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RESEARCH ARTICLE

Analysis Of Coronary Artery Dosimetry In 3- Dimensional Era In Left Sided Tangential Breast Ir-radiation.

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Abstract

Background: Radiotherapy for breast cancer often involves some incidental exposure of the heart to ionizing radiation.
The aim of the study: To evaluate the dose received by the left anterior descending coronary artery (LAD), correlate it with cardiac dose & acute cardiac toxicity in relation to the dose received by LAD within first 2 months following RT to left sided breast cancer.
Patients and Methods: This prospective study included 26 left-sided breast cancer patients who operated with breast conservative surgery and all of them had to have the inclusion criteria. Patients evaluated pretreatment by medical history, complete physical examination &Cardiologic consultation., Laboratory evaluation: Complete blood count , Liver, kidney functions tests and serum CA 15-3. Radiological evaluation: Chest x-ray,Pelvi-abdominal ultrasound. Bone scan., Evaluation of cardiac status e.g. ECG, ECHO. Treatment protocol: Patients were simulated using a CT-planning system, target volumes and organ at risk were contoured .The detailed dosimetry of target volumes and organ at risk were obtained and analyzed.Treatment evaluation and follow-up:Patients were evaluated weekly during treatment for cardiac, hematological, skin, lung toxicities and after completing RT by 2,6 months,and 0ne year according to WHO grading system.**Results:** The mean age was 47.80 ± 10.17., 42.3% of patients were premenopausal ,while postmenopausal women represented 38.5%, The perimenopausal women were represented by 19.2%. A significant direct correlation was found between mean LAD dose and mean heart dose with Regression line equation: Mean LAD Dose (cGy) = 4.24 x Mean Heart Dose (cGy).and we couldn't identify acute heart toxicity.Mean LAD dose was 15.8 Gy.Mean heart dose was 3.5 Gy and median V25 was 2.7%., for every 1 Gy increase in mean heart dose, mean LAD dose increased by 4.24 Gy. For every percent increase in the heart V10 and V25, there was a 2.24 Gy and 3.74 Gy increase in mean LAD dose, respectively **.** For every percent increase in the heart V40 a 5.06 Gy increase in mean LAD dose was noted and for every percent increase in heart V25 a 5.16% increase in the LAD V20 was demonstrated. There was no significant association between central lung distance(CLD) ,minimal, and mean LAD dose while there is a direct correlation between CLD and Max LAD dose. There was no significant association between heart volume,mean and max., LAD dose while there is a direct correlation between heart volume and mean LAD dose.**Conclusion:** Clear excellent correlation between the dose to the heart and LAD artery was discovered**,** So, LAD artery does not need to be contoured separately when standard tangential borders are used.
Key Words:Breast cancer radiotherapy ,Cardiac &left anterior descending coronary artery dose.

Introduction:-

Radiation therapy (RT) plays an integral role in the treatment of breast cancer. In a meta-analysis of nearly 42,000 women who were treated within clinical trials, the use of RT after mastectomy or lumpectomy improved local control, disease free survival, and overall survival. [1]

Unfortunately, the use of RT also has a dark side. In the same meta-analysis, the hazard ratio for death secondary to heart disease, presumably radiation related, was 1.27%**.** RT for breast cancer can clearly increase the risk of cardiovascular disease, including: pericarditis, coronary artery disease (CAD), conduction abnormalities, congestive heart failure, and valvular disease. [2] In addition, essentially all of the increased risk of clinically meaningful cardiac events is not manifest until more than 10 years after RT. Although the incidence of cardiac events was lower in the first 5 years of follow-up, it increased over time and persisted after 15 years.

The wide-spread use of computed tomography (CT) -based treatment planning, along with the simultaneous development of improved treatment delivery techniques, have allowed for 3-dimensional visualization and delineation of normal tissue structures and enhanced methods for sparing normal tissue more effectively. While these developments in treatment planning and delivery have diminished the cardiac sequelae of left-sided radiation significantly, the data on this topic are somewhat conflicting. [3]

Several publications demonstrate persistent altered cardiac perfusion after left-sided radiation treatment for patients treated with modern techniques. [4] Furthermore, when analyzing radiated cardiac volumes with contemporary methods, the existing published data suggest that a fraction of left-sided breast cancer patients undergoing radiation are still receiving potentially significant doses of radiation to their heart and left ventricle[5]. This calls into question whether radiation-induced coronary artery disease has truly been eliminated, or whether it has merely been reduced to the point where current studies are statistically underpowered to detect its presence.

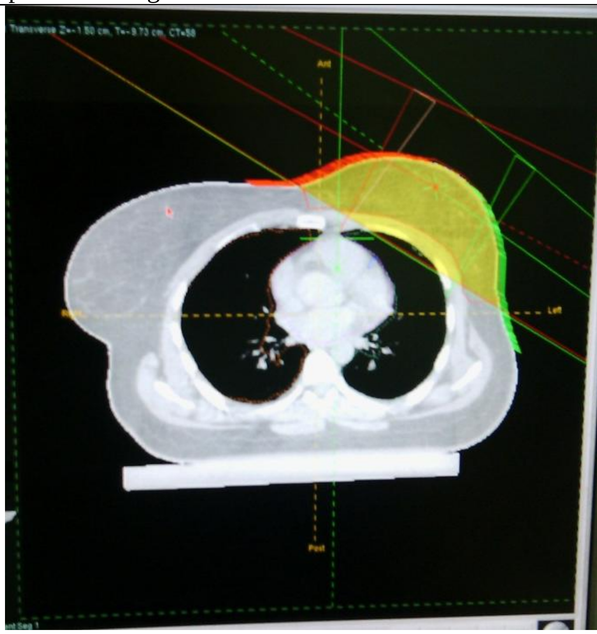
Aim of the work:-

To evaluate the dose received by the left anterior descending coronary artery (LAD), correlate it with cardiac dose& acute cardiac toxicity in relation to the dose received by LAD within first 2 months following RT to left sided breast cancer.

