



Original Research Article

Comparative study between conventional and field-infield techniques in early-stage breast cancer radiotherapy

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ABSTRACT

Introduction: “Breast cancer is one of the foremost reasons for cancer death in the fewer developed countries of the world. This is partially because a change in lifestyles it’s affecting growth in occurrence and partially because of clinical advances to combat the disease are not reaching women existing in these regions. Adjuvant radiotherapy given subsequent operation for primary carcinoma of the breast has been revealed to reduce the occurrence of locoregional reappearance from 30% to 10.5% at 20 years and breast cancer deaths by 5.4% at 20 years.

Materials and Methods: 40 patients by initial-stage breast cancer underwent calculated tomography. 2 diverse treatment strategies were created for each patient: the wedge-based (conventional) strategy and the FIF plan. Dosimetric parameters and monitor components were associated with paired sample t-test.

Results: FIF technique gained significantly lower dose homogeneity index, lower maximum doses, and higher median doses in PTV ($P < 0.05$). Similarly, the conformity index, and mean doses were higher in the FIF technique but the changes were not significant ($P > 0.05$). In ipsilateral lungs, FIF significantly reduced the maximum and mean doses ($P < 0.05$), and showed a tendency to reduce V20 ($P > 0.05$). In patients with left-sided breast cancer, minimum and maximum doses and V40 of heart were significantly decreased in FIF plans ($P < 0.05$). Doses to the contralateral lungs did not differ significantly.

Conclusion: These results along with significantly fewer monitor unit’s essential for therapy in FIF suggest that this technique may be more advantageous during breast irradiation.

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1. Introduction

“Breast cancer is one of the foremost reasons for cancer death in the fewer developed countries of the world. This is partially because a change in lifestyles it’s affecting growth in occurrence and partially because of clinical advances to combat the disease are not reaching women existing in these regions.¹ Adjuvant radiotherapy given subsequent operation for primary carcinoma of the breast has been revealed to reduce the occurrence of loco regional reappearance from 30% to 10.5% at 20 years and breast cancer deaths by 5.4% at 20 years. Radiotherapy is the normal action after

complete local cutting out of ductal carcinoma in situ (DCIS) and present trials are assessing its role in little risk patients linked with operation alone.²

In the traditional 3DCRT breast radiation method, the beam technique encloses 2 reverse outlying oblique gateways³ which lets suitable care of the breast tissue through decreasing the dose to the neighboring thoughtful structures (i.e., ipsilateral lung, contralateral breast, and heart). Physical or active blocks are usually added to these outlying waves in command to return for continuous differences in outer frameworks and to improve the dose constancy to the whole breast. The probability of contralateral breast cancer has remained reflected in current studies,⁴ which highlight the requirement for the reduction

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of radiation dose to the contralateral breast using physical wedges, escaping cerrobend part ray blocks, and using unequal jaws and few method of strength change.⁵ Dose-related disease because of radiation of heart tissue has been informed in a rare study before.⁶

In reverse Calculated Strength Moderated Radiotherapy methods directing to produce a constant dose distribution in the complete mark capacity however defending the dangerous organs have been recommended.⁷ To achieve this, the capacities of attention (Aim and dangerous organs) are generally defined and a capacity-based optimization is made, balancing the incompatible necessities of the goal and dangerous organs. This method can yield greater outcomes, while related to average stuck rays.⁸ Numerous solo institute findings and two randomized trials for breast cancer has been conveyed that IMRT develops the dose similarity and declines the critical skin deadliness as well as the dose to contralateral breast associated with conventional peripheral methods with wedges.⁹

Accelerative IMRT for breast radioactivity has been earlier defined by other agents. It is a very basic procedure of IMRT with only some divisions per field, whose figure and weight are improved by the dosimetrist in instruction to accomplish the best-standardized dose delivery to the target.¹⁰ A dosimetric evaluation among multi-segmented conformal radioactivity treatment and 3DCRT with weight-improved medial and side exposed fields in a huge group of unselected patients. The authors determined that multi-segmented conformal radiation treatment providing an enhanced aim treatment than 3DCRT with exposed fields.¹¹ Initial assessment of acute noxiousness of advancing IMRT for breast radioactivity along with a modest dosimetric evaluation of dose delivery inside the aim in the complete patient population have newly circulated.¹²

The target of this task is to associate preparation effectiveness stated in dosimetric goals used to progress the therapy plan between FIF, Forward Strategic IMRT and Reverse Strategic IMRT to obtain the best strategy for Breast Cancer therapy.

