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A comparison of contralateral breast dose due to breast cancer radiotherapy using two different treatment machines in a radiotherapy center

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▶ ***Original article***

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ABSTRACT

Background: The radiation dose received by contralateral breast (CLB) is one of the concerns of breast radiotherapy, because it may lead to the induction of secondary breast cancer. The aim of this study was to evaluate the CLB surface dose in the breast treatment in Yazd radiotherapy center. ***Materials and Methods***: The surface dose of CLB was measured using TLD dosimetry in 50 cancer breast patients. The TLD chips were placed at four points on the each of CLBs. The patients were treated by 6MV photon beams of Oncor (physical wedge) and Compact (motorized wedge) LINAC. The TLD chips were placed on the surfaces of CLB during the medial and lateral tangent radiation fields in one of radiotherapy fractions. ***Results:*** The mean percent of prescription dose of the CLB surface doses on the point 1 in the two Linac (Oncor & Compact) were significantly different. The mean of CLB surface doses of point 1 in the physical and the motorized wedge techniques were 5.78 and 7.84 percent of prescription dose of breast cancer, respectively. The medial and lateral fields' contribution from 7.4% surface dose of CLB were 5.8% and 1.6%, respectively. ***Conclusion:*** In Shahid Ramezanzadeh radiotherapy center, the CLB surface dose due to breast cancer radiotherapy by the Compact machine (7.84 %) was significantly more than the allowable value (6% prescription dose). The CLB does due to the medial field beam was more than the lateral field.

Keywords: *Contralateral breast, radiotherapy, LINAC, thermoluminescence dosimetry, secondary cancer.*

INTRODUCTION

Achievement to the maximum tumor control probability (TCP) and the minimum normal tissue complication probability (NTCP) is the main goal of radiation therapy [1]. Audit of target organ dose and critical organ dose is one of the quality assurance programs by in vivo dosimetry such as TLD dosimetry [2].

Breast cancer is the most common malignant tumor in women. Surgery, chemotherapy and radiation therapy are the most common treatments methods for it [3]. The risk of CLB cancer in the patients who have been treated by radiotherapy is a concern [4]. The radiosensitivity of breast tissue is high (W_T = 0.12) [5]. The radiotherapy method is effective in the radical and palliative treatment of cancer, although, risk of the secondary cancers could increase [6]. In a case-control study including 1084 women with breast cancer, the relative risk of the secondary breast cancer associated with radiotherapy was 1.4 for the patients with age lower than 45 years at the time of treatment [7]. During radiotherapy of breast cancer, CLB receives radiation dose due to the leakage and scattering of machine head and patient body [9]. Yaparpalvi *et al.* reported that the CLB doses were between 4.9% and 10.5% of the prescribed dose [10]. Bhatnagar *et al.* showed that the CLB dose were 9.74 ± 2.04 percent of the prescribe dose in the patients who were treated by the conventional radiotherapy techniques [11].

The aim of this study was the measurement of CLB dose to evaluate cancer breast radiotherapy that had been accomplished by the two accelerators in Yazd radiotherapy center.

MATERIALS AND METHODS

In this study the CLB surface dose was measured for fifty breast cancer patients who had been treated in Shahid Ramezanzade radiotherapy center. The patients with cancer breast mainly in the stages of two and three, had been treated mastectomy and lumpectomy. Half of the patients i.e. 25 patients were randomly treated by one of the accelerators and another half by another accelerator.

Patients were irradiated by the 6 MV photon beams ($TPR_{20,10}$ = 0.68) with 3DRT technique that were produced by the Oncor and Compact accelerators. The Oncor (Siemens medical system) equipped with physical wedge and the Compact (Elekta medical system) with motorized wedge. The treatment planning system (TPS) was Prowess Panther, version 5.2.

