RESEARCH ARTICLE

Reduction of Dose to the Contralateral Breast by Superflab Use in Radiation Therapy for Mammary Carcinomas

Akanksha Solanki[1]*, Athiyaman M[2], Hemalatha A[3], H S Kumar[1]

Abstract

Background: Radiation therapy is an integral part of multimodality treatment for locally advanced carcinoma of breast. Radiation doses to nearby critical normal structures like heart, lungs, and contralateral breast (CLB increases risk of second malignancies. In this study, we measured doses to the CLB and studied effects of a 1 cm thickness superflap. **Materials and Methods:** Fifty post-mastectomy carcinoma breast patients were included in the study.Radiation therapy of 50 Gy was planned in 25 fractions, 5 days a week, using the Eclipse Treatment Planning System version 8.9.15, with a pencil beam convolution algorithm and 6 MV photon beam. Plans were transferred to a linear accelerator (Varian 2300 CD) for execution of treatment. Twenty-four CaSO4 thermoluminescent dosimeter discs (TLDs) were used for dose measurement over the CLB. The dose was measured for each patient without a superflab for ten fractions and with for another ten fractions for subsequent comparison. **Results:** Mean doses/fractions received by the CLB with and without a superflab? were 3.78 ± 1.29 cGy and 7.82 ± 2.62 cGy, respectively, with total dosees of 94.69 ± 32.43 cGy (1.89% of prescribed dose) and 191.14 ± 65.62 cGy (3.82% of prescribed dose). The average reduction in mean dose with a 1 cm thick superflab was 46.57 ± 17.18%, in the range of 20 to 80% and statistically significant ($p < 0.001$). **Conclusion:** Superflab? is an effective method for dose reduction to CLB. It is an easy, convenient and low time consuming method. Elucidation of any role in reduction of 2nd malignancies in CLB now needs large studies with long follow-up.

Keywords: Contralateral breast dose- second malignancy- CaSO4 TLDs- superflab

Asian Pac J Cancer Prev, **18 (4)**, 1025-1029

Introduction

Breast cancer is the most common cancer diagnosed and the leading cause of cancer-related deaths following lung cancer in the women worldwide. In less developed countries, breast cancer still is the leading cause of cancer incidence and mortality (Torre, 2015). Due to lack of resources and awareness, most of the patients present with a locally advanced disease in developing and underdeveloped countries. A multimodality approach to treatment including surgery, radiotherapy, and chemotherapy is followed for such patients. Radiation therapy is an essential integral part of the treatment in locally advanced breast cancer patients (Halperin et al., 2013; Gradishar et al., 2016). With the use of advanced technology, early detection and multimodality approach the life expectancy of breast cancer patients have increased. For such patients, concerns should be raised to increase the quality of life.

Radiation therapy for breast cancer plays a role in the loco regional control of disease but at the same time, it is also associated with the delivery of radiation to the nearby critical normal structures like heart, lungs, contralateral breast (CLB) etc. Radiations to these normal structures may impair their functioning and decrease the quality of life. At the same time, radiations also act as a carcinogen for contralateral breast and increase the risk of malignancy in it. The radiations to the contralateral breast are scattered and leakage radiations from the treatment head. There are well-known pieces of evidence that suggest an elevated incidence of contralateral breast cancer in patients receiving radiation as compared with those who did not receive radiation (Boice et al., 1191; Schneider et al., 2000; Clarke et al., 2005). This risk is even more in young patients < 45 years age (Boice et al., 1192; Stovall et al., 2008).

Many studies are available that aim to measure the radiation dose to the contralateral breast (Boice et al., 1192; Bhatnagar et al., 2006; Stovall et al., 2008). Investigators have also tried to decrease the dose to the contralateral breast by various methods (Muller-Runkel et al., 1994; Jamal et al., 2001).

This study was carried out to estimate the total dose received by the contralateral breast during irradiation of the malignant breast by the help of Thermoluminescent dosimeter discs (TLDs). This study also investigated the role of superflab of 1-centimeter thickness in modifying the dose to the contralateral breast during radiation therapy

*[1]Department of Radiotherapy, [2]Demonstrator Mediacl Physics, [3]Medical Physics, Acharya Tulsi Regional Cancer Center, Bikaner, Rajasthan, India. *For Correspondence: akanksha.dr.07@gmail.com*

for carcinoma breast.