2. Materials and Methods

40 patients with initial-phase breast cancer (18 left-sided and 22 right-sided) were registered in the reflective study. The patients' appearances are registered in Table 1. All patients have suffered breast-conserving operation previously being presented to the radiotherapy division. Only patients with initial-phase breast cancer without any lymph node participation or unfriendly metastasis remained involved in this study, i.e. patients with phase 0 (Tis, N0, M0), phase I (T1, N0, M0), and IIA (T2, N0, M0) who were established over pathological examinations. All patients with lymph node participation or distant metastasis remained omitted. The capability to raise the arms and to uphold this situation through regular treatment was an

additional standard for participation in this study.

All patients undergone computed tomography (CT) with a 16-slice Neusoft CT simulator (Neusoft Corporation, China). In the development of CT imaging, patients were cited in the same way as the treatment room position through irradiation (prostrate position through hands up, using a breast board to uphold the position). The whole breast and thorax of individual patients were scanned with a 2/5 mm slice thickness in free-living mode. The CT datasets were formerly transmitted to the DOSI soft Isogray (DOSIsoft, Paris, France) treatment planning system (TPS) via digital imaging and communication in medicine connection system (DICOM).

Table 1: Patients characteristics

	Mean Values \pm SD*	Range
Age (years)	49 \pm 7.1	41- 60
Weight (kg)	74 \pm 12.3	51- 95
BMI	29.1 \pm 4	21- 39
Left Side Lesion	22 (55%)	-
Right Side Lesion	18 (45%)	-
Stage 0	8 (20%)	-
Stage I	24 (60%)	-
Stage IIA	8 (20%)	-

SD: standard deviation; BMI: body mass index. *Statistically significant

The clinical target volumes (CTVs) and the PTVs of cancers as well as the outlines of the OARs (including the heart and lungs) were defined by the same oncologist in line with the International Instruction of Radioactivity Components and Measurements (ICRU; reports 50 and 62) strategies. Skin shapes were mechanically defined with TPS. All the remaining breast tissue after the operation procedure was considered as the CTV. The PTVs were made with a 5-mm extension of the CTVs excluding the front part. Subsequently, section-based (conventional) and FIF treatment plans were planned by the same medical physicist for each patient.

In the conventional plan, 2 opposite fields conformal to the breast were calculated to completely cover the PTV. To decrease in regular doses within the PTV, hard sections on the medial and the lateral sides were used. Severe breast surface irregularities which can cause inhomogeneity were usually detected in the PTV. Therefore, to attain the most constant and regular dose distribution within the objective volume, wedge approaches were operated over trial and error procedure. The gantry approaches were determined using the Beam's-eyeview ability of TPS by engaging the healthy OARs out of the exposed field as much as possible. A replica of the section-based strategy was defined by eliminating the sections to transmit out the main computation on the FIF strategy with 2 similarly weighted, open, and peripheral fields with a similar gantry angle as that used in the straight method. Dose circulation and hot/cold

spot areas were resolute using TPS. 2 or 3 subfields were formerly added up to recover the dose similarity in the PTVs while reducing the OAR doses. Finally, the main field and the related subfields were merged into one portal.

The regular treatment dose for individual patients was 2 Gy/portion with 25 portions total to define the best dose circulation while dropping the doses of the OARs in each strategy. The mention point was easily moved over the PTV. All tactics were considered with a fact kernel (bent cone) procedure, spending the DOSI soft Isogray TPS. All tactics were calculated by the same medical physicist, after discussion with another physicist in tough cases. The tactics were tested and confirmed by a skilled oncologist. The Dose-volume histograms (DVHs) were intended for the PTVs, the heart, the ipsilateral lungs, and the contralateral lungs for individual treatment strategy in all patients (heart DVHs were measured only in left-sided breast cancer cases). Dose homogeneity index (DHI) was employed to assess dose homogeneity in the PTVs. This index could be used to associate dose tolerance inside the PTVs among conformists and the FIF methods. The numerical value of DHI was calculated with the equation (1)¹³

