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Effect of target breast volume on the scattered dose to the contralateral breast during the radiotherapy of breast cancer patients

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ABSTRACT

This study's goal was to assess how the volume of the target breast affected how much dispersed radiation was delivered to the contralateral breat following treatment for primary breast cancer. Fifteen females have been involved in this study, they were diagnosed as having unilateral breast cancer and underwent unilateral breast lumpectomy or mastectomy. The patient's age range (40-60) years and their mean target breast volume was (1318.5 ± 553.9) cc. breasts imaged with CT scan to produce an image that imported to the radiotherapy planning system. The three-dimensional conformal radiotherapy planning technique (3DCRT) was used for generating of therapeutic plan, where he contoured regions included the target breast, and the contralateral breast. The dose delivered was 50 or 40.05 Gy which were fractionated according to the treatment protocol of each case. The target beast volume measurement was obtained by the CT image and the mean, maximum and minimum doses of the contralateral breast were determined by the generated treatment plan. The scattered dose measurements that included the mean, maximum and minimum doses of radiation therapy to the contralateral breast pointed to a non-significant correlation between these measurements and the volume of the target breast (P= 0.56, 0.33, 0.47 respectively). As the breast volume increase, there is a linear negative non-significant decrease in the amount of the mean dose, maximum dose and the minimum dose that reaching the contralateral breast.

Key words: breast volume, breast cancer.

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INTRODUCTION

It has been established that radiation causes cancer, particularly at subtherapeutic dosages. Due to internal and exterior scatter from the primary beam, normal tissue is exposed to a dosage during therapeutic irradiation. The main irradiation dosage to the contralateral breast may result in subsequent breast cancers [1]. Breast volume measurements are not frequently carried out since there is no accepted method, despite the fact that they are crucial for planning breast reconstruction following mastectomy. The ideal measurement would be quick, easy, and most importantly accurate, using a method that doesn't put patients through additional time, expense, or discomfort [2]. It is generally established that regardless of the dosage fractionation approach, patient-related factors, such as a higher body mass index (BMI) and larger breasts, enhance the likelihood of grade 2 (G2) dermatitis.

A previous study by Berris from 2013 found that the dose to peripheral organs was frequently higher for large breast sizes because of the larger field and increased scattering from a wider area of the body in the primary beam [3-8]. Large breast volume, however, appears to be a risk factor for acute or late adverse effects regardless of dose inhomogeneity, conformal radiation method (3D-CRT vs. IMRT), or fractionation schedule, according to certain studies [9–11]. In a multiple regression model that also took into account other prognostic indicators, breast size was the only independent significant risk factor for changing the look of the breast [11]. A subgroup of patients from the UK FAST hypofractionation (3D-CRT) trial underwent a univariate analysis, and the results revealed that breast size and dosimetric parameters are strongly linked with late effects.

Patients with breast cancer who are at a high risk of recurrence benefit from boost therapies, which involve giving a small volume of breast tissue a larger dose to increase the probability of local control [12–14]. Recent studies have taken advantage of the breast dose-volume effect by limiting the exposed volume to radiation to the region surrounding the tumor bed in an effort to reduce toxicity while maintaining local control rates. Partial Breast Radiation (PBR) is used for patients with low recurrence risk.

There doesn't seem to be any published study on the topic, despite the fact that there is substantial evidence indicating a dose-volume effect of radiation on a number of organs, including the lung and rectum. The extent of breast tissue exposed to radiation and late NTCs, such as general cosmesis, breast fibrosis, breast induration, and telangiectasia, are examined in this extensive study.

Additionally, it is being researched whether a slight dose reduction to a breast region facilitates dose escalation to the tumor bed with a lower-than-anticipated NTC [15] .

PATIENTS AND METHOD

This is a prospective study, it has been taken place in Baghdad radiotherapy hospital/ Baghdad Medical City. Fifteen females have been involved in this study, they were diagnosed as having unilateral breast cancer and underwent unilateral breast lumpectomy or mastectomy. For patients' setup purposes, the patients were strapped to a breast support board in a supine position and had both arms raised over their heads, and the breasts imaged with CT scan to produce an image that imported to the radiotherapy planning system type Philips company (Philips healthcare). Right and left anterior-posterior (AP) oblique supraclavicular fields of radiation, as well as bilateral opposing medial and lateral tangents, were employed to create the plan using the three-dimensional conformal radiotherapy planning approach (3DCRT). The contoured regions included the target breast, and the contralateral breast. Each plan has been evaluated by the dose-volume histogram (DVH) analysis to measure the maximum dose percentage received by the PTV and the contralateral breast, and the mean dose received by the contralateral breast. The radiotherapy was performed by using photons energy of 6 MV, and 10 MV provided by the linear accelerator model Elekta made in Sweden. The multileaf collimator (MLCs) of linac is 80 pairs. The dose delivered was 50 or 40.05 Gy which were fractionated according to the treatment protocol of each case. The target beast volume measurement was obtained by the CT image, produced by the CT scanner type Philips company (Philips healthcare). The patients' and radiation dose data are listed in Table 1.

