiotherapy in the year 2006. Int J Radiat Oncol Biol Phys 2008; 72:501-7.
8. Fisher B, Anderson S, Bryant J, Margolese RG, Deutsch M, Fisher ER, et al. Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy and lumpectomy plus irradiation for the treatment of invasive breast cancer. New Engl J Med (2002) 347(16):1233–41.doi:10.1056/ NEJMoa022152.
9. Early Breast Cancer Trialists' Collaborative Group. Effects of chemotherapy and hormonal therapy for early breast cancer on recurrence and 15-year survival: an overview of the randomised trials. Lancet 2005; 365:1687–717.
10. McGale P, Darby SC, Hall P, Adolfsson J, Bengtsson N, Bennet AM, et al. Incidence of heart disease in 35,000 women treated with radiotherapy for breast cancer in Denmark and Sweden. Radiother Oncol (2011) 100(2):167–75. doi:10.1016/j.radonc.2011.06.016.
11. Carr ZA, Land CE, Kleinerman RA, et al. Coronary heart disease after radiotherapy for peptic ulcer disease. Int J Radiat Oncol Biol Phys 2005; 61:842-50.
12. Shimizu Y, Kodama K, Nishi N, et al. Radiation exposure and circulatory disease risk: Hiroshima and Nagasaki atomic bomb survivor data, 1950-2003. BMJ 2010; 340:b5349.
13. Azizova TV, Muirhead CR, Druzhinina MB, et al. Cardiovascular diseases in the cohort of workers first employed at Mayak PA in 1948–1958. Radiat Res 2010; 174:155-68.
14. Darby SC, Ewertz M, McGale P, Bennet AM, Blom-Goldman U, Bronnum D, et al. Risk of ischemic heart disease in women after radiotherapy for breast cancer. N EnglJMed (2013) 368(11):987–98.doi:10.1056/NEJMoa1209825.
15. Robert E. Beck, Leonard Kim, Ning J.Yue, Bruce G. Haffty, et al. Treatment techniques to reduce cardiac irradiation for breast cancer patients treated with breast-conserving surgery and radiation therapy: a review. November 2014 | Volume 4 | Article 327, doi: 10.3389/fonc.2014.00327.
16. RTOG; https://www.rtog.org/CoreLab/ContouringAtlases/BreastCancerAtlas.aspx
17. Mary Feng, M.D, Jean M. Moran, Todd Koelling, Aamer Chughtai, et al. Development and validation of a heart atlas to study cardiac exposure to radiation following treatment for breast cancer. Int J Radiat Oncol Biol Phys. 2011 January 1; 79(1): 10–18. doi:10.1016/j.ijrobp.2009.10.058.
18. Tomas Rodrigo Merino Lara, Emmanuelle Fleury, Shahram Mashouf, Joelle Helou, et al. Measurement of mean cardiac dose for various breast irradiation techniques and corresponding risk of major cardiovascular event. October 2014 | Volume 4 | Article 284 doi: 10.3389/fonc.2014.00284.
19. Swanson T, Grills IS , Ye H , Entwistle A , Teahan M , Letts N, et al . Six-year experience routinely using moderate deep inspiration breath-hold for the reduction of cardiac dose in left-sided breast irradiation for patients with early- stage or locally advanced breast cancer. Am J Clin Oncol (2013) 36(1):24–30. doi:10.1097/COC.0b013e31823fe481.
20. Joanne S Haviland, J Roger Owen, John A Dewar, Rajiv K Agrawal et al. The UK Standardisation of Breast Radiotherapy (START) trials of radiotherapy hypofractionation for treatment of early breast cancer: 10-year follow-up results of two randomised controlled trials; Lancet Oncol 2013; 14: 1086–94.

Appendix:

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

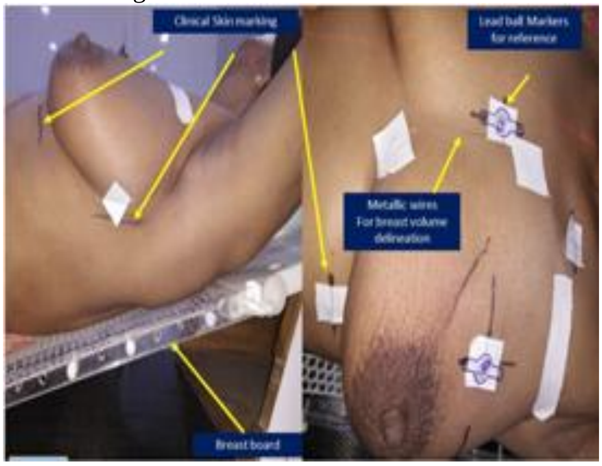

Figure 2: Patient with surgical scar extending across mid line

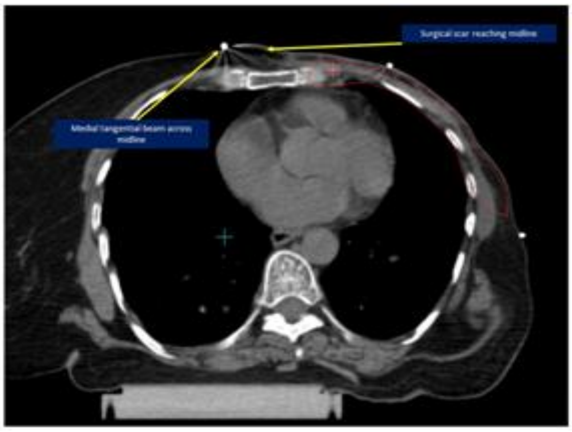

Figure 3: Position of heart with respect to chest wall and separation method between medial and lateral; tangential beam