The surface dose of the CLB was measured by the TLD dosimeter, (GR200, LiF: Mg, Cu, P, the chip with the diameter 4.5 mm and thickness 0.8 mm) [4]. Annealing was done at 240 ˚C for 15 sec by TLD reader. The irradiated TLDs were read by the TLD reader, model 7103. The time temperature profile (TTP) was set at an initial preheat temperature of 135˚c, with rate of 6˚C/s for 18 s. The required chips with 2.7% reproducibility was selected. The TLDs were calibrated using the SSD technique at 6MV photon by Scdx-Wellhofer FC65-G ionization chamber. The TLDs displayed a linear dose response (R^2 = 0.998) with respect to the measured dose at d_{max} from 2 to 20 cGy. For determination of TLD dose ECC correction was done. Fifty patients were treated equally by the Oncor and the Compact machines. TLD chips were irradiated during one fraction of patients' treatment only from the medial and lateral tangent field of breast and mediastinum irradiation was negligible because of its small portion in CLB surface dose. The prescribed dose in the tangential field was 50 Gy during 25 fraction. The gantry angles of medial fields were from 54˚ to 64˚ with the wedge angles 15˚, 30˚, 45˚and 60˚. The surface dose of CLB was measured at the four different points on the surface of CLB demonstrated in. Fig 2. These points were included of the point one, 5 cm from the middle of medial tangential field border, the point two, 5 cm from the top of medial tangential field border, the point three, 5 cm from the down of medial tangential field border and the point four on nipple. Distance of point 1 from the medial field border was a constant value 5 cm for all patients whereas distance of the other points varied for the different patients. Three TLD chips wrapped in a thin plastic foil were placed in the each point and the average was taken from three TLD counts. The field size was considered as a factor in production of CLB dose, so it was evaluated in the both treatment methods. The contribution of the medial and lateral fields in the CLB dose was measured separately by the TLDs for 10 patients who were treated by Compact machine. Finally, for comparison of CLB surface doses results T-test was applied by SPSS-19. This study was approved by the ethical committee of Shahid Sadoughi Medical Sciences University conforming by the code of IR.SSU.MEDICINE.REC.1393.110.

RESULTS

The results of prescription percent dose in the four points of CLB surface are summarized in table 1. The CLB surface dose in point 1 in the accelerator with physical wedge was lower than accelerator with motorized wedge, ($p < 0.001$). The CLB surface doses in point 1 for physical wedge was in the range of 3.69-9.35 percent of prescription dose whereas for motorized wedge was 5.11 -11.37 (figure 1).

Mean of CLB surface dose in point 1 due to medial and lateral radiation fields for 10 patients in the motorized wedge was 7.4% of the prescription dose and the contribution of medial and lateral fields were 5.8% and 1.6%, respectively.

The CLB surface dose results as a function of the radiation field size in the Oncor and the Compact accelerator for the 7 patients are shown in table 2. Results show with increase of field size, the CLB surface dose is increased.

Table 1. The percent of prescribed dose of surface dose of CLB due to radiotherapy of breast cancer by Oncor and Compact accelerators in the two tangential fields. Prescribed dose was 50 Gy in 25 fraction.

Technique	N	accelerator	Point 1	Point 2	Point3	Point 4
Physical wedge	25	Oncor	5.78±1.28	4.6± 1.04	4.3± 0.88	3.12± 1.07
Motorized wedge	25	Compact	7.84± 1.42	4.85± 1.04	5.24± 1.26	3.06± 1.5
P-Value			0.000	0.4	0.004	0.8

The values are Mean±SD.

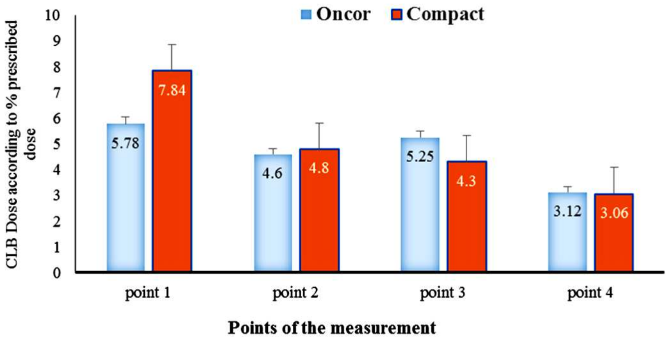

Figure 1. The comparison of percent surface dose of CLB ratio to prescription dose due to two tangential fields' radiotherapy of breast cancer by Oncor and Compact accelerators. (The Error bars are SEM, Standard Error of the Mean).