Patients And Methods

This study was conducted in Clinical Oncology & Nuclear Medicine Department, Zagazig University Hospitals in the duration from August 2013 to August 2015, 26 patients with left conservative surgery for breast cancer were prospectively selected and treated by linear accelerator machine(Linac, Elekta 151204,precise plan,release 2.12,477.08).**Inclusion criteria:**Female patient >18 years old underwent conservative surgery for left breast cancer.Histologically confirmed invasive left breast carcinoma,.T1-T2 tumors.,Stage I , stage II breast cancer., No history of contralateral breast cancer., No previous radiotherapy., Received adjuvant chemotherapy., No medical comorbidity (cardiovascular or pulmonary diseases).,Normal hematological, liver and kidney function tests.**Pretreatment evaluation:** Clinical evaluation: Medical history, complete physical examination &Cardiologic consultation., Laboratory evaluation:Complete blood count , Liver, kidney functions tests and serum CA 15-3. Radiological evaluation: Chest x-ray, Pelvi-abdominalultrasound.Bone scan.,Evaluation of cardiac status e.g. ECG, ECHO. **Treatment:**Radiotherapy techniques:Patients were simulated using CT:C.T. images included the entire thoracic region from level of third cervical vertebra to diaphragm,Immobilization: The position of the patient must remain identical for localization on a CT scanner or simulator and during subsequent treatment. The patients were treated supine using an immobilization device which secures both arms above the head. A system of medial and lateral tattoos and orthogonal laser lights, alignment of the patient and consistency of set-up were ensured. An inclined plane was used with fixed angle positions. Target volume definition:CTV and PTV:The clinical target volume (CTV) comprised of Whole Breast: the whole breast down the deep fascia but not including underlying muscle, rib cage or overlying skin. The planning target volume (PTV) included the entire breast defined by inspection , palpation and imaging with a 2 cm margin, extending from the anterior midline to the mid-axillary line. Superior and inferior margins to the PTV were at the sternal notch and 2 cm below the inframammary fold (or overlapping breast tissue), respectively. Posterior margins of the CTV extended to the deep fascia.**Supraclavicular region**: contouring of the supraclavicular region was guided by the origin of the internal mammary artery.Cranial: Thyroid cartilage,Caudal: Clavicular head,Medial (med): Trachea,Posterior (post)-lateral (lat): Anterior scalene muscle .Post-med: Carotid artery.The treatment plan optimized to result in no more than 5% to 8% dose variation

,with maximum dose not exceeding 15% of the presdriptionand if ≤ 10% of the heart volume and ≤ 25% of the ipsilateral lung volume received 25 GY.



A : Left Medial tangential irradiation

B : Left lateral tangential irradiation

C : Left Medial tangential irradiation

D : Left lateral tangential irradiation

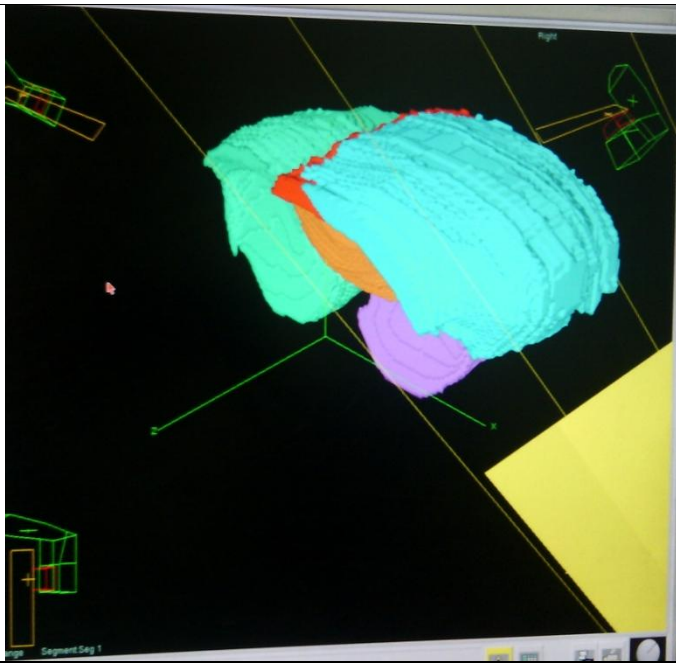
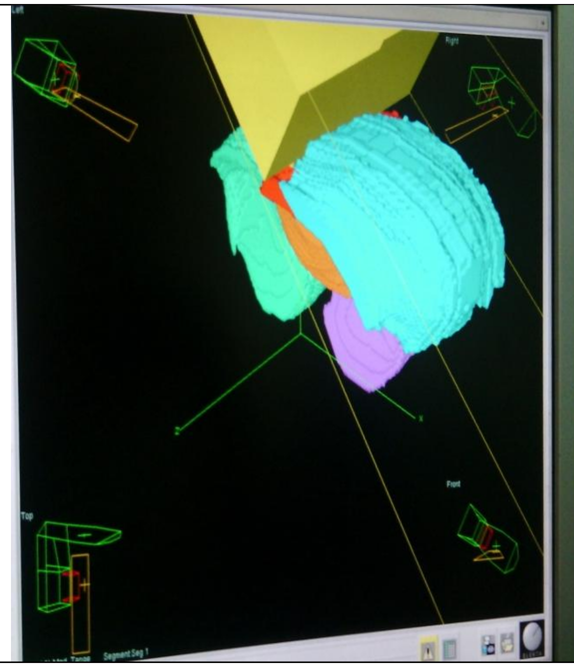
	
