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Dosimetric Comparison between Intensity Modulated Radiotherapy versus Volumetric Modulated Arc Therapy Treatment Plans for Breast Cancer

Rahman Mahfuzur*

Department of Radiation Oncology, Enam Medical College and Hospital, Savar-1340, Bangladesh

***Corresponding Author:** Rahman Mahfuzur, Department of Radiation Oncology, Enam Medical College and Hospital, Savar-1340, Bangladesh. Tel: +8801617884554, E-mail: mafuzrana348@gmail.com

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Abstract

Purpose: This study compared the dosimetric characteristics of Intensity-modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMAT) techniques regarding target volume coverage and dose to heart, spinal cord, and lung for patients with breast cancer. We analyzed the dosimetric differences of plans in the treatment planning system (TPS) between IMRT and VMAT in treating breast cancer. The aim of this study is to compare the dosimetric aspects of IMRT plans with VMAT according to EMAMI, QUANTEC, and RTOG protocols.

Method and Materials: Treatment plans were analyzed for 30 patients. Patients were treated with a technique that concurrently combines IMRT beams and the VMAT technique. IMRT treatments are generated using 4 tangential fields IMRT and VMAT plans were made with one arcs field for the same patients. IMRT and VMAT treatments plans were planned for 5000 cGy in 25 fractions. All treatment plans were planned due to protocols & the patient's condition. The VMAT and IMRT plans were compared using the planning target volume (PTV) dose and doses to the other organs at risk (OARs). Comparative endpoints were dose homogeneity within PTV, target dose coverage, doses to the critical structures including heart, lungs, and the contralateral breast, number of monitor units, and treatment delivery time. Both plans were optimized to Dose-volume histograms values. DVH were calculated for the planning target volume, heart, lung, spinal cord, and breast.

Result: The IMRT & VMAT average mean heart dose was (cGy), V30 (%) and V33 (%) for the heart were 453.7±75.5,0.85%±0.06% and 0.19%±0.017% by VMAT, and 421.7±48.6 ,0.25%±0.11% and 0.016%±0.011% by IMRT, respectively. The left lung mean dose (cGy), V10 (%), V20 (%) were significantly reduced from 1459.5±36.99, 36.5%±0.96% and 19.1%±0.51% with VMAT to 1356.2±48.77, 35.7%0.49% and 18.27%±0.64 with IMRT, respectively. The mean dose to the contralateral breast was 244.16±16.29 cGy with VMAT and 45.2±2.01cGy with IMRT. The mean dose (Gy), 0.03 cc for the spinal cord were by 1 872.6 ± 25.64 cGy VMAT, and 872.6 ± 25.64 cGy by IMRT, respectively.

Conclusion: IMRT plans showed significantly higher mean dose coverage to the PTV than that of VMAT plans. The IMRT plans typically had more favorable dose characteristics to the lung, heart, spinal cord and body dose when compared with

VMAT. The target of IMRT plans has better conformity, homogeneity when compared then the VMAT. The main important advantage of VMAT is MU & treatment delivery time less than IMRT.

