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A Comparative Dosimetric Study on Three-Dimensional Conformal Radiation Treatment and Multisegmented Conformal Radiation Treatment for Breast Cancer

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Abstract: The goal of this study was to elucidate if the field in field (FIF) technique can be utilized rather than the three dimensional conformal radio therapy (3D-CRT) technique in early breast cancer radiotherapy planning. Two different plans were implemented for 29 cases; one with 3D-CRT and the other with FIF technique. The mean integral doses using the two techniques for all studied patients were 70.91±23.9 and 74.28±24.9 in the FIF and 3D-CRT techniques respectively with nonsignificant difference ($p = 0.60$). The difference in V2 and V5 by the two techniques did not differ significantly as well ($p=0.8$). The delivery time of 3D-CRT plan was longer than FIF plan ($P < 0.01$) with a higher maximum dose for planning target volume (PTV) ($P < 0.0001$) and higher dose to organs at risk (OARs). The FIF technique improved dose distribution which was translated into less acute skin reactions.

Key words: Breast Cancer · Contralateral Breast · Field In Field Breast Technique · Integral Dose · Skin Dose · The Peripheral Dose

INTRODUCTION

Breast cancer has been accounted for as the most well-known cancer in females around the world. In patients with early stages, the standard treatment is local conserving surgery then radiotherapy to the entire breast or after mastectomy in high risk category [1].

One of the late reactions that have gotten expanding consideration in the most recent years is radiation induced [2].The most widely recognized secondary cancer is contralateral breast cancer, representing nearly half of every single second malignancy [3, 4]. Moreover, cardiac toxicity should be considered [5, 6]. One of the points in current radiotherapy is to minimize acute and late normal tissue reaction. One of the methods to reach this goal is by achieving sudden dose gradients between the target volume and the neighboring healthy tissues.

The radiotherapy for breast cancer has many techniques in different organizations one of them is the conventional breast irradiation. The beam arrangement consists of two opposing tangential glancing portals [7]. which permits adequate coverage of the breast tissue while limiting the dosage to the neighboring healthy structures [8].

Conventional hard wedge (HW) frameworks are generally used to decrease dose inhomogeneity because of extreme breast surface abnormality and tissue heterogeneity [7]. Wedge filters are typically produced using lead, steel or metal [9]. Despite the fact that the international commission on radiation units and measurements (ICRU) suggests that the field of planning target volume (PTV) inside the 95 and 107% isodose surfaces [10]. The radiation dosage homogeneity for radiation therapy utilizing this wedge is rarely accomplished.

Dosage inhomogeneity is affected by factors as the shape of the breast tissue, deviations between entry and exit points of the beam and source to skin distances. Inhomogeneity leads to a lesser cosmetic effect, breast pain and major fluctuation in the whole dosage conveyed

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to the resection site, especially in women with big breast tissue [11].

To enhance the isodose scattering, the technique by segment fields has been presented. The technique of segmented fields (Or field in field technique), likewise named forward IMRT technique, is a straightforward technique that can be performed with multi leaf collimator (MLC).There are numerous parameters to assess the plan quality, for example, conformity indices and outfield dose.

Another point of this work was ascertaining the skin dose of PTV for two techniques; skin dose due to electron contamination of the incident beam in addition to the backscattered radiation for photon and electron from the medium. When using x-ray and γ-ray beams in radiotherapy these radiations contaminated with secondary electrons, which originate from photon interactions in the air, in the collimator and in any other scattering material in the path of the beam [12].

The reduction in skin toxicity was related to the dose received by the skin PTV in the treatment of early breast cancer [8].

Our aim of this work was an improved breast treatment planning system by combing the advantages of 3D-CRT and intensity-modulated radiation therapy (IMRT), this had been performed with the FIF technique. The purpose of this FIF was to improved dose homogeneity and conformity on the PTV, reduced doses to the OARs, short treatment time and reduced the doses deposited outside the treatment volume.

MATERIALS AND METHODS

Patients: Twenty –nine patients with breast cancer were chosen randomly and treated in the Department of Radiotherapy. Among these patients, 8 patients had been already treated with a mastectomy and others had breast conservative surgery. Fifteen patients were right-sided cancer and the rest had left-sided. The average volume of PTV was 805.49cm3 (392.1cm3 - 2405.7 cm3).