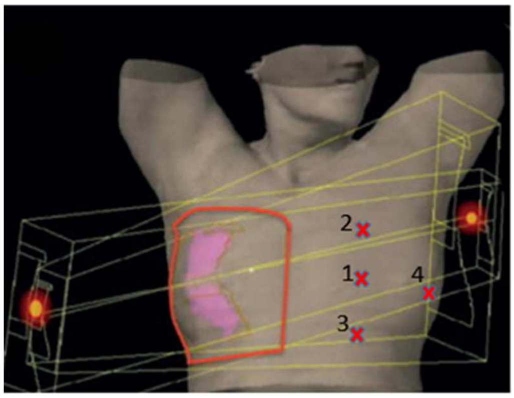

Figure 2. The places of the TLD cheeps on the surface of patient's body.

Table 2. The effect of photon beam field size on the percent prescript dose of surface dose of CLB in Compact and Oncor radiotherapy machines. The CLB doses of the 7 patients as a function of the field size in the Oncor and Compact, the wedge angle 30˚, the field sizes are square equivalents. Prescription dose was 50 Gy in 25 fraction.

Field size (cm)	10×10	11×11	12×12	13×13	15×15	16×16	17×17
Percent CLB Dose (Compact)	5.85	6.2	6.81	7.73	8.64	9.76	11.5
Percent CLB Dose (Oncor)	3.48	4.66	5.22	6.49	7.11	7.9	9.3

DISCUSSION

Secondary breast cancer followed by breast radiotherapy is an important concern. Therefore, the CLB dose should be emphasized in breast radiotherapy, especially in women younger than 45 years [7]. The CLB dose has been reported in some studies [6, 10].

The results of this study show that the surface dose at the point 1 for the patients who had been treated by Oncor machine was lower than the Compact ($p < 0.00$). The range of CLB dose in this study was comparable to the some studies [6, 10, 11]. Yaparpalvi *et al.* reported that the CLB doses had been between 4.9% and 10.5% of the prescribed dose [10]. Bhatnagar *et al.* showed that the mean / SD of the CLB doses was 11.22 ± 2.73 percent of the prescribed dose for the patients who were treated by the conventional tangential field techniques [11]. The CLB dose had been reported in the range of 5.2 to 15 percent of prescribed dose (50 Gy) by Faaruq *et al.* [6]. Sohn et al. concluded that the CLB dose from a beam radiation field without wedge has been $^2/_3$ a field with wedge and the main contribution has been related to the medial field radiation [12]. When a wedge is placed in the beams path, scattered photons will be increased and some of the primary beams also will be attenuated. Therefore, the adequate monitor unit (MU) should be increased. With increase of MU, head leakage and scattering will be growth and finally, the CLB dose will be increased [13].

Present results showed that the contribution of the CLB dose from the medial field was more than the lateral field (pv <0.00). The distance of CLB lateral view from radiation source is farther than its medial view. Hence contribution of the lateral field in scattering dose will be less than the medial. These results are compatible with the some studies [4, 9, 14, 15].

Table 2 shows that by increasing radiation field size, the surface dose of CLB is also increased. Similarly, Faaruq *et al.* showed that there was a linear relationship between CLB dose and Lateral separation[6]. Muller *et al.* reported that the average of CLB doses in small radiation field size was 8.4% whereas in large field size it was 16.9 % [16].

As our results the CLB dose significant reduced when using the physical wedge compared to the motorized wedge. This results was inconsistent with the results of the other studies [11, 17]. In several studies, it is shown that a dynamic wedge significantly reduce the dose of CLB [11, 17, 18]. Although, Prabhakar *et al.* claimed that there was no significant difference between the physical and dynamical wedge [19]. These contradictory results could be due to various devices radiotherapy.

CONCLUSION

In radiotherapy center of Yazd, The CLB surface dose of patients due to radiotherapy of cancer breast by Oncor machine was lower than the Compact, though the Compact was equipped to motorize wedge and the Oncor to physical wedge. The surface dose of CLB due to medial field was more than lateral field. The mean percent of surface dose of CLB to prescript dose in point 1 was more than guide line 6%[3].