Materials and Methods

Fifty histologically proven post-mastectomy patients of carcinoma breast were included in the study. All these patients were planned for radiation therapy with conventional fractionation to receive 50 Gy in 25 fractions, 5 days a week. Planning was done by the help of Eclipse Treatment Planning System version 8.9.15, using pencil beam convolution algorithm with 6 MV photon beam. These plans were transferred to Linear accelerator make Varian 2300 CD for execution of treatment.

Selection and calibration of TLDs

A Total of 24 CaSO4-Dy TLD discs with enough sensitivity and reproducibility were selected for dose measurement. All the selected discs were annealed at 400o c for 1 hour in hot air oven. Calibration curve for each disc was obtained by exposing it up to 10cGy for 6MV X-Rays at dmax for 10 x10 field size in solid slab phantom of density 1.03gm/cc, with a 1cGy interval. The reading following each irradiation was obtained 24 hours post irradiation using TLD reader (TLD research reader TL10091 Nucleonix System). These calibrated discs were used for dose calculations.

The arrangement of TLDs over CLB

The contralateral breast was contoured as an organ at risk. The dimensions and volumes of contralateral breast were estimated with the help of treatment planning system (TPS). The distribution of the discs over CLB was such that it covers the complete surface area. 24 discs were arranged in 4 rows and 6 columns. Thus, each row consisted of 6 TLD discs. The medial most column of discs lied at a distance of 5 cm from the patient's midline. The TLD discs were left in place during the entire daily fraction of treatment including the supraclavicular field. The same set of TLDs was used for each patient.

Measurement of Dose

All the patients were cases as well as control of their own. In the first week of treatment i.e. first 5 fractions, the patients were treated without any dose measurement or intervention for dose reduction, allowing the patient to settle down. In the next 10 fractions, the patients were treated as regular with the placement of TLD discs over the contralateral breast in an arrangement discussed above to measure the dose delivered to contralateral breast. In the remaining 10 fractions, patients were treated in a similar fashion as above with the placement of 10 mm thick superflab over the TLD discs on the contralateral breast to find out the effect of superflab in dose reduction.

Statistical Analysis

To compare the various dose parameters, the mean values were analyzed with the Wilcoxon signed ranks test or the paired-samples t-test on statistical significance whenever appropriate. All tests were two-tailed, and differences were considered statistically significant at p ≤0.05.

Results

Distribution of radiation dose over whole CLB

The mean dose per fraction received by the contralateral breast without superflab was 7.82 ± 2.62 cGy while the mean dose per fraction received with superflab was 3.78 ± 1.29 cGy. The total dose received by contralateral breast without superflab was 191.14 ± 65.62 cGy (3.82% of prescribed dose) and with superflab was 94.69 ± 32.43 cGy (1.89% of prescribed dose). An average reduction in the mean dose in the presence of 1 cm thick superflab as compared to the absence of superflab was 46.57 ± 17.18%. The reduction of dose on comparing the two situations was approximately of the range of 20 to 80% and was statistically significant (p< 0.001). Table 1. Show the total mean dose received by the contralateral breast of fifty patients without and with superflab and also shows percentage dose reduction for each patient.

Quadrant wise distribution of dose to the CLB

Table 2 shows the distribution of dose to different quadrants of the contrlateral breast. The reduction of dose to the contralateral breast with 1 cm thick superflab as compared to that without superflab can be seen in Figure 1. Mean dose received by all the 24 discs without and with superflab are compared in Figure 2. These figures show a decreasing pattern of dose on moving from medial towards lateral quadrant.