During CT scanning patients were positioned supine on a breast board and the board angle was tailored based on each patient's anatomy with elevated ipsilateral arm. Patients were demarcated on the skin with a colored marker according to the physicians instructions where in this study the patients were demarcated with anterior and one lateral marks the images were transferred to the TPS (Treatment planning system) (Prowess panther) through a DICOM network5 or3 mm increment CT scans for all patients.

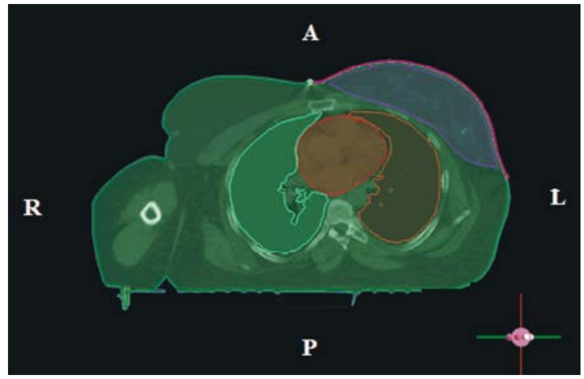

Fig. 1: PTV, OARs and skin delineation.

Contouring: Body and lung forms were made by a programmed contouring application of TPS. The PTV, heart and contralateral breast were defined. For the consistency of target volume and OARs, these were shaped by a skilled radiation oncologist. The PTV depended on the RTOG atlas [13]. The PTV was revised for being 5 mm under the skin surface (Fig. 1).

Treatment Protocol: Two different treatment techniques were thought about in this investigation. For each patient, 3D-CRT plan and FIF plan were composed on prowess (Version 5.1) treatment planning framework (Siemens Primus). The therapy was done with 6 MV photon beams from the linear accelerator with 58 multi leaf collimators (MLCs). For the dose computation calculation in every treatment design, pencil beam convolution was utilized. The Batho power law was utilized as the tissue heterogeneity correction method.

Three-dimensionalConformalRadiotherapyTechnique: In this conventional planning technique, the beam arrangement is comprised of two parallel opposing beams to accomplish the most ideal scope of the breast tissue and limit the dosage to the nearby basic structures. The "Isocenter" of the therapy machine is situated at center point of the midline joining two parallel opposing fields. The HW frameworks on both medial and lateral sides were used to conform the field shape to the target projection and MLCs were utilized to adjust the field shape to the objective projection. The dose was prescribed at a single reference point where 40Gy in 15 daily fractions of 267CGy given in3 weeks, the reference point was determined according to ICRU, which found the reference point should be to be localized both and near the center of the PTV, also on the beam axis in an area where the dose distribution is homogeneous but in some situations, the conditions do not allow for the ICRU reference point to be at the center as when treating the chest wall, where the center of the gravity of the PTV may be in healthy lung tissue. In this case, one has to select the ICRU reference point in side that tissues represented by the PTV.

The Field in Field Conformal Radio Therapy Technique: This technique was modified based on the original 3D-CRT technique. The gantry angles, collimator angles and primary field sizes of FIF were the same as those of 3D-CRT technique, but the wedge angles were removed (The same plan but without wedge filters) and were replaced with segments inside two fields the number of segments were 2-3 segments.

By viewing the dose distribution in axial cuts the hot regions were located at axial cuts and were determined on BEV after that the medial main field was copied as the first subfield; The MLCs were set to block the dose level at 1–2% lower than the D max Then dose calculation was performed. The beam weight of this subfield was added until the dose cloud disappeared.

Also the lateral main field was copied as the second subfield; The MLCs were set to block the dose level at 2–3% lower than the dose blocked at the first subfield then Dose calculation was performed again and the beam weight of this subfield was added until the dose cloud disappeared. When the hot spot such as110% and107% disappeared and distribution became optimized, the plan became final.in the case of the hot areas was still present, we must use another segment in medial or lateral fields. The beam weight of this subfield was added until the dose cloud disappeared.

Plan Quality

Dose Volume Histogram: The two techniques were thought about equitably utilizing the dosage volume histograms (DVHs) for PTV and diverse Organs at Risk (OARs) areas of concern. For PTV the qualities of (V107, V105, V95, V90, D95, D90, D98, D2,D5, Dmax, Dmean, Dmedium, Dmodel), were looked at for every one of these techniques. D2 (Dosage got by no less than 2% of the objective volume) and D98 (Dosage got by no less than 98% of the objective volume) are thought to be the close greatest and close least doses to the objective volume, respectively. For ipsi-lateral lung estimations of D-max, V mean, V5, V20; for heart, V mean, V5,V25,V30; and V2,V1.2,V0.4,Vmean,Dmax measurements for contralateral breast were assessed. Furthermore, D-max, V mean, measurements for skin dosage of PTV assessed and equated with measurement with PTV.