E:Beam eye view of left lateral tangential irradiation by 6 MV photon	**:F Beam eye view of left medial tangential irradiation by6 MV of the same patient.**

Fig (1) : A, B :Dose distribution from 15 MV photon tangential irradiation,The heart is outlined in red .LAD is outlined in blue. **C, D** : dose distribution from 15 MV photon tangential irradiation ,The heart is outlined in yellow.LAD is outlined in orange.**E, F** : Beam eye view from 6 MV photon tangential irradiation **.**

Organs at risk and DVH: Lung: V20<15%, V30<10%., Heart : <35 GY to the heart., LAD: contoured by the guidance of Cardiac Atlas[6].,Spinal cord : <45GY.,Esophagus: maximum 40 GY in 15 cm.,Larynx: <20Gy. The dose reaching the heart should be minimized by shielding the heart using MLC(multi-leaf collimator) without interference with the target coverage. Radiotherapy dose prescription:50 Gy in 25 fractions over 5 weeks . , A breast boost of 10 Gy in 5 fractions was delivered to patients with conservative surgery Fig(1). Treatment evaluation and follow-up: Patients were evaluated weekly during treatment for cardiac, hematological, skin, lung toxicities and after completing RT by 2 months according to WHO grading system**.**[7]

Statistical analysis: All data were collected, tabulated and statistically analyzed using SPSS 22.0 for windows (SPSS Inc., Chicago, IL, USA) & Graph Pad Prism 5 for windows (Graph Pad Software Inc., San Diego, CA, USA). Continuous data, e.g., physical characteristics and radiation exposures of the heart and LAD were described using mean ± standard deviation (SD) & median (25th and 75th percentiles) and range. The categorical data are expressed as a number(percentage). The area under a curve (AUC) was calculated in order to characterize the cumulative radiation levels in LAD and the heart of each patient. The AUC calculation was derived from the first dose point measured (5 Gy for the heart, 10 Gy for the LAD). Spearman's rank correlation analysis was done between a volume of LAD radiated and physical attributes of the heart and LAD, as well as cumulative and dose-specific radiation levels in the heart. We consider (+) sign as an indication for direct correlation & (-) sign as an indication for inverse correlation, also we consider values near to 1 as an indication for strong correlation & values near 0 as the indication for weak correlation. The association between mean LAD doses and heart doses was determined using linear regression. All tests were two-sided. $P < 0.05$ was considered statistically significant (S), $P < 0.01$ was considered highly statistically significant (HS), and $P \geq 0.05$ was considered non-statistically significant (NS).

Results:-

The present work is a prospective study to evaluate dose received by LAD, correlate it with cardiac dose& acute cardiac toxicity in relation to the dose received by LAD within first 2 months following RT to left-sided breast cancer. The study included 26 breast cancer patients who presented to Clinical Oncology Department, Zagazig University Hospitals from August 2013 to August 2015.**Patients' characteristics:** The mean age was 47.80 ± 10.17., regarding the menopausal status, 42.3% were premenopausal while postmenopausal women represented 38.5%, The perimenopausal women were represented by 19.2%. **Tumor characteristics:**Histopathological grade II was 69.2% and grade III was 30.8% .All tumors were T1 and T2; T1 and T2 represented 42.3%, 57.7% respectively. Node negative disease represented 46.1%, while N1 disease was 53.8% . Stage I represented 26.9% & Stage II represented 73%.Most patients received (FAC) regimen as adjuvant chemotherapy 53.8%, while patients received AC-Taxol &FEC regimens represented 23.1%, 23.1% respectively as shown in Table (1).

Table (1): Patients characteristics, (N = 26 patients).

Patients characteristics	Left breast cancer patients (N=26)	
	Number	Percent (%)
Age (years)		
Mean ± SD	47.80 ± 10.17	
Median (Range)	47 (32 – 67)	
Menstrual status		
Premenopausal	11	42.3%
Perimenopausal	5	19.2%
Postmenopausal	10	38.5%
Grade		
Grade II	18	69.2%
Grade III	8	30.8%
Phenotype		
Luminal A-like	18	69.2%
Basal-like	8	30.7%
T		
T1	11	42.3%
T2	15	57.7%
N		
No	12	46.1%
N1	14	53.8%
Stage		
Stage I	7	26.9%
Stage II	19	73%
Chemotherapy		
FAC	14	53.8%
AC & Taxol	6	23.1%
FEC	6	23.1%

Acute toxicity: Thirteen patients (50%) showed G1 acute skin toxicity reaction to radiotherapy while G2 acute skin reaction represented 23% . Grade 1 acute lung toxicity (pneumonitis) affected 3 patients (11.5%) . **Table (2)**, Regarding acute cardiac toxicity, there were no ECG or ECHO changes in all patients within 2 months after radiotherapy.

Table (2): Clinical and radiological assessment of toxicity, (N = 26 patients).

Clinical assessment of toxicity	Left breast cancer patients (N=26)	
	Number	Percent (%)
Erythema		
Grade 1	13	50%
Grade 2	6	23%
Desquamation		
Grade 1	3	11.5%
Pneumonia		
Grade 1	3	11.5%

All the patients had breast conservation surgery. Characteristics of the segmented organs within the patient population are shown in **Table (3)**.

Table (3) also details the dosimetric characteristics of the study population. All subjects met the Quantitative Analysis of Normal Tissue Effects in the Clinic recommendation of heart V25 <10%. Of note, the mean dose to the LAD was 15.78 Gy.

Table (3): Anatomical and dosimetric parameters, (N = 26 patients).