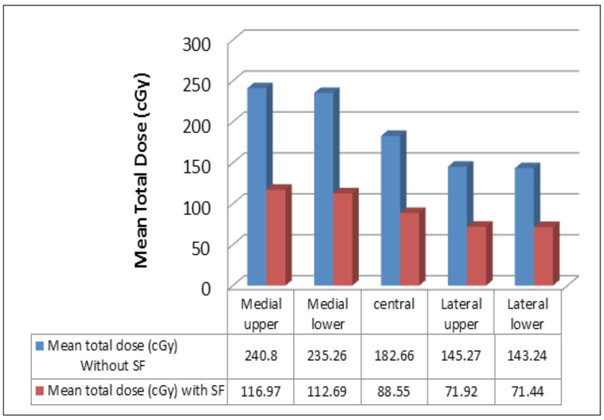

Figure 1. Bar Graph Showing Comparison of Quadrant Wise Dose Distribution to Contralateral Breast: without Vs with Superflab

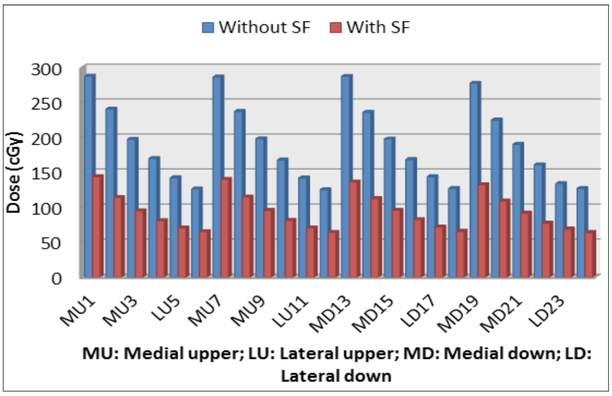

Figure 2. Bar Graph Showing Comparison of Dose to CLB for 24 TLD Discs: without Vs with Superflab

Table 1. Comparison of Dose to CLB without Vs with Superflab and Percentage Reduction

	Without Superflab		With Superflab		
S No.	Mean total dose CLB (cGy)	% of prescribed dose	Mean total dose CLB (cGy)	% of prescribed dose	% Reduction of dose
1	230.81 ± 99	4.62	115.75 ± 29.52	2.31	49.9
2	179.38 ± 65.5	3.59	89 ± 31.5	1.78	50.28
3	291.92 ± 115	5.84	123.25 ± 39	2.46	57.81
4	122.02 ± 33.25	2.44	64.25 ± 21.5	1.28	47.55
5	322.33 ± 123.5	6.45	255 ± 36.75	5.01	22.21
6	157.13 ± 51.5	3.14	73.5 ± 21.25	1.46	53.51
7	316.67 ± 128.75	6.33	189.25 ± 58.75	3.78	40.29
8	117.98 ± 19	2.36	56 ± 22.25	1.12	52.55
9	134.44 ± 29.75	2.69	86 ± 35	1.72	35.83
10	210.58 ± 76.25	4.21	85 ± 34	1.69	59.86
11	339.04 ± 135.5	6.78	133.75 ± 48.25	2.67	60.62
12	311.94 ± 125.25	6.24	159.75 ± 51	3.19	48.88
13	108.17 ± 35.5	2.16	48.25 ± 19.5	0.96	55.56
14	78.92±3.25	1.58	51.75 ± 18	1.03	34.4
15	102.63 ± 17.25	2.05	63 ± 20.5	1.26	38.54
16	159.56 ± 49.75	3.19	81.25 ± 31.25	1.62	49.22
17	271.94 ± 90.75	5.44	146.5 ± 43.75	2.93	46.05
18	157.27 ± 29.25	3.15	69.5 ± 23.75	1.38	56.06
19	297.54 ± 123.25	5.95	186 ± 54.5	3.71	37.65
20	229.94 ± 80	4.6	108.25 ± 30.5	2.16	52.95
21	343.77 ± 145.75	6.88	244.25 ± 144.5	4.88	28.97
22	164.27 ± 48	3.29	110.5 ± 41.5	2.21	32.63
23	126.83 ± 11.5	2.54	61.25 ± 20.75	1.22	51.78
24	102.27 ± 16.5	2.05	44.25 ± 15.5	0.88	56.87
25	270 ± 97.5	5.4	127.75 ± 44	2.55	52.78
26	154.31 ± 44.25	3.09	107.5 ± 20.25	2.14	30.52
27	136.44 ± 21	2.73	88.5 ± 30	1.78	34.56
28	189.94 ± 52.25	3.8	103.5 ± 39	2.06	45.65
29	106.6 ± 13.25	2.13	72.5 ± 37.5	1.45	31.93
30	304.25 ± 150.25	6.09	243 ± 66.5	4.85	20.24
31	116.27 ± 4.5	2.33	64.25 ± 22.75	1.28	44.83
32	337.38 ± 124.75	6.75	76.25 ± 26.75	1.52	77.45
33	271.81 ± 92	5.44	121.25 ± 40.25	2.42	55.44
34	345.85 ± 154.5	6.92	52.25 ± 8.75	1.04	84.95
35	55.65 ± 27.5	1.11	47.5 ± 24.5	0.95	14.42
36	187.06 ± 85.5	3.74	56.75 ± 23.75	1.13	69.79
37	289.67 ± 112.75	5.79	123 ± 48	2.45	57.69
38	60.48 ± 25.75	1.21	51.25 ± 18.75	1.02	15.71
39	71.54 ± 13.75	1.43	55.75 ± 22.75	1.16	18.89
40	253.25 ± 67.25	5.07	85.75 ± 37.25	1.71	66.21
41	108.27 ± 34.5	2.26	48.13 ± 19.62	0.96	55.51
42	336.38 ± 124.65	6.74	76.11 ± 26.89	1.55	77.05
43	345.75 ± 154.5	6.93	52.29 ± 8.71	1.53	77.44
44	186.16 ± 85.5	3.72	56.64 ± 22.76	1.14	70.32
45	107.6 ± 12.25	2.23	72.48 ± 37.52	1.49	33.19
46	55.42 ± 27.55	1.13	47.53 ± 24.51	0.91	36.81
47	61.48 ± 24.75	1.21	51.28 ± 18.72	1.05	21.65

