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Assessment of Interventricular Septum and Left Ventricular Posterior Wall Thickness Changes Following Radiotherapy in Breast Cancer Patients Using Echocardiography

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ABSTRACT

Background: *Radiotherapy (RT) is a key component of breast cancer treatment; however, incidental cardiac radiation exposure may cause early myocardial injury detectable by echocardiography.* ***Purpose:*** *To evaluate changes in interventricular septum (IVS) thickness and left ventricular posterior wall thickness (LVPWT) after RT in breast cancer patients, and to assess the effect of radiation laterality on these changes.* ***Methods:*** *This prospective cohort study was conducted at Al-Najaf Center for Cardiac Surgery and Transcatheter Therapy, Al-Sader Teaching Hospital, Al-Najaf, Iraq, from January to September 2025. Forty women with breast cancer aged 20–65 years were enrolled and divided into left-sided breast cancer (n=18) and right-sided breast cancer (n=22). IVS and LVPWT were measured using standard 2D transthoracic echocardiography before RT and within 10 days after completion of RT sessions. Paired t-test and independent t-test were used for statistical analysis.* ***Results:*** *Compared with pre-radiotherapy values, post-radiotherapy mean IVS thickness increased significantly (mean difference: 0.68 mm; 95% CI: 0.40–0.95; $p<0.05$). Similarly, LVPWT increased significantly after RT (mean difference: 0.63 mm; 95% CI: 0.30–0.90; $p<0.05$). The post-RT increase was greater in left-sided RT than right-sided RT for IVS thickness (mean difference: 1.40 mm; 95% CI: 1.04–1.76; $p<0.05$) and LVPWT (mean difference: 1.19 mm; 95% CI: 0.74–1.63; $p<0.05$). Hypertensive patients showed greater post-RT increments in IVS thickness (mean difference: 0.80 mm; 95% CI: 0.28–1.32; $p<0.05$) and LVPWT (mean difference: 0.70 mm; 95% CI: 0.23–1.17; $p<0.05$). No significant age-related differences were found between patients aged ≥50 and <50 years.* ***Conclusion:*** *Increased IVS and LVPWT may represent early subclinical myocardial remodeling shortly after breast cancer RT. Echocardiographic wall thickness assessment may be useful in post-RT surveillance, particularly in high-risk patients. Longer follow-up studies are recommended.*

Keywords: Breast Cancer, Interventricular Septum, Left Ventricular Posterior Wall Thickness , Radiotherapy.

Article Information

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INTRODUCTION

Radiotherapy plays an essential role in the curative treatment for breast cancer, which is still the most common cancer affecting women globally (1). Despite the advancement in new radiotherapy techniques like intensity-modulated radiotherapy (IMRT), the heart may still accidentally receive radiation exposure, mainly in left-sided cases (2). Radiation exposure may result in the presence of radiation-induced cardiotoxicity (RIC), which has now a clinically important long-term concern affecting breast cancer survivors (3). Radiation-induced cardiotoxicity involves wide range of pathological conditions including pericardial disease, myocardial fibrosis, conduction abnormalities, and coronary artery disease (4). Many studies have identified that the dose of radiation the heart exposed to is the main factor leading to cardiovascular events mainly ischemic heart disease (5).

Echocardiography is an important tool for cardiac monitoring in cancer patients because of it is available, safe, and reproducible. Global longitudinal strain (GLS) and left ventricular ejection fraction (LVEF) have been the main parameters that recent research identified as indicators of radiation-induced heart disease (6,7). Despite that GLS has provided valuable findings for detecting early systolic dysfunction, its role may be limited by its dependence on image quality and vendor variability. Structural echocardiographic measures , like interventricular septum (IVS) and left ventricular posterior wall (LVPW) thickness, may demonstrate myocardial remodeling and fibrosis. Some researches showed that radiation exposure may lead to myocardial hypertrophy and fibrotic changes even before presence of functional impairment (8). However, changes in these parameters in breast cancer patients are not yet fully recognized, mainly with the relation to cancer laterality. Also, the effect of patient-related cardiovascular risk factors (such as age, hypertension) on post-radiotherapy myocardial remodeling has not been adequately explained. This limits the knowledge to recognize the routinely measured echocardiographic parameters as early markers of subclinical cardiac dysfunction.

This study aimed to prospectively evaluate changes in interventricular septal (IVS) and left ventricular posterior wall (LVPW) thickness following radiotherapy in breast cancer patients and to investigate if these changes are affected by patients' cardiovascular risk factors and radiation laterality.

METHODS

It is a prospective cohort study conducted at Al-Najaf Center for Cardiac Surgery and Transcatheter Therapy, Al-Sader Teaching Hospital, Al-Najaf city, between January and September 2025. It included forty females with breast cancer (aged 20–65) going to be treated with radiotherapy.

Participants were divided according to cancer laterality into two groups, right sided cancer (22 patients)and left sided breast cancer (18 patients). Participants were excluded if they had otherwise type of malignancy, metastatic cancer, aged older than 65, had history of cardiac diseases and/or had previous chest radiotherapy.