Tab 1. Patients and radiation dose data

Age range (years)	from 40 to 60
Mean age ± SD (years)	51.6 ± 7.4
BMI Kg/m²	32.0 ± 4.9
Max. dose to contralateral breast (cGy)	1884.0 ± 1220.6
Min. dose to contralateral breast (cGy)	15.0 ± 15.5
Mean. dose to contralateral breast (cGy)	97.7 ± 53.1
Total dose to the target breast (cGy)	5000 or 4005
Mean target breast volume (cm³)	1318.5± 553.9

The statistical analysis of the radiotherapy dose differences that may be affected by the target breast volume pointed to a non-significant correlation between the mean radiation scattered dose that was reached the contralateral breast and the volume of the target breast (P> 0.05). the target breast volume tends to be negatively correlated with the mean scattered dose that received by the contralateral breast during the radiotherapy of the target breast, as shown in figure 1.

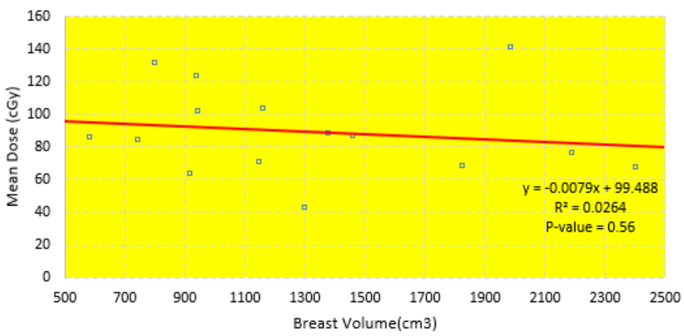

Fig 1. The correlation between the target breast volume and mean radiation dose reaching the contralateral breast

In the same manner, the maximum and minimum scattered radiation doses that were received by the contralateral breast have been also non-significantly correlated with the target breast volume (P= 0.33, 0.47) as presented by figures 2 and 3. The curves indicated that increasing the target breast volume was associated with a non-significant decrease of the maximum and minimum doses that scattered to the contralateral breast during the radiotherapy course (Figure 2 and 3).

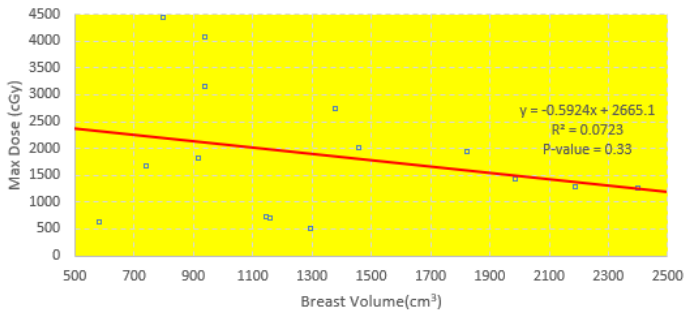

Fig 2. The correlation between the target breast volume and maximum radiation dose reaching the contralateral breast

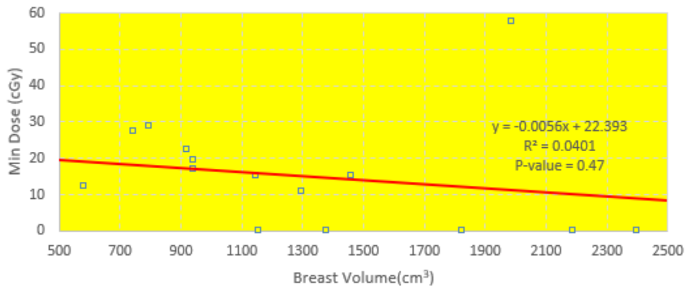

Fig 3. The correlation between the target breast volume and minimum radiation dose reaching the contralateral breast

DISCUSSION

Contralateral breast dose from primary breast irradiation has been implicated in the risk of second breast malignancies [16]. The insignificant inverse relationship between the target breast volume and the mean, minimum and maximum scattered doses that obtained by statistical analysis of this research data is confirmed by the findings of Vikneswary 2015 who studied the effect of the target breast volume on the amount of the sporadic dose to the contralateral breast, the primary breast volume, according to the authors, negatively linked with the contralateral breast dosage when examined by three different imaging modalities: megavoltage computed tomography (MV-CT), megavoltage electronic portal image (MV-EPI), and megavoltage cone-beam computed tomography (MV-CBCT). This result revealed that as breast volume grows, the absorbed dose to the contralateral breast decreases [17].

Moreover, Ratosa, Jenko [18] pointed to the necessity of assessing the primary breast volume considering it as one of the independent factors that may affect the dose inhomogeneity. Although the risk of toxicity is lower the lower the excessive radiation dosage, the mentioned authors found that larger breast volume alone, regardless of the fractionation approach or dosage inhomogeneity, is a risk factor for acute adverse effects. This is also a factor, along with the target volume, heterogeneity, and a higher proportion of an excessive radiation dosage.
The thickening of the contralateral breast tissue which appears few months post the radiotherapy of the primary breast can be considered as an early sign of a future complications of a secondary cancer as a result of the effect of the scattered dose from the primary breast [16]. A previous study for the effect of large target breast volume of obese breast cancer patients referred to a significant effect for the amount of the scattered dose that is absorbed by the contralateral breast specifically in the nipple region due to the influence of increasing the radiation field size during the radiotherapy of the target breast by the using the 3DCRT planning technique, this finding may don't support the findings of the current study and the reason may relate to the lower BMI of the patients who were involved in this study [19].

CONCLUSION

When compared to breast volume, the amount of the mean dose, maximum dose, and lowest dose that reaches the breast grows linearly adversely and insignificantly.

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