Anatomical & dosimetric parameters	Mean	±	SD	Median	Percentile		Range	
					(25^{th}	, 75^{th})		
Central lung distance(CLD) (cm)	3.2	±	0.5	3.5	(2.9	, 3.8)	2.4	– 3.9
Heart volume (cc)	574.2	±	88.1	596	(533.4	, 614)	430	– 853
LAD volume (cc)	1.9	±	0.7	2.1	(1.2	, 2.3)	1.2	– 4.8
Heart V5 (%)	8.3	±	4.4	9.0	(4.6	, 13.0)	1	– 16
Heart V10 (%)	5.6	±	3.7	5.5	(5.5	, 10.0)	0	– 12
Heart V15 (%)	4.9	±	3.3	4.5	(4.5	, 9.0)	0	– 10
Heart V20 (%)	4.0	±	3.1	3.5	(3.5	, 8.0)	0	– 9
Heart V25 (%)	3.2	±	2.3	2.7	(2.7	, 6.0)	0	– 7
Heart V30 (%)	2.6	±	2.0	2.0	(2.0	, 5.0)	0	– 6
Heart V40 (%)	0.5	±	1.1	0.0	(0.0	, 0.3)	0	– 5
Heart V50 (%)	0.1	±	0.3	0.0	(0.0	, 0.0)	0	– 2
Min Heart Dose (Gy)	0.355	±	0.502	0.11	(0	, 0.5925)	0	– 1.23
Mean Heart Dose (Gy)	3.456	±	1.452	3.26	(2.3425	, 5.24)	1.23	– 5.29
Max Heart Dose (Gy)	36.761	±	11.806	38.69	(38.69	, 42.09)	12.45	– 51.63
LAD V10 (%)	41.5	±	31.5	55	(14	, 72)	1	– 94
LAD V20 (%)	31.1	±	30.7	46	(0	, 52)	0	– 85
LAD V30 (%)	25.8	±	27	23	(0	, 45)	0	– 81
LAD V40 (%)	9.4	±	20.9	0	(0	, 2.5)	0	– 75
Min LAD Dose (Gy)	2.021	±	0.781	1.80	(1.6075	, 2.51)	1.11	– 4.93
Mean LAD Dose (Gy)	15.789	±	10.666	19.51	(7.2575	, 20.76)	2.85	– 4.073
Max LAD Dose (Gy)	30.445	±	13.984	37.33	(18.6275	, 40.2325)	12.19	– 51.42

Significant correlation was found between volumes of heart receiving ≤30 GY and min, mean LAD doses. Significant correlation was found between mean Heart dose **,**min and mean LAD doses.Significant correlation was found between max Heart dose , mean and max LAD doses. **Table (4)**

Table (4): Correlation between heart dose parameters and mean, maximum, and minimum dose to the left anterior descending artery (LAD), (N = 26 patients).

Heart dose parameters	Min LAD Dose (Gy)		Mean LAD Dose (Gy)		Max LAD Dose (Gy)	
	R	p-value (Sig.)	r	p-value (Sig.)	R	p-value (Sig.)
Heart V5 (%)	+ 0.537	0.005 (HS)	+ 0.410	0.037 (S)	+ 0.261	0.199 (NS)
Heart V10 (%)	+ 0.810	0.013 (S)	+ 0.415	0.035 (S)	+ 0.309	0.124 (NS)
Heart V15 (%)	+ 0.485	0.012 (S)	+ 0.432	0.027 (S)	+ 0.318	0.113 (NS)
Heart V20 (%)	+ 0.405	0.040 (S)	+ 0.392	0.048 (S)	+ 0.324	0.107 (NS)
Heart V25 (%)	+ 0.467	0.016 (S)	+ 0.479	0.013 (S)	+ 0.402	0.042 (S)
Heart V30 (%)	+ 0.475	0.014 (S)	+ 0.496	0.010 (S)	+ 0.402	0.042 (S)
Heart V40 (%)	+ 0.091	0.660 (NS)	+ 0.581	0.002 (HS)	+ 0.747	<0.001 (HS)
Heart V50 (%)	+ 0.311	0.123 (NS)	+ 0.338	0.092 (NS)	+ 0.338	0.092 (NS)
Mean Heart Dose (Gy)	+ 0.531	0.005 (HS)	+ 0.457	0.019 (S)	+ 0.293	0.146 (NS)
Max Heart Dose (Gy)	+ 0.249	0.220 (NS)	+ 0.647	<0.001 (HS)	+ 0.849	<0.001 (HS)

r Spearman's rank correlation coefficient.
$P < 0.05$ is significant.
Sig.: Significance.

Significant correlation was found between the sampled dose-volume heart parameters and the respective mean LAD doses, as shown in **the table (5)**

Table (5): Correlation between absolute heart volume dose parameters with mean dose to the left anterior descending artery (LAD), (N = 26 patients).

Absolute heart volume doses parameters	Mean LAD Dose (Gy)	
	R	P-value (Sig.)
Heart V5 (cc)	+ 0.438	0.025 (S)
Heart V10 (cc)	+ 0.413	0.036 (S)
Heart V15 (cc)	+ 0.466	0.016 (S)
Heart V20 (cc)	+ 0.362	0.069 (NS)
Heart V25 (cc)	+ 0.364	0.067 (NS)
Heart V30 (cc)	+ 0.517	0.007 (HS)
Heart V40 (cc)	+ 0.522	0.006 (HS)
Heart V50 (cc)	+ 0.338	0.092 (NS)

r Spearman's rank correlation coefficient.
$P < 0.05$ is significant.
Sig.: Significance.

There was no significant association between central lung distance ,min, and Mean LAD Dose ,while there is a direct correlation between CLD and Max LAD Dose. There was no significant association between heart volume,mean and max LAD dose,while there is a direct correlation between heart volume and min LAD dose. **Table (6)**

Table (6): Correlation between volumes (left anterior descending artery [LAD], heart, and central lung distance) and dosimetry of LAD, (N = 26 patients).