Keywords: Breast Cancer; Radiotherapy; VMAT; IMRT

Introduction

Breast cancer is the most frequently diagnosed cancer among women in 140 of 184 countries worldwide. About 1.2 million women are newly diagnosed with breast cancer each year in the world, and 500,000 women die of it each year. Most of these tumors arise between 45 to 65 years. It is also the principal cause of death from cancer among women globally. Therefore, breast cancer remains the primary cause of cancer mortality in women after lung cancer [1]. Breast cancer can be treated using a multimodality approach to surgery, chemotherapy, radiotherapy, and targeted therapy [2]. The therapeutic techniques for breast cancer vary. Traditional 3D conformal radiotherapy (3D-CRT) uses the tangential fields method, in which it's difficult to achieve treatment target conformity and uniform dose distribution and leads to more irradiation around the target or normal tissue like the lung and heart and mores tissue damage and complications [3]. IMRT uses a multi-leaf collimator (MLC) and inverse treatment planning to modulate beam flux intensity to improve target conformity and lower irradiation dose to critical organs [4]. VMAT is a technique that uses single or multi-arc rotating irradiation. During irradiation, position, speed, beam dose rate, and gantry rotation speed on MLC can be modulated to achieve higher target conformity and treatment efficiency [5]. The planning target volume (PTV), the outcomes of various treatment planning techniques could be different. For instance, a PTV only with a breast is relatively simpler than the PTV with the chest wall, internal mammary (IM), and Supraclavicular (S/C) field. The conventional 3D plan is more common if the PTV includes only the breast and in such cases, two tangential fields along medial and lateral direction can be used to minimize the irradiation to the underlying normal tissues [6].They investigated the number of beams necessary for optimal dose coverage of the breast and found that 4-5 field IMRT was the best choice. A newer technique known as VMAT was introduced in 2007 as a novel extension of IMRT, in which an optimized three-dimensional dose distribution could be delivered in a single gantry rotation. Compared to IMRT planning, VMAT resulted in even better Planning Target Volume (PTV) coverage and sparing of OARs than IMRT [7]. IMRT, it is possible to reduce the volume of the lung irradiated to full doses by tangential fields, and in left-sided cases, the heart can also be partially spared. Several publications on this topic have discussed the advantages and disadvantages of IMRT & VMAT [8]. The use of IMRT is receiving increased attention as an advanced technique in radiotherapy for fast delivery treatment with improved dose distribution and better normal tissue sparing, with fewer monitor units and shorter delivery time. To identify and characterize dosimetric differences between VMAT and IMRT techniques for breast cancer, we analyzed the calculated dose characteristics of VMAT and simulated treatment plans of IMRT in 30 breast cancer patients. [9].For this analysis, we assumed a similar mean dose within the target produces similar tumor control with these two techniques. The IMRT resulted in even better PTV coverage than VAMT. The IMRT has the potential of lowering the radiation doses to the OAR while improving the conformity and homogeneity to the tumor compared with VMAT. The VMAT has fewer monitor units (MUs) compared with IMRT. To master the application of IMRT with better efficacy, we investigated the dosimetric difference between the VMAT and IMRT in patients with breast cancer in the present study.

Materials and Method

Patient Selection

Thirty patients were enrolled in this retrospective study under an Institutional Review Board-approved protocol. These patients had left-sided, early-stage invasive mammary carcinoma (pT1N0M0), and underwent breast-conserving surgery followed by radiotherapy at the hospital between February to October 2021. Patients between 35 and 45 years old, with the adequate function of the lung, heart, kidney, and hematopoietic system were considered eligible for the study. Patients with positive axillary or Supraclavicular lymph nodes and distant metastasis were excluded from the study. All patients were immobilized in the supine position with the arm abducted (90° or greater) on the disease side.

A computed tomography (CT) scan with 5 mm slice thickness was acquired for each patient, with coverage from the mandible to 4–6 cm below the inframammary fold to cover the entire lung volume. CT scans range from the mandible to the thorax, which completely covers all the adjacent normal tissues and organs such as the lung, heart, opposite breast, and spinal cord, etc. The clinical target volume (CTV), including the whole ipsilateral chest wall and lymph node region around the collar bone, was outlined by using the Varian eclipse 13.7 TPS, and the OARs including ipsilateral lung, contralateral lung, contralateral breast, heart, and the spinal cord were delineated then.

Delineation of Target Volumes and Organs at Risk

All patients were immobilized in the supine position on an AIO cover image breast board which increased patient comfort, and armrests to allow for comfortable but reproducible positioning of the arms above the head and out of the treatment fields. A CT scan with a slice thickness of 5 mm was acquired from each patient with coverage from the mandible to 4 to 6 cm below the inframammary fold to cover the entire lung volume. After CT scan, Digital Imaging and Communication in Medicine (DICOM) images were transferred to the Eclipse treatment planning system (V13.7). The breast targets with other volumes were delineated by the radiation oncologist with the following considerations. The CTV for the whole left breast included the Supraclavicular head (Figure 3.9-B) as the superior margin, 2 cm below the inframammary fold as the inferior margin, anterior axillary line as the lateral margin, and midstream line as the inner margin. The CTV for the tumor bed was defined as the lumpectomy cavity (seroma) found on the CT scan image or the fibrous tissue under the surgical scar if no seroma could be found on the CT scan image. The normal tissue and OAR including healthy tissue, the lungs, the heart, the spinal cord, and the contralateral breast were contoured for dose calculation. The target delineation was performed based on Radiation Therapy Oncology Group (RTOG) guidelines (Fig.2.1) the margin from CTV to