Conformity Index: Conformity index is described by RTOG (the Radiation Therapy Oncology Group) as

$$CI=V_{RI}/TV \tag{1}$$

where V_{RI} is for isodose volume and TV is a target volume [14].

A conformity index equivalent to 1 relates to perfect conformation. When it is more than 1 demonstrates that the irradiated volume is more prominent than the target volume and incorporates normal tissues, but if it is less than 1, the target volume is only halfway irradiated [15].

As indicated by RTOG rules, ranges of conformity index esteems have been characterized to decide the nature of conformation, as that an estimation of 1 is once in a while acquired. In the event that the similarity record is arranged between 1 and 2, treatment is considered to agree to the treatment plan; a list between of 2 and 2.5, or 0.9 and 1, is thought to be a minimum violation. Also, an index under at least 0.9 than 2.5 is thought to be a major violation [15].

However, this Index Presents a Major Drawback: It can never take into account the degree of spatial intersection of two volumes or their shapes. In extreme cases, it may be equal to 1 while these two volumes are situated away from each other and present volume and the volume delineated by an isodose or a fraction of this volume [14]. So we used another index called conformation number (CN) [14] a confirmation number to quantify the degree of conformity in brachytherapy and external beam irradiation was a good illustration example Calculation, of this CN simultaneously takes into account irradiation of the target volume and irradiation of healthy tissues

$$CN=TV_{RI}/TV\times TV_{RI}/V_{RI} \tag{2}$$

where:

RI : Reference isodose,

TV : Target volume,

TV_{RI} : Target volume covered by the reference isodose,

V_{RI} : Volume of the reference isodose.

Integral Dose: Although it is generally believed that the probability of damage to normal tissue increases with the increase in the integral dose, this quantity is seldom used with clinical attention. The integral dose was reported as the sum of all dose voxel times their mass [16] as shown in Equation 3.

$E_{integral}=N\times D_{mean}\times m_{voxel}$

$$E_{integral}=D_{body}\times D_{mean,body} \quad (3)$$

where, N: the number of voxels,
D mean: The mean dose to the body contour,
m voxel: The mass of a voxel.

Although for a proper evaluation of integral dose different density values should be considered for different structures, for the sake of simplicity a constant density ñ = 1 g/cm^3 was assumed for all structures.

Volume Receving2Gy and5Gy: Some models of radiation carcinogenesis suggest that the dose-response relationship is linear up until a dose 6 Gy, where it then reaches plateau [17]. The volume receiving 2 Gy and 5 Gy were reported in this study for each treatment plan.

Monitor Units: We estimated the treatment time by recording the monitor units (Mus).

Statistical Analysis: It was performed with SPSS version 18. Paired sample t-test, P < 0.05 was used for assessing the statistical significance of the difference between plan 1 and plan 2.

RESULTS

Dose Volume Histograms: Fig. (2A) shows the dose-volume histogram of PTV comparison of wedge versus FIF technique. Table (1) shows the mean values of PTV as shown in Table (1) FIF technique significantly decreased

Table 1: The PTV doses of the two different techniques 3D-CRT and FIF.

parameters	3D-CRT Mean±SD (%)	FIF Mean±SD (%)	P-value
D max	113.93±2.32	107.68+1.15	0.0001
D mean	102.35±0.92	99.97±0.42	0.0001
D medium	102.30±1.00	100.16±0.51	0.00001
D model	102.19±2.43	100.37±0.977	0.00051
D_{95}	96.13±0.81	95.5±0.40	0.00032
D_{90}	97.52±0.76	96.4±0.370	0.00001
D_{98}	94.41±0.98	93.3±0.80	0.00037
D_2	110.23±1.892	104.6±0.80	0.00001
D_5	108.85±1.75	103.8±0.68	0.00001
V_{95}	97.093±1.22	96.4±0.94	0.00084
V_{90}	99.65±0.25	99.2±.36	0.02102
V_{105}	24.81±9.51	1.2±2.02	0.00001
V_{107}	12.68±8.63	0±0.36	0.00001

V_n% volume receiving n Gy or higher
D_n% the dose received by n%
SD Standard Deviation
P value >0.05– not statistically significant
P value <0.05– significant
P value <0.000– high statistically significant

the mean values of D max, V105, V107, D2 and D5 compared with the conformal technique (p <0.00001). However the FIF technique reduced V95 compared with the 3D-CRT technique, the difference was less than 1%and two plans achieved that 95% of the volume of PTV received 95% of the prescribed dose of 40Gy.