Parameters	CLD (cm)		Heart volume (cc)		LAD volume (cc)	
	r	p-value	r	p-value	R	p-value

		(Sig.)		(Sig.)		(Sig.)
Min LAD Dose (Gy)	+ 0.213	0.297(NS)	+ 0.410	0.037(S)	- 0.320	0.111(NS)
Mean LAD Dose (Gy)	+ 0.228	0.262(NS)	+ 0.276	0.173(NS)	- 0.251	0.217(NS)
Max LAD Dose (Gy)	+ 0.509	0.008(HS)	+ 0.131	0.524(NS)	- 0.181	0.377(NS)
LAD V10 (%)	+ 0.133	0.517(NS)	+ 0.193	0.344(NS)	- 0.388	0.050(NS)
LAD V20 (%)	+ 0.029	0.890(NS)	+ 0.266	0.190(NS)	- 0.475	0.014(S)
LAD V30 (%)	+ 0.057	0.781(NS)	+ 0.301	0.136(NS)	- 0.431	0.028(S)
LAD V40 (%)	+ 0.632	0.001(HS)	- 0.152	0.458(NS)	- 0.043	0.836(NS)

r Spearman's rank correlation coefficient.
P< 0.05 is significant.
Sig.: Significance.

The magnitude of the association between heart and LAD radiation doses are shown in **Table 7**. For example, for every 1 Gy increase in mean heart dose, mean LAD dose increased by 4.24 Gy **Fig (1**) . For every percent increase in the heart V10 and V25, there was a 2.24 Gy and 3.74 Gy increase in the mean LAD dose, respectively **Figs (2, 3).** For every percent increase in the heart V40 a 5.06 Gy increase in mean LAD dose was noted **Fig (4),** and for every percent increase in heart V25 a 5.16% increase in the LAD V20 was demonstrated **Fig (5).**

Table (7): Linear regression analysis* for a magnitude of the association between various volumes and dosimetric parameters of heart and LAD, (N = 26 patients).

Variables	Mean Heart Dose & Mean LAD Dose	Heart V10 & Mean LAD Dose	Heart V25 & Mean LAD Dose	Heart V40 & Mean LAD Dose	Heart V25 & LAD V20
Β	4.24	2.24	3.74	5.06	5.16
R	0.838	0.793	0.781	0.711	0.652
R^2	0.702	0.630	0.609	0.506	0.425
Adjusted R^2	0.690	0.615	0.594	0.486	0.402
F	58.785	42.480	39.019	25.605	18.458
p-value (Sig.)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)

* Linear regression was done through the origin (no-intercept model): e.g. Mean LAD dose = β x Mean heart dose
β: regression coefficient; R: correlation coefficient; R^2: coefficient of determination;
F: Fischer ratio of ANOVA; Sig.: significance.
P < 0.05 is significant.

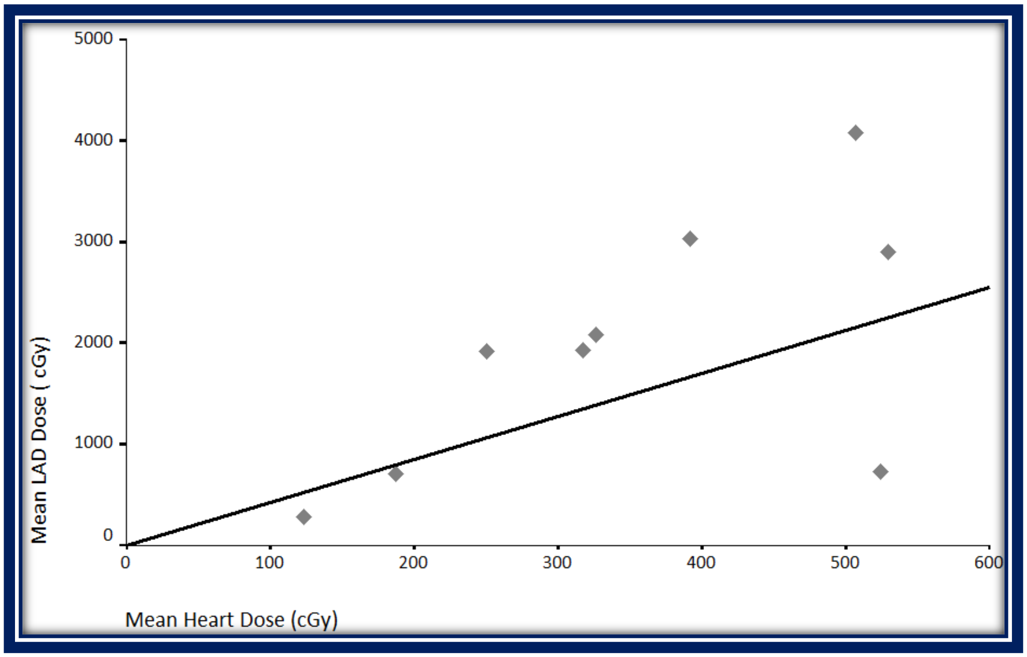


Fig. (2): Scatter plot with a regression line for a magnitude of the association between Mean Heart Dose (Gy) & Mean LAD Dose (Gy); Regression line equation: Mean LAD Dose (Gy) = 4.24 x Mean Heart Dose (Gy).
There is a significant direct correlation between mean LAD dose and mean heart dose with Regression line equation: Mean LAD Dose (Gy) = 4.24 x Mean Heart Dose (Gy).