For each patient, height and body weight were measured to obtain their BMI. Additionally, a history of hypertension was documented with measurement of blood pressure. IVS thickness and LVPW thickness measurements were conducted by GE vivid E95 system with two-dimensional transthoracic echocardiography in parasternal long-axis (PLAX) view then the measurement was done using M-mode at the end of diastole according to American Society of Echocardiography and the European Association of Cardiovascular Imaging guidelines (9).

All measurements were done by the same echocardiography specialist and using the same machine, the specialist was blinded to patient's

cancer side, left or right sided, and to the patient's treatment status (if pre or post radiotherapy measurement).

IMRT radiotherapy technique was used for all patients at a dose of 40.05 Gy over 15–20 sessions over 4 to 6 weeks (table 1).

For each patient, IVS thickness and LVPW thickness were measured before starting radiotherapy and within 10 days after completion of last radiotherapy session (about 5 to 7 weeks after the baseline assessment).

IVS thickness and LVPWT ≥ 11 mm were considered as mild LV hypertrophy (10).

To perform the Statistical analyses, version 26 of the Statistical Package for the Social Sciences (SPSS) software was used , with paired t-test for comparisons of pre and post-radiotherapy changes, while comparisons of mean of IVS and LVPWT according to age, side of cancer and co-morbidities presence were done by independent t-test. P-value was considered statistically significant when it is P <0.05 for all analysis.

RESULTS

Sample

In this study, a forty female diagnosed with breast cancer were involved in analysis , 45% had left-sided disease (18 patients) and 55% had right-sided disease (22 patients). The mean age of participants was 49.25±9.1 years, 23 (57.5%) patients were under 50 years and 17(42.5%) patients were 50 years and above. Regarding co-morbidities 35% (14) of the patients had hypertension.

Overall changes

The results showed a significant increase in mean of IVS thickness post radiotherapy compared to pre radiotherapy (12.03 ± 1.7 mm vs. 11.35 ± 1.4 mm, p < .001) and the same finding for LVPW thickness (12.3 ± 1.9 mm vs. 11.7 ± 1.7 mm, p < .001).

Laterality of breast cancer

Regarding IVS thickness, patients with left-sided breast cancer showed a markedly higher mean difference (1.44 ± 0.7 mm) compared with those with right-sided breast cancer (0.04 ± 0.21 mm). The overall mean difference between the two groups was 1.40 mm (95% CI: 1.04 to 1.76), which was statistically significant (p < 0.001).

Similarly, for LVPWT, the mean difference was higher in patients with left-sided breast cancer (1.27 ± 0.82 mm) compared with those with right-sided breast cancer (0.09 ± 0.42 mm). The mean difference between groups was 1.19 mm (95% CI: 0.74 to 1.63), also demonstrating a statistically significant difference (p < 0.001).

Age

The comparison of the mean differences in interventricular septum (IVS) thickness and left ventricular posterior wall thickness (LVPWT) before and after radiotherapy among participants aged 50+ years and 50 < years reported that For IVS thickness, the mean difference in patients aged ≥50 years was 0.64 ± 0.78 mm, while in patients aged <50 years it was 0.69 ± 0.92 mm. The overall mean difference between the two age groups was −0.05 mm (95% CI: −0.60 to 0.50), with no statistically significant difference (p = 0.86).

Regarding LVPWT, the mean difference in patients aged ≥50 years was 0.82 ± 0.88 mm, compared to 0.47 ± 0.84 mm in those aged <50 years. The mean difference between the two groups was 0.35 mm (95% CI: −0.22 to 0.92), which was also not statistically significant (p = 0.21).

Hypertension

The comparison between pre- and post-radiotherapy IVS and PWT among hypertensive patients (n = 14) showed that regarding the interventricular septum (IVS), the mean value increased from 12.6 ± 1.1 mm before radiotherapy to 13.4 ± 1.5 mm after radiotherapy, with a mean difference of 0.8 mm (95% CI: 0.28 to 1.32). This increase was statistically significant (p = 0.006).

Similarly, the left ventricular posterior wall thickness (LVPWT) increased from 13.4 ± 0.9

mm pre-radiotherapy to 14.1 ± 1.2 mm post-radiotherapy, with a mean difference of 0.7 mm (95% CI: 0.23 to 1.17), which was also statistically significant (p = 0.007).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Participants (n = 40).

	Subgroup	No.	%
Age group (years)	< 50	23	57.5
	50+	17	42.5
Mean±SD	49.25±9.1		
Side	Left	18	45
	Right	22	55
HT	Positive	14	35

HT: hypertension , SD: standard deviation.