Figure 2 (B and C) shows the dose-volume histogram of organs at risk and skin for two techniques, respectively. The mean values of OARs such as lateral lung, heart and contra lateral breast are described as shown in Table 2, where FIF technique reduced the doses that were received by these organs.

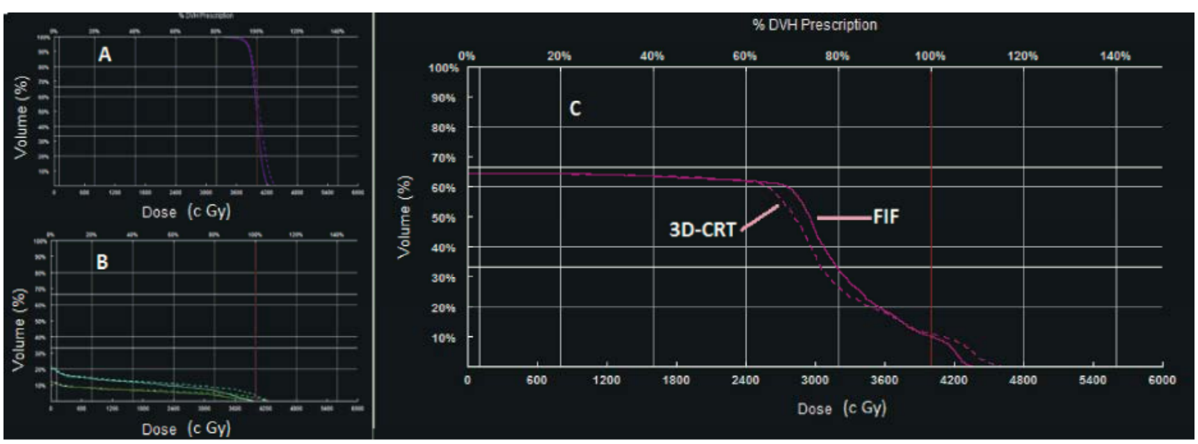

Fig. 2: Comparison of dose volume histograms (DVHs) (A) PTV for two treatment techniques. (B) OARs for two treatment techniques. (C) Skin OAR for two treatment techniques. Where solid line refer to FIF technique but the dotted line refer to 3D-CRT technique.

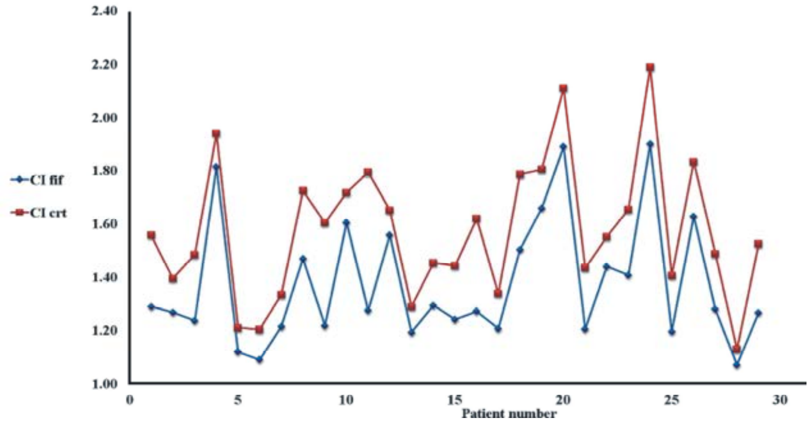

Fig. 3: Conformity index for two techniques.

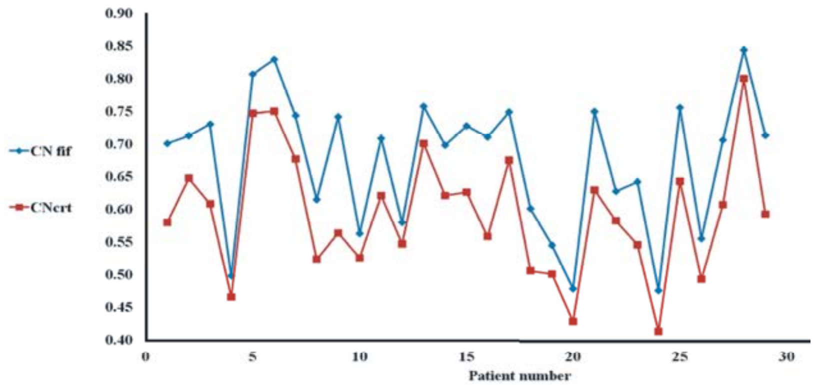

Fig. 4: Conformation Number for two techniques.