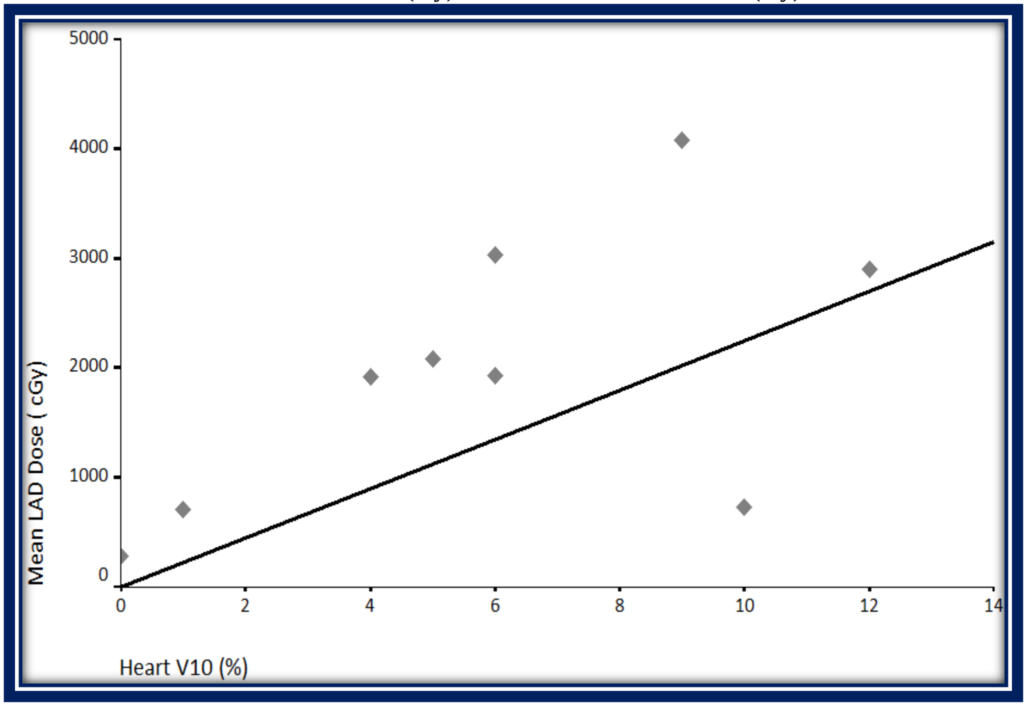


Fig. (3): Scatter plot with a regression line for a magnitude of the association between Mean Heart Dose (Gy) & Heart V10 (%); Regression line equation: Mean LAD Dose (Gy) = 2.24 (Gy/%) x Heart V10 (%).There is a significant direct correlation between mean LAD dose and Heart V10(%) with Regression line equation: Mean LAD Dose (Gy) = 2.24 (Gy/%) x Heart V10 (%).**Fig.(3)**

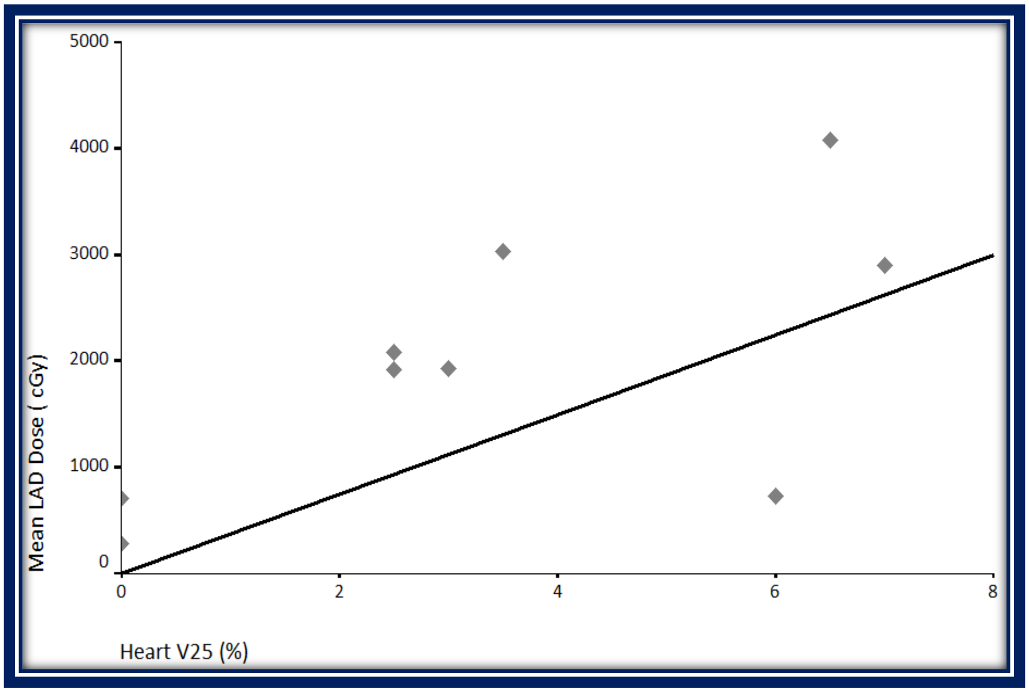


Fig. (4): Scatter plot with a regression line for a magnitude of the association between Mean heart dose (Gy) & Heart V25 (%); Regression line equation: Mean LAD Dose (Gy) = 3.74 (Gy/%) x Heart V25 (%).There is a significant direct correlation between mean LAD dose and heart V25 (%) with Regression line equation: Mean LAD Dose (Gy) = 3.74 (Gy/%) x Heart V25 (%).**Fig.(4).**