Table 1. Continued

S No.	Without Superflab Mean total dose CLB (cGy)	Without Superflab % of prescribed dose	With Superflab Mean total dose CLB (cGy)	With Superflab % of prescribed dose	% Reduction of dose
48	72.54 ± 12.75	1.44	55.73 ± 22.77	1.21	21.94
49	102.54 ± 15.78	2.17	44.26 ± 15.48	0.84	58.42
50	153.21 ± 45.15	3.1	107.51 ± 20.24	2.11	35.28

Table 2. Quadrantwise Distribution of Dose to CLB: without Vs with Superflab

S No.	Quadrant	Mean Total Dose Without SF (cGy)	Mean Total Dose With SF (cGy)	% reduction
1	Medial upper	240.8 ± 110.12	116.97 ± 57.63	48.58
2	Medial lower	235.26 ± 113.21	112.69 ± 59.17	47.9
3	Central	182.66 ± 99.76	88.55 ± 50.28	48.48
4	Lateral upper	145.27 ± 84.17	71.92 ± 42.41	49.51
5	Lateral lower	143.24 ± 85.36	71.44 ± 43.99	49.87

Discussion

The average total surface dose (Dmean) received by the contralateral breast in our study was 191.14 ± 65.62 cGy which was 3.82% of the prescribed total dose of 50 Gy. The study conducted by Chougule (2007), had shown a similar dose statistics and the contralateral breast dose in their study was 152.5 to 254.75 cGy for similar total prescribed dose and dose fractionation as in our study. Bhatnagar et al., (2004), in their study, concluded that the contralateral breast dose was 7.2% of prescribed dose. In the study conducted by Boice et al., (1992), the average dose received by the contralateral breast was 2.82 Gy in women receiving radiation for breast cancer.

A reduction in dose was observed on moving from medial to lateral quadrant. This is evident by the fact that the radiations reaching the contralateral breast are scattered radiations of very less energy and thus the amount of these radiations decrease gradually on moving away from the radiation field. Stovall et al., (2008) had shown a similar pattern of dose reduction from medial to lateral quadrants. The dose received by medial quadrants in their study was 1.9 Gy (0.2 – 7.7 Gy) while the doses received by lateral and central quadrants were 0.8 Gy (0.1 – 2.5 Gy) and 1.2 Gy (0.1 – 3.8 Gy) respectively.