$$\text{DHI} = \frac{D2 - D98}{\text{Prescription Dose}} \quad (1)$$

In this equation (1), D98 mentioned to the dose received by 98% of the PTV on the increasing DVH, representing that 98% of the target capacity received this dose or a higher dose. Consequently, D98 is considered the "minimum dose." D2 is the dose received by 2% of the PTV on the increasing DVH, representing that only 2% of the target capacity received this dose or a higher dose. So, D2 is considered the "maximum dose." Lower DHI values represent more unvarying dose distribution within the target capacity.¹⁴ One more index used in this study was the PTV dose improvement (PDI) or the proportion of the PTV receiving 97%-103% of the agreed PTV dose. This index has been used to calculate enhancement in the PTV dose treatment when wedges or subfields were associated to open fields without ray transformers. Higher PDI values validated healthier development in the PTV dose treatment. Conformity index (CI) or the ratio capacity limited by medicine isodose to the target capacity was also examined.¹³ Median PTV doses (D50) were extracted and equated as per ICRU approvals (reports 50 and 62).¹⁴ The Maximum, minimum, and mean PTV doses were also calculated. DVHs were determined for the ipsilateral lungs, the contralateral lungs, and the heart (in left-sided cases). Minimum (Dmin), maximum (Dmax), and median (D50) doses for these tissues have been measured and compared among the conventional and the FIF strategies. The V40 of the heart (in left-sided breast radioactivity) and the V20 of the ipsilateral lung have also been compared. The MUs required for each plan have also been calculated. Preparation density and the number of portals resolute the MUs and the treatment time. This procedure might

be stimulating, particularly in old age patients, for whom continuing the treatment position for a long duration is unbearable. All statistical examines have been performed using IBM SPSS software version 22. The Normality of data circulation have been calculated by SPSS routine test (Kolmogorov – Smirnov test) and then, paired sample t-test was employed to associate the mean value of the stated indices. The consequence level was set at $p < 0.05$.

3. Result

40 patients with initial-stage breast cancer (18 right-sided and 22 left-sided) have been registered in the current study. The mean capacities and the average deviations of the PTVs and the OARs are explained in the given Table 1.

An evaluation of dosimetric factors for PTVs among the conventional and the FIF methods is shown in Table 2. The FIF strategy presented in a sufficiently lower DHI values (0.16 vs. 0.18, $P=0.006$), lesser maximum doses (49.97 vs. 52.12 Gy, $P=0.0002$), larger volumes receiving 97% and 103% of the given doses ($P=0.0001$ and 0.01, correspondingly), and median doses (47.59 vs. 47.43 Gy, $p=0.04$) associated to the conventional method. The CI, the mean of dosages, and the volumes getting 95% of the prescribed method, but the variances were not significant ($P>0.05$). PDI was equal in both groups.

Dosages received by the OARs with ipsilateral lung, the heart (in left-sided breast radioactivity), and the contralateral lung are shown in Table 3. In the ipsilateral lungs, the FIF method condensed the maximum and the mean doses significantly ($P<0.05$) associated with the wedge-based method and presented a propensity to decrease the V20 and the least dosages ($P>0.05$). In patients by left-sided breast cancer, the least and the highest dosages to the heart are knowingly reduced in the FIF plan ($P<0.05$). Additionally, the V40 of the heart was knowingly reduced in the FIF method. FIF also led to a decrease of the mean dosage to heart, but the variation was not substantial ($P>0.05$). In the contralateral lungs, the standards displayed no substantial variances ($P>0.05$).

4. Discussion

The gold regular treatment for initial-stage breast cancer is a conventional operation followed by RT.¹⁵ RT can upsurge the patient's existence rate by 4.8% and decrease the probabilities of recurring distortion by 19.7% over 20 years.¹⁶ Though, despite the compensations of postoperative RT in breast cancer patients, it may lead to several difficulties. These late contrary effects are associated with dosage inhomogeneity that can be produced by numerous influences such as the unusual shape and big size of the breast.¹⁷ Numerous RT methods with the wedge-based method and the FIF method has established to confirm homogenous dosage delivery inside the target