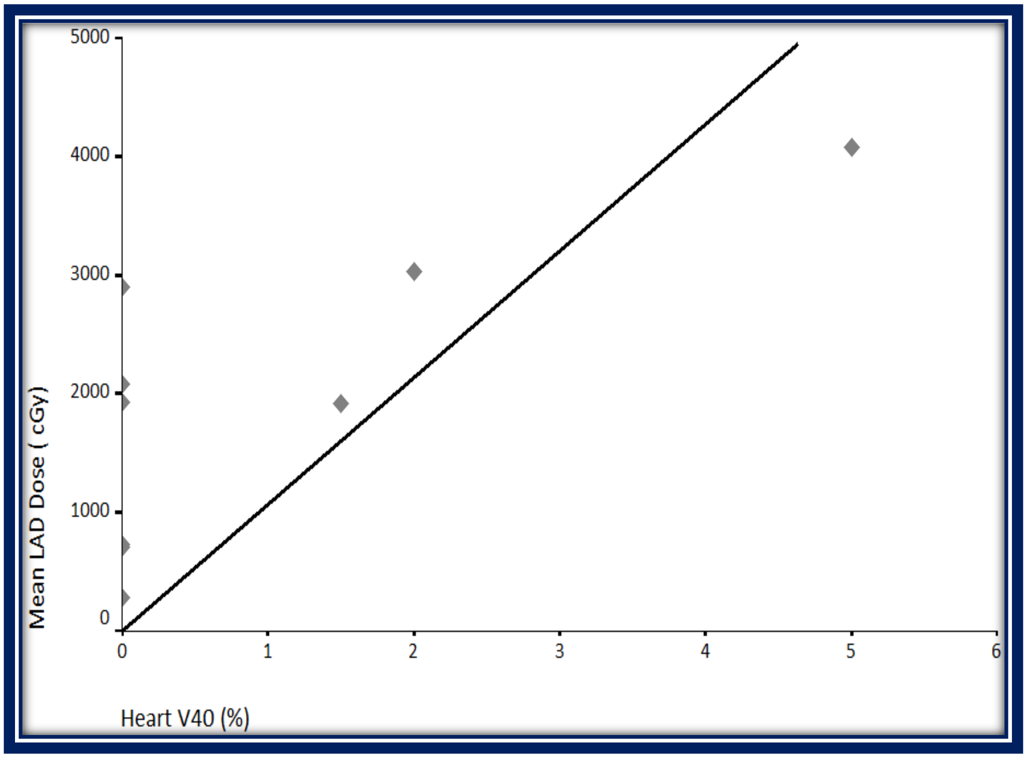


Fig. (5): Scatter plot with regression line for magnitude of the association between Mean Heart Dose (cGy) & Heart V40 (%); Regression line equation: Mean LAD Dose (Gy) = 5.06 (Gy/%) x Heart V40

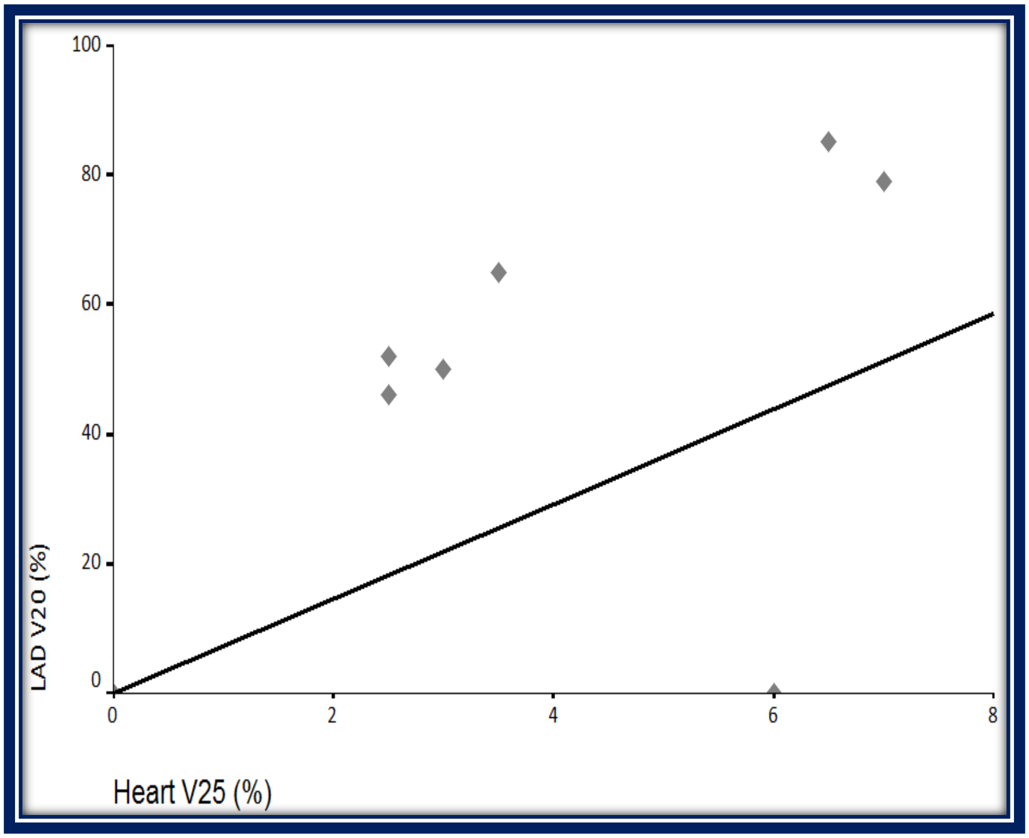


Fig. (6): Scatter plot with regression line for magnitude of the association between LAD v20 (%) & Heart V25 (%); Regression line equation: LAD V20 (%) = 5.16 x Heart V25 (%).