On comparison of dose received by contralateral breast without and with supeflab, a reduction of contralateral breast surface dose was observed by an average 46.57 ± 17.18% with superflab. The reduction of dose on comparing the two situations was approximately of the range 20 to 80%. Similar results were obtained in the study conducted by Jamal, Das. (2001) in which the surface dose of contralateral breast was reduced by 40-75% by placing 10 mm thick superflab over the contralateral breast. Similar to our study, Jamal et al used CaSO4-Dy thermoluminescent dosimeter discs for dose measurement to contralateral breast. In an another study conducted by K tse. (2014) 15 metal oxide semiconductor field effect transistor (MOSFET) detectors were used on the surface and inside the contralateral breast for measuring the contralateral breast dose. The dose received by contralateral breast was1.25 Gy for no shielding while it was 0.76 Gy for 0.5 cm SF, and 0.72 Gy for 1 cm SF. Therefore, a reduction of approximately 42.4% was observed in their study which was comparable to our study. Butson, et al., (2015) used a bolus (superflab) of 1 cm thickness over the contralateral breast and tested its efficacy in dose reduction. The dosimetry in their study was done by using Gafchromic films and Eclipse AAA algorithm. Buston et al also concluded that superflab was an efficient method of dose reduction to the contralateral breast.

It can be concluded that superflab is an effective method of dose reduction to contralateral breast. It is an easy, convenient and less time-consuming method. Its role in the reduction of 2nd malignancy in opposite breast needs larger studies with longer follow-up.

Statement Conflict of interest

No conflict of interest.

References

Bhatnagar AK, Heron DE, Deutch M, et al (2006). Does breast size affect the scatter dose to ipsilateral lung, heart or contralateral breast in primary irradiation using intensity modulated radiotherapy (IMRT). *Am J Clin Oncol*, **29**, 80-4.

Boice JD Jr, Preston D, David FG, et al (1991). Frequent chest X ray fluoroscopy and breast cancer incidence among tuberculosis patients in Massachusetts. *Radiat Res*, **125**, 214-22.

Boice JD, Harvey EB, Blettner M, et al (1992). Cancer in the contralateral breast after radiotherapy for breast cancer. *N Engl J Med*, **326**, 781-5.

Butson M, Carroll S, Whitaker M, et al (2015). SU-E-T-373: Evaluation and reduction of contralateral skin /subcutaneous dose for tangential breast irradiation. *Med Phys*, **42**, 3419.

Chougule A (2007). Radiation dose to contralateral breast during treatment of breast malignancy by radiotherapy. *J Cancer Res Ther*, **3**, 8-11.

Clarke M, Collins R, Darby S, et al (2005). Effects of radiotherapy and of differences in the extent of surgery for early breast cancer on local recurrence and 15-year survival: an overview of the randomised trials. *Lancet*, 366, 2087-106.

Gradishar MD, William J, Benjamin O, et al (2016). Breast cancer. NCCN Clinical practice guidelines in oncology. Version 2.2016.

Halperin EC, Wazer DE, Perez CA, Brady LW (2007). Breast cancer: Locally advanced and recurrent disease, postmastectomy radiation, systemic therapies. In: principal and practice of radiation oncology, 6th edition. Lippincott Williams and Wilkins. PP 1140 – 163.

Jamal N, Das KR (2001). Measurement of dose to the contralateral breast during radiation therapy for breast cancer: reduction by the use of superflab. *Australas Phys Eng Sci Med*, **24**, 102-5.

K Tse (2014). A comparison of contralateral breast dose from primary breast radiotherapy using different treatment techniques. University of Hong Kong, http://hdl.handle.net/10722/206498.

Muller-Runkel R, Kalokhe UP (1994). Method for reducing scatter radiation dose to the contralateral breast during tangential breast irradiation therapy. *Radiology*, **191**, 853-5.

Stovall M, Smith SA, Langholz BM, et al (2008). Dose to the contralateral breast from radiotherapy and risk of second primary breast cancer in the WECARE study. *Int J Radiat Oncol Biol Phys*, **72**, 1021-30.

Schneider U, Lomax A, Lombriser N (2000). Comparative risk assessment of secondary cancer incidence after treatment of Hodgkin's disease with photon and proton radiation. *Radiat Res*, **154**, 382–8.

Torre LA, Bray F, Siegel RL, et al (2015). Global cancer statistics 2012. *CA Cancer J Clin*, **65**, 87-108.