Table 2: Volumes of planning target volume and organs at risk

	Mean Volume (cm ³) ± SD	Maximum	Minimum
PTV	953.6 ± 149.3	1973.2	395.6
Ipsilateral Lung	1059.6 ± 210.3	1420.2	609.2
Contralateral Lung	1021.1 ± 210.3	1431.2	593.6
Heart	549.3 ± 93.7	762.1	437.6

SD: standard deviation; PTV: planning target volume

Table 3: Comparison of dosimetric parameters for planning target volume

	Wedge Plan (Mean ± SD)	FIF Plan (Mean ± SD)	p- value
DHI	0.18 ± 0.02	0.16 ± 0.04	0.006
CI	0.87 ± 0.003	0.89 ± 0.002	0.07
PDI	0.61 ± 0.12	0.61 ± 0.19	0.13
Mean Dose (Gy)	41.96 ± 3.69	41.23 ± 3.21	0.51
Max Dose (Gy)	52.12 ± 3.12	49.97 ± 3.65	0.0002
Min Dose (Gy)	27.32 ± 3.54	25.34 ± 3.57	0.038
Median Dose (Gy)	47.43 ± 3.58	47.59 ± 3.86	0.04
D2 (Gy)	49.47 ± 3.69	50.12 ± 3.73	0.06
D98(Gy)	43.46 ± 3.62	42.12 ± 3.59	0.04
V95% (cm ³)	862.63 ± 124.38	863.58 ± 121.53	0.31
V97% (cm ³)	764.29 ± 94.23	831.43 ± 98.49	0.0001
V103 (cm ³)	231.48 ± 63.59	294.49 ± 74.23	0.01

SD: standard deviation; PDI: planning target volume dose improvement; DHI: dose homogeneity index; CI: conformity index; D2: dose received by 2% of the PTV on the cumulative dose-volume histograms; D98: dose received by 98% of the PTV on the cumulative dose-volume histograms. *statistically significant Vx%: volume of tissue receiving x percent of the prescribed dose.

Table 4: Doses to organs at risk

	Wedge Plan (Mean ± SD)	FIF Plan (Mean ± SD)	p- value
Ipsilateral Lung			
Min Dose (Gy)	0.17 ± 0.11	0.16 ± 0.12	0.07
Max Dose (Gy)	49.03 ± 3.32	47.42 ± 3.65	0.0001
Mean Dose (Gy)	8.01 ± 1.38	7.34 ± 1.81	0.01
Lung V20 (%)	14.65 ± 3.12	13.65 ± 3.64	0.34
Heart (in left-sided breast irradiation)			
Min Dose (Gy)	0.46 ± 0.11	0.42 ± 0.12	0.02
Max Dose (Gy)	47.34 ± 3.65	43.65 ± 3.25	0.0002
Mean Dose (Gy)	7.11 ± 1.34	7.26 ± 1.65	0.15
Heart V40 (%)	6.54 ± 1.65	5.87 ± 1.79	0.02
Contralateral Lung			
Min Dose (Gy)	0	0	-
Max Dose (Gy)	2.54 ± 0.58	2.89 ± 0.47	0.09
Mean Dose (Gy)	0.19 ± 0.03	0.16 ± 0.02	0.14

capacity and to spare strong tissues close to the tumor.¹⁸ The conventional method, where 2 opposite peripheral arenas with wedge filters are applied, usually improves dosage delivery. This method is described to deliver brilliant local control with rare long-term difficulties.¹⁹ Though, one essential difficulty of the conventional method is that increasing the wedge viewpoint leads to a better scatter module from the wedge, managing additional dosages to the patient.²⁰ Additionally, growing the wedge angle in a peripheral field RT might upsurge the dosage in the central and the lateral beam entries. Consequently, inducing high dosage areas produced by wedge filters is

predictable.²¹ Numerous studies have showed that dosage circulation through WBRT can be enhanced along with the FIF method.²² In this method, another subfield is added to the main field by engaging a multi-leaf collimator (MLC) instead of wedge filters. The main fields and the comparative subfields are consequently combined in one gateway. In the FIF method using MLC scatter dosages controlled to the patient can be reduced associated with those in the conventional wedge-based methods. The FIF method decreases the quantity of MUs and the entire treatment time. Moreover, few hotspot areas that persevere in the conventional methods and the additional time needed for