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Conflicts of interest: *Declared none.*

REFERENCES

1. Baumann M and Petersen C (2004) TCP and NTCP: a basic introduction. *Rays, **30(2)**: 99-104.*
2. Pawlicki T, Dunscombe P, Mundt AJ, Scalliet P. (2010) Quality and safety in radiotherapy: CRC Press.
3. Tse Kh (2014) A comparison of contralateral breast dose from primary breast radiotherapy using different treatment techniques: The University of Hong Kong (Pokfulam, Hong Kong).
4. Alzoubi AS, Kandaiya S, Shukri A, Elsherbieny E (2010) Contralateral breast dose from chest wall and breast irradiation: local experience. *Australas Phys Eng Sci Med, **33(2)**: 137-44*.
5. Protection R. (2007). ICRP publication 103. *Ann ICRP, **37 (2.4)**: 2*.
6. Faaruq S, Kakakhail B, ur Rehman S (2009) Comparison of Contra lateral Breast & Chest wall doses during Radiotherapy of Ca-Breast (with mastectomy) using Co-60 machine and 6 MV LINAC. World Congress on Medical Physics and Biomedical Engineering. Place where and the date the congress was held
7. Yadav BS, Sharma SC, Patel FD, Ghoshal S, Kapoor RK (2008) Second primary in the contralateral breast after treatment of breast cancer. *Radiother Oncol, **86(2)**: 171-6*.
8. Gao X, Fisher SG, Emami B (2003) Risk of second primary cancer in the contralateral breast in women treated for early-stage breast cancer: a population-based study. *Int J Radiat Oncol, **56(4)**: 1038-45*.
9. Rather SA, Haq MM-u, Khan NA, Khan AA, Sofi A (2014) Determining the contralateral breast dose during radiotherapy of breast cancer using rainbow dosimeter. *J Radiat Res Appl Sci, **7(4)**: 384-9*.
10. Yaparpalvi R, Fontenla DP, Yu L, Lai PP, Vikram B (1996. Radiation therapy of breast carcinoma: Confirmation of prescription dose using diodes. *Int J Radiat Oncol, **35(1)**: 173-83*.
11. Bhatnagar AK, Brandner E, Sonnik D, Wu A, Kalnicki S, Deutsch M, *et al.* (2004) Intensity-modulated radiation therapy (IMRT) reduces the dose to the contralateral breast when compared to conventional tangential fields for primary breast irradiation: Initial report. *Cancer J, **10 (6)**: 381-5*.

12. Sohn JW, Macklis R, Suh JH, Kupelian P (1999) A mobile shield to reduce scatter radiation to the contralateral breast during radiotherapy for breast cancer: preclinical results. *Int J Radiat Oncol,* ***43(5):*** *1037-41*.
13. Balasubramanian R, Sellakumar P, Bilimagga RS, Supe SS, Sankar B (2006) Measurements of peripheral dose for multileaf collimator based linear accelerator. *Rep Prac Oncol Radiother,* ***11(6):*** *281-5*.
14. Chougule A (2007) Radiation dose to contra lateral breast during treatment of breast malignancy by radiotherapy. *J Cancer Res Ther,* ***3(1)****: 8*.
15. Muller-Runkel R, Kalokhe UP. (1994) Method for reducing scatter radiation dose to the contralateral breast during tangential breast irradiation therapy. Radiology, 191 (3):853-5.
16. Muller-Runkel R, Kalokhe UP. (1990) Scatter dose from tangential breast irradiation to the uninvolved breast. *Radiology,* ***175(3)****:873-6*.
17. Kelly CA, Wang XY, Chu JC, Hartsell WF (1996) Dose to contralateral breast: a comparison of four primary breast irradiation techniques. *Int J Radiat Oncol,* ***34(3):*** *727-32*.
18. Akram M, Iqbal K, Isa M, Afzal M, Buzdar SA (2014) Optimum reckoning of contra lateral breast dose using physical wedge and enhanced dynamic wedge in radiotherapy treatment planning system. *Int J Radiat Res,* ***12(4)****: 295-302*.
19. Prabhakar R, Haresh KP, Julka PK, Ganesh T, Rath GK, Joshi RC, *et al.* (2007) A study on contralateral breast surface dose for various tangential field techniques and the impact of set-up error on this dose. *Australas Phys Eng Sci Med,* ***30(1)****: 42-5*.