Discussion:-

Breast cancer is the most common malignant tumor in women worldwide; with more than 1 million new cases diagnosed each year. [8] Radiation therapy (RT) plays an integral role in the treatment of breast cancer. Lumpectomy followed by whole breast RT provides equal outcomes to mastectomy. [1]The use of RT after mastectomy or lumpectomy improves local control, overall survival, and breast cancer–specific survival, [1], the hazard ratio for death due to heart disease, secondary to radiation, is 1. 27%. [1] Although the incidence of cardiac events is low in the first 5 years of follow-up, it exaggerated by time and persist for fifteen years[1]. Radiotherapy is also associated with reduction in regional perfusion as evaluated by single photon emission computed tomography (SPECT) scans, in a manner consistent with microvascular injury, relatively soon after RT (e.g., 6 months to 5 years). [9]

Nilsson et al (2012)[2]reported that among all of the patients who treated with RT, those with left-sided breast cancer had a statistical significance increased rate of stenosis in the coronary artery branches on the left-anterior surface of the heart (the mid distal, and distal diagonal branch of the LAD) when compared with those with right-sided cancer.
Randomized trials that began in the 1950s to the 1980s have shown that adjuvant radiotherapy for breast cancer can reduce breast cancer related deaths in many groups of patients[10] .(However, many of the regimens used in these trials involved some unwanted irradiation to the heart, resulting in 27% (95% confidence interval [CI] 13–41%) increase in mortality from cardiac disease and reducing the beneficial effect of the radiotherapy on overall survival .[10]Radiotherapy regimens for breast cancer have differed since the women in these trials were irradiated, and the doses of radiation to which the heart is subjected are now generally lower.[11]Nevertheless, in most women, the heart still receives doses of 1 to 5 Gy.[11,12] Several studies have suggested that this level of exposure can cause ischemic heart disease.[13,14]The rate of major coronary events increased by 7.4% for each increase of 1 Gy in the mean radiation dose delivered to the heart (95% CI, 2.9 to 14.5; P<0.001) [15]. Our study included 26 patients with mean age of 47.80 ± 10.17. The mean heart dose was 3.4Gy and mean LAD dose was 15.78Gy, which is nearly similar to results obtained by **S. B. Evans et al (2013)**[16] which were3. 10Gy&17.98Gy respectively. The mean heart dose was

4.9 Gy (range, 0.03 to 27.72). In the study carried out by **Sarah C. Darby et al (2013)** [15] while in the study carried by **Taylor, et al (2006)**[17] the average mean (SD) dose was 2.3 (0.7) Gy to the heart and 7.6 (4.5) Gy to the LAD coronary artery. With our every 1Gy increase in mean heart dose, mean LAD dose increased by 4.24Gy. For every percent increase in the heart V10 and V25, there was a 2.24 Gy and 3.74Gy increase in mean LAD dose, respectively. For every percent increase in heart V25, a 5.16% increase in the LAD V20 was demonstrated. These results are nearly the same as **S. B. Evans et al (2013)** where, For every 1Gy increase in mean heart dose, mean LAD dose increased by 4.82 Gy. For every percent increase in the heart V10 and V25, there was a 2.23 Gy and 2.77 Gy increase in mean LAD dose, respectively. For every percent increase in heart V25, a 5.6% increase in the LAD V20 was demonstrated.

The current study was conducted to quantify LAD doses in patients treated with left-sided tangential breast radiation, to determine whether the LAD is a critical structure that needs to be independently contoured separate from the cardiac volume. This was achieved by analyzing LAD and heart dose and volume parameters to determine whether a significant correlation exists between the 2structures. The potential implications of finding non congruence between the LAD and heart volumes and doses would be potentially requiring contouring of the LAD, in addition to the

Heart and lung, in left-sided breast cancer cases to generate dose-volume histograms for clinical relevance. After consistent contouring of a series of 26 left-sided breast cancer patients, we demonstrated a significant correlation between whole heart dosimetry and LAD dosimetry does exist these findings are in accordance with **S. B. Evans et al (2013)** in which their contoured 50 left sided breast cancer patients. For clinicians wishing to minimize LAD dose, any maneuver that limits heart dose

While keeping standard tangent angles will decrease the LAD dose. These data suggest that specific LAD contouring or contrast-enhanced simulation are not necessary.The mean dose to the LAD in this study was 15.78Gy this is going with **S.B. Evans et al (2013)**,in their study mean dose to the LAD was 17.98 GY ,However **Taylor et al (2007)**[18.]reported a mean LAD dose of 7.6 Gy, their findings may differe from ours partially due to their use of accelerated,hypofractionated radiation and thus a total lower dose to the whole breast.Another explanation for this difference in mean LAD dose may be their technique of using a 1-cm expansion on the coronary artery to account for localization uncertainty of the vessel. In contrast, in our study, we segmented the vessel without expansion. As resting heart rates were a minimum of 60 beats per minute, there was certainly some cardiac motion from systole represented on our images, which lessens the need for accounting for localization uncertainty due to the cardiac cycle. Other series have attempted to correlate dosimetric and field metrics with LAD dose. **Taylor et al (2009)**[19] attempted to correlate maximum heart distance to LAD dose, with only weak correlations. **Storey et al (2001)**[20] examined changes in coronary artery doses with increases in perpendicular long distance. They found a relationship between perpendicular lung distance and LAD dose that we were not able to demonstrate in our current study **S. B. Evans et al (2013)** also didn't find a relationship between perpendicular lung distance and LAD dose.In conclusion, we found excellent correlation between cardiac doses and LAD doses, suggesting that for the vast majority of patients, contouring of the heart and utilization of stringent dose constraints to minimize the volume and dose delivered to the heart clinically correlates to minimization of dose to the LAD. Regarding acute side effects in our study heart toxicity wasn't noted probably due to the short time of follow- up (only 2 months after radiotherapy).

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