contracting the wedge can be avoided.²³

In a study led by Barnett GC et al. (2009), 40 following patients with left-sided breast cancer suffering BCS were registered. 2 diverse treatment strategies (FIF and conventional) were considered for individual patients and the dosimetric parameters were calculated. The FIF method provided improved dosage circulation in the PTV and reduced the mean dosages of OARs. The MUs needed for the treatment were also knowingly reduced. Therefore, it was determined that the FIF method was more effective in the entire breast radioactivity.²⁴ Lingos TI et al. (2011) used dosimetric indices parallel to those in the current study to associate the FIF and the wedge-based methods in breast radioactivity between 40 patients.²⁵ Their outcomes were reliable with the study executed by Barnett GC et al. (2009). Associated with the wedge beam method, the FIF method enhanced the DHI by 18% and condensed the required MUs by 22%.²⁴

McParland BJ et al. (2011) directed a study and found reversing outcomes with the previous declared studies. 2 diverse FIF and wedge filter methods were associated and 3 indices (homogeneity, conformity, and uniformity) along with dosages of the OARs were calculated. The outcomes specified that the wedge-based method offers a knowingly lower DHI and a knowingly advanced CI than the FIF method. It was settled that the FIF method has no greater dosimetric benefit over the conventional method in breast radioactivity.²⁶

In the current study, the similar indices as the ones used by Wallgren A. (2012) were employed. The outcomes exposed that the FIF method was more active than the wedge-based method in mean of DHI, CI, middle dosage (D50), maximum dosage, dosages of the OARs, and MUs. DHI was knowingly condensed by 7.7% in the current study (0.167 and 0.154 for the conventional and FIF methods, correspondingly and $p=0.005$).²⁷ This discovery was reliable with the earlier stated studies excluding the study by Das IJ (1997).²⁸ Lower DHI represents lesser dosage variations within the target capacity. CI was greater in the FIF method, but the variance was not statistically significant. The FIF method also condensed the maximum dosage and enhanced the D50, which was reliable with the earlier studies. PDI was employed to calculate the development in the dosage delivery in the treatment strategies with physical wedges or the FIF method associated to open field methods without any beam modifiers. Lee et al. (2008) set dosage stages consistent with PDI indices of 97%-103% even though most of the earlier studies used PDI indices among 95%-107%. The previous was more hard and precise, as exposed in the current study. Though, contrary to the findings of Xiao Y al. (2008), the current study perceived no significant variance.²⁹

The dosage of the OARs is added standard for selecting an improved method in RT. In contract with the outcomes of added studies, the mean dosages established by the

ipsilateral lung were knowingly been condensed by 5% ($p=0.02$). The V20 of the ipsilateral lung and dosages to the contralateral lung have also condensed in the FIF method. However, the variances are not statistically important. Additionally, associated with the conventional method, the FIF method knowingly condensed the V40 of the heart by 14% ($p=0.03$). The higher dosage got by the heart (in left-sided radioactivity) was also knowingly reduced in the FIF method by 4% ($p=0.0002$). The FIF method declined the mean dosages to the heart (in left-sided radioactivity), but the variance was not statistically important. The MUs needed for individual methods have also fallen in the FIF strategies by 33% ($P<0.0001$). Same as the results of Jursinic PA et al. (2007), studies, the variances in the MUs among the 2 methods are extremely important ($P<0.0001$). The MUs are condensed due to their alteration among the subfields in the FIF method. Treatment time can be saved due to the decrease of MUs and wedge-less treatment preparation, as there was no requirement for the RT specialists to re-enter the treatment room after regular setup. Additionally, there was no pretreatment quality declaration process in the FIF method, which was important for IMRT. Due to these compensations, FIF is a simple, possible, helpful, and time-saving method.

It is proposed that upcoming inquiries associate the FIF method and the conventional RT in other cancers as well as in numerous types of TPS systems.

5. Conclusion

The FIF and the wedge-based methods were dosimetrically and clinically measured in the current study. Dosimetric outcomes are evidently in favor of the FIF plan. The FIF method with MLC accomplished extra homogenous dosage delivery through the goal volume while it condensed dosages to the nearby healthy tissues. Considering these outcomes and also the knowingly fewer MUs essential for treatment, the FIF method appears to be added beneficial than the conventional method through WBRT.

6. Source of Funding

None.

7. Conflicts of Interest

None.

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