Table 2: Doses received by the organs at Risk of the two plans.

		3D-CRT	FIF	
		-----------------	-----------------	
Structures	Parameters	Mean±SD (%)	Mean±SD (%)	P-value
Ipsi lateral lung	D mean	11.04±4.41	10.19±4.31	0.458
	D-max	105.43±4.15	101.21±3.36	0.00004
	V20Gy	11.5±4.66	10.88±4.67	0.614
	V5Gy	14.39±5.18	14.09±5.13	0.821
Heart	D mean	3.80±2.51	3.44±2.30	.697648
	V30Gy	2.38±1.71	1.79±1.32	0.331
	$V25_{Gy}$	3.14±2.21	2.64±1.93	0.535
	V5Gy	5.69±3.79	5.54±3.78	0.917
	V20Gy	3.95±2.74	3.54±2.53	0.68638
Cont lateral breast (CC)	D mean	0.53±0.08	0.52±0.06	0.699
	D-max	83.37±133.56	67.65±108.63	0.625
	V2Gy	0.010±0.04	0.003±.02	0.412
	V1.2Gy	0.05±0.12	0.03±0.07	0.438
	V0.4Gy	0.30±0.0.61	0.21±0.44	0.557

P value >0.05 is not statistically significant, P value <0.05 is significant and P value <0.0001 is high statistically significant

Table 3: Organs at risk skin doses according to two treatment techniques

	3D-CRT	FIF	
	-----------------	-----------------	
Parameters	Mean±SD (%)	Mean±SD (%)	P-value
D max	113.57±3.40	107.09±2.624	0.00001
D mean	40.7±13.10	41.6±13.61	0.077006

P value >0.05 is not statistically significant, P value <0.05 is significant and P value <0.0001 is high statistically significant

Table 4: Indicates the CI & CN for two techniques (FIF and 3D-CRT)

	3D-CRT	FIF	
	-----------------	-----------------	
Parameters	Mean±SD (%)	Mean±SD (%)	P-value
CI	1.57±0.30	1.37±0.2	0.002798
CN	0.59±0.10	0.67±0.1	0.000728

P value >0.05 is not statistically significant, P value <0.05 is significant and P value <0.0001 is high statistically significant

Skin Dose: Table (3) & Fig. (2C) show the mean values of skin doses for two techniques. As shown in Table (3) FIF technique significantly reduced D max compared with the conformal technique (p <0.00001). Although the mean values of the skin dose of the FIF technique increased compared with conformal technique but not significantly (P- values=0.770).

Conformity Indices: Fig. (3&4) show the values of CI&CN between the two different techniques were improved using FIF technique. The difference was statistically significant as shown in Table (4).

Integral Dose: The means EI for two techniques were 70.91±23.9J and 74.28±24.9 for FIF and 3D-CRT

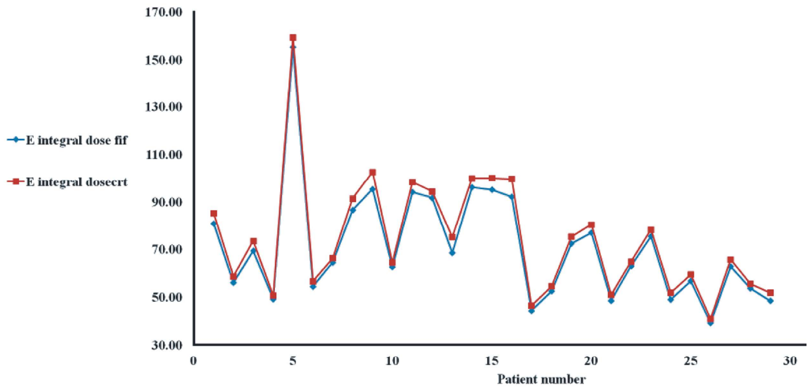

Fig. 5: The Integral dose for two different techniques.