Table 2: Pre- and Post-Radiotherapy Comparison of IVS and PWT of breast cancer (n = 40)

	Pre-radiotherapy ±SD	Post-radiotherapy ±SD	Mean difference(95%CI)	P
IVS	11.35mm±1.4	12.03mm±1.7	0.68mm (0.4 to 0.95)	<0.001
LV PWT	11.7mm±1.7	12.3mm±1.9	0.63mm (0.3 to 0.9)	<0.001

IVS: interventricular septum , LVPWT: Left ventricle posterior wall thickness , SD: standard deviation

Table 3: Comparison of IVS and PWT mean difference between pre and post radiotherapy according to side of breast cancer (n = 40)

	Left (n=18) ±SD	Right(n=22) ±SD	Mean difference (95%CI)	P
IVS mean difference	1.44mm±0.7	0.04mm±0.21	1.40mm (1.04 to 1.76)	<0.001
LVPWT mean difference	1.27mm±0.82	0.09mm±0.42	1.19mm (0.74 to 1.63)	<0.001

IVS: interventricular septum , LVPWT: Left ventricle posterior wall thickness , SD: standard deviation.

Table 4: Comparison of IVS and PWT mean difference between pre and post radiotherapy according to age group of breast cancer patients (n = 40)

	Age≥ 50 (n=17) ±SD	Age<50 (n=23) ±SD	Mean difference(95%CI)	P
IVS difference	0.64mm±0.78	0.69mm±0.92	-0.05mm(-0.60 to 0.50)	0.86
LVPWT difference	0.82mm±0.88	0.47±0.84	0.35mm(-0.22 to 0.92)	0.21

IVS: interventricular septum , LVPWT: left ventricle posterior wall thickness , SD: standard deviation.

Table 5: IVS and LVPWT in Hypertensive Breast Cancer Patients pre- radiotherapy vs. post-radiotherapy

	Pre-radiotherapy ±SD	Post- radiotherapy ±SD	Mean difference(95%CI)	P
IVS of hypertensive patients (n=14)	12.6±1.1mm	13.4±1.5mm	0.8mm (0.28 to 1.32)	0.006
LVPWT of hypertensive patients	13.4±0.9mm	14.1±1.2mm	0.7mm(0.23 to 1.17)	0.007

IVS: interventricular septum , LVPWT: left ventricle posterior wall thickness,, SD: standard deviation.

DISCUSSION

The current study showed that radiotherapy significantly increased the interventricular septum (IVS) and left ventricular posterior wall thickness (LVPWT) of breast cancer patients, which is evidence of early subclinical remodeling of myocardium. Increased thickness could be explained by the acute inflammatory response of myocardium to the radiation exposure.

Ionized radiation is associated with oxidative stress, endothelial and microvascular damage that leads to interstitial fibrosis and eventual wall thickening (11). The significant higher rise of thickness post radiotherapy in left sided radiotherapy supported the theory of localized radiation exposure damage. The increment may be temporary and the measurement may back to baseline line after following up for few years (8).

In addition, the present study demonstrated that there were no statistically significant differences in the mean changes of inter ventricular septum (IVS) thickness and left ventricular posterior wall thickness (LVPWT) between patients aged ≥50 years and those aged <50 years following radiotherapy. These findings suggest that age alone may not be a major determinant of early structural myocardial changes after radiotherapy in breast cancer patients. Instead, other factors such as radiation dose to the heart, treatment techniques, and the presence of cardiovascular risk factors may play a more significant role in the development of radiation-induced cardiac injury (12).

Also, there is evidence in literature that being younger at time of radiotherapy increases the risk of radiation induced cardiotoxicity, making risk factors assessment and quantification of risk of cardiotoxicity of even more importance in younger patients (12).
Hypertensive patients developed significantly greater wall thickening than normotensive patients post-radiotherapy. Myocardium hypertrophy is a known effect of hypertension that may act in combination with radiation-induced damage to increase myocardial remodeling. These findings are consistent with previous study reported that patients with underlying cardiovascular risk factors are at greater risk of developing structural and functional cardiac abnormalities after cancer therapy (13). This finding emphasizes the importance of considering pre-existing cardiovascular risk factors when planning and monitoring radiotherapy for breast cancer patients (14).

The study was limited by the short follow-up duration, small sample size and single center study design. Further studies are needed to evaluate whether early wall thickening predicts long-term cardiac events with measurement and correlation with functional parameters using global longitudinal strain echocardiography.

CONCLUSION

Radiotherapy for breast cancer, mainly for left-sided cancer, had been linked to early elevation in posterior wall thickness and the interventricular septum, demonstrating acute effect before the presence of obvious signs of cardiac dysfunction. These results support the thought that structural echocardiographic parameters may be used as early predictors of radiation-induced cardiotoxicity in addition to functional parameters such as left ventricular ejection fraction and strain imaging.
Future researches with longer follow up duration are recommended to demonstrate the prognostic importance of early myocardial wall thickening and its progression to clinically relevant cardiac disease.

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Ethical approval

The present study which is conducted by authors (Ekram Balasim AL-Hasnawi and Amina Abdul-Baki. Al-Dujaili) was approved by the local Department of Ethical committee for clinical studies in faculty of medicine in university of Kufa.

Statement of Permission and Conflict of Interests

We declare that we have no any financial interests or connections, direct or indirect, or other situations that might raise the question of bias in the work reported or the conclusions, implications or opinions stated – including pertinent commercial or other sources of funding for the individual authors or for the associated departments or organizations, personal relationships, or direct academic competition.

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