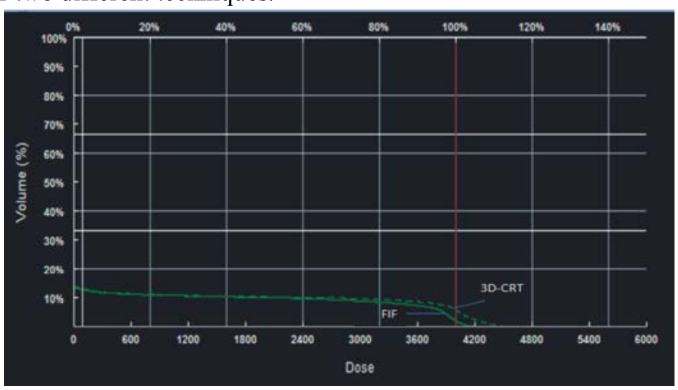

Fig. 6: DVH for help structure for two plans where the solid line refer to FIF technique and the dotted line refer to 3D-CRT for calculating v2&v5.

Table 5: The Integral dose for two different techniques

	3D-CRT	FIF	
Parameter	Mean±SD (%)	Mean±SD (%)	P-value
E integral	74.28±24.9 J	70.91±23.9J	0.601 NS

P value >0.05 is not statistically significant, P value <0.05 is significant and P value <0.0001 is high statistically significant

Table 6: TheV2Gy andV5Gy for two plans.

	3D-CRT	FIF	
Parameters	Mean±SD (%)	Mean±SD (%)	P-value
V2	11.59±2.13	11.5±2.13	0.868512NS
V5	10.52±1.94	10.6±1.96	0.809384NS

Table 7: Shows the monitour units for two techniques.

	3D-CRT	FIF	
Parameter	Mean±SD (%)	Mean±SD (%)	P-value
Total MUs	538.68±138.8	313.91±13.1	0.00001

P value >0.05 is not statistically significant, P value <0.05 is significant and P value <0.0001 is high statistically significant

techniques respectively. The differences were not statistically significant (p=0.60). Table (5) and Fig. (5) represent the integral dose in joule.

Volume Receiving 2 Gy and 5 Gy: The volumes that received 2Gy and 5Gy were calculated for all patients where the help structure of each patient had been delineated and became represented in the DVH as shown in Figure (6).Table (6) shows the mean values of V2 and V5for two techniques. The FIF techniques were reduced the volume that received 2Gy and5Gy but these values not significantly. P-value for V2 was (0.869) and for V5was (0.809).

Estimation of Treatment Delivery Time: Table (7) shows the MUs for two techniques and shows high lower significantly MUs for FIF p- value was (p <0.00001).

DISCUSSION

In this study we compared between two different techniques tangential breast irradiation. The two plans used DVH to assess the target coverage and normal tissue sparing and found that:

For PTV: To facilitate direct comparison between the competing techniques, the primary planning object was to

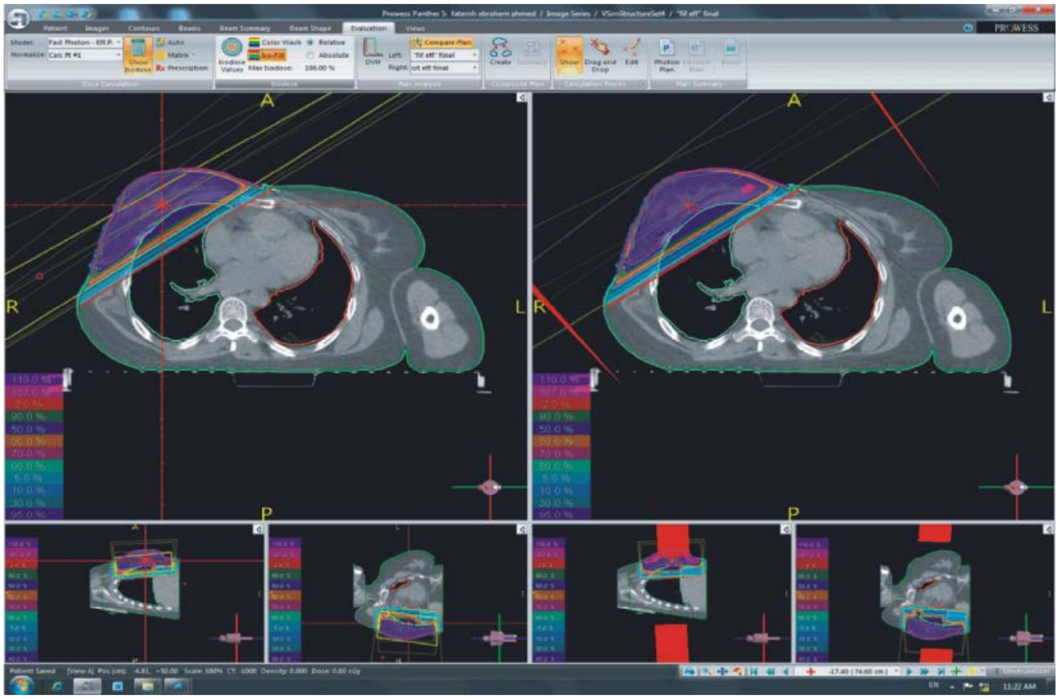

Fig. 7: The dose distribution for PTV and OARS for Axial, sagittal, coronal cuts for two plans. The right side represents FIF plan and left side represents 3D-CRT plan for atypical patient.

cover 95% of the volume of PTV by 95% of the prescribed dose. In this study we found that there were statistically significant in reducing D-max, D2, D5, D mean, D medium, D model and V105andV107 for FIF. This means that FIF improved the coverage and homogeneity inside the target volume as shown in Fig.2 (A). Fig. (7) Shows the dose distribution for PTV and OARs for Axial, sagittal, coronal cuts for two plans for atypical patient.

For OARs: The doses received by the ipsi lateral lung are very important in this study we found: The maximum dose of the ipsi lateral lung was significantly reduced with the FIF technique, More ever a D mean, V_5 (Represents the low doses received by lung) and V20Gy; was chosen based on prior analysis identifying this value to be an independent predictor of pneumonitis [18]. There were reduced in values for FIF technique but these values were not statistically significant.

In the case of the heart we used many parameters such as Dmean, V30, V25, V5, V20; the important parameter wasV30because the volume of the heart receiving doses more thanV30Gy was the cut off limit for the calculated risk of ischemic heart diseases [19]. We found that the FIF technique reduced the dose of the heart but not significantly.

In the case of the contra lateral breast the values decreased but not significantly for FIF. Due to the use of wedges for 3D-CRTespecially for medial tangential field so the scattered dose received by the contralateral breast.

Conformity Index and Conformation Number: However, for evaluating treatment plans only DVH parameters were used. Actually, although both plans have same high-dose volumes, this does not mean the two plans are similar, where the location of a high-dose region is not the same. For this reason, some other indices were required for evaluating the dose distribution within the target and also for assessing the healthy tissue doses. The CI and CN were used to achieve better dose distribution within the target dose and outside the target dose. Improved conformity may help to deliver higher doses to PTV without delivering more doses to surrounding normal tissues. Conformity has been described using both the CI (Equation 1) and the CN (Equation 2). It is known as the closer the CI value is to 1, the better the dose conformity so the conformity index (CI) for FIF plan better than the3D-CRT plan as shown in Table (4), it was also found that the healthy tissue conformity index is higher in FIF than in 3D-CRT that was 0.59for 3D-CRT and 0.67 in case of FIF which means that FIF achieve more normal tissue

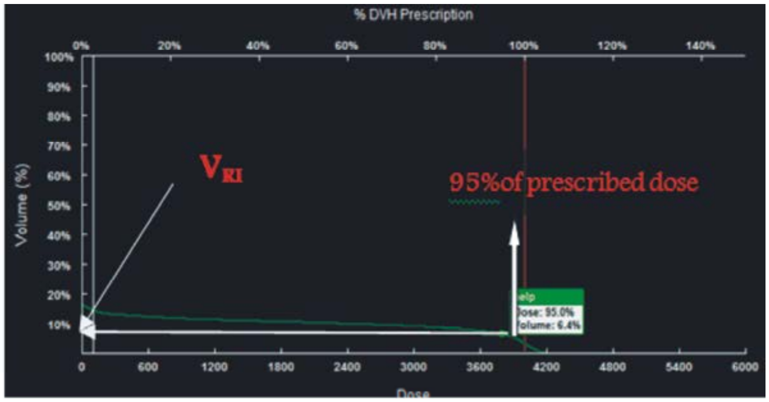

Fig. 8: Extraction the V_{RI} using the DVH of the help structure.

dose sparing than 3D-CRT. The values of the FIF as shown in Figs. (3&4) and table (4) were statistically significant. In our study we faced a major problem in the calculation of the CI&CN because the software did not support all the parameters required to calculate them. This problem had been overcome manually by calculation of the V_{RI} from help structure (To calculate all tissues enclosed by the external contour).An example to calculate V_{RI} (Assume 95% isodose line is the reference isodose) from DVH Fig. (8).

Integral Dose: The quality of the plan increases due to improve the conformity and reduce integral dose.as shown in Fig. (5) and Table (5) the FIF plan reduce the integral dose although the values not significantly but this difference might be clinically significant this mean that the FIF has highly quality plan.

Volume receiving 2 Gy and 5 Gy and Monitor Units: two asses the quality of two plans we measured the volume in cm^3 that receiving 2Gyand5Gy of the body(V2 &V5) and shown that the FIF technique had the lower volumes that receiving2Gy and5Gy.however the differences were not statistically significant but the differences might be clinically significant this reducing in these values because The 3D-CRT technique used wedges to improve the homogeneity inside the PTV but this lead to scatter components (Especially when the angle of this wedge increase the scatter component from the wedge also increase) resulting increased un wanted dose to the patients. So the FIF reduced the scattered dose to the patients due to replace wedges by segments fields, Another advantage in FIF technique is technicians do not need to reenter the treatment room after daily setup because the wedges are not used for the 3D-CRT technique MUs increased especially when the wedge angle increased due to decreased of wedge factor but in FIF technique, MUs are adjusted among the sub-fields and even an increase in the number of sub-fields won't have much change in MUs [9].The values that received 2 Gy and 5Gy reduced by using FIF technique as shown in Table (6).So the FIF technique had less peripheral dose also the peripheral dose decreased in FIF technique due to the less MUs. In the context of lack of literature on the radiation dose responsible for induction of secondary cancer, reduction of MUs may help to reduce the chances of occurrence of secondary cancer in radiotherapy [9]. So MUs were the biggest advantage of the FIF technique especially the difference was highly significant.

Skin doses of PTV: The beam obliquity has a large effect on the surface dose. The highest surface dose has been observed where the beam is more tangential to the surface. so in this study we took into consideration the skin doses of PTV as shown in Figure(2C) and Table(3) the maximum dose of the skin significantly decreased and the mean dose increased but not significantly. Some studies have shown that, the areas of large dose in homogeneities (>10%) may be related to significant radiation-induced, acute skin toxicity, including the presence of breast erythema with patchy desquamation and pitting edema [12]. So the toxicity of skin dose also decreases.

There are several studies in the literature comparing the dosimetry in the FIF and standard radio therapy in breast cancer cases. Prabhakar *et al*. [9] found that the FIF technique in the case of breast cancer reduced significantly D-max, D2, V107 and the CI improved significantly. Onal *et al*. [20] studied a dosimetric comparison for three techniques 3D-CRT (For lateral wedge and bilateral wedge) and FIF and they found that Contra lateral breast doses were significantly lower in the plan. The lung and heart doses and dose volume parameters were not significantly different for each plan The FIF plan significantly lowered MUs compared to both the single wedge and bilateral wedge plans. Gulyban *et al*. [21] found that for PTV The multi segmented (FIF) plan was significantly better target coverage and significantly reduced D-max for PTV, for OARs The mean OARs doses remained almost unchanged and The FIF technique significantly reduced MUs ($p>0.0001$). Yavas *et al* [6]. also found that the FIF technique significantly decreased D-max for PTV, MUs and OARs decreased significantly. Sasaoka and Futami [11] found that the FIF technique significantly reduced the D-max, V107of PTV_{eval} and reduced V95of PTV_{eval}, the OARs significantly decreased for FIF, The FIF significantly decreased grade II acute skin toxicity compared with the tangential field technique (3.1% vs. 10.6%) and MUs were significantly reduced by the FIF. Tanaka *et al*. [22] found that the FIF technique was useful in high tangent radiation therapy (HTRT) that intentionally irradiates the axillary lymph node region and improved homogeneity in the target.

In this study we found that the difference for heart and lung wasn't statistically significant although many other studies [7, 11] showed the difference was significant because in this study the subfields were used for reducing high dose region at the outer part of the target rather than with in the lung and heart, which may contribute to dose reduction with in the target volume.

There are several studies in the literature comparing the dosimetry in the FIF and standard radio therapy for other cases other breast [9, 23-25] and all these studies approved that the FIF plan was better than 3D-CRTplan, which improved the target coverage, reduced the doses for OARs and reduced MUs.

CONCLUSIONS

The conformity index, integral dose and the outfield dose are important aspects of plan quality, although they don't always receive clinically attention. Based on the data obtained in this study, we found the superiority of the FIF in conformity and lower volume that received 5 Gy and 2 Gy. The low MUs is the biggest advantage for the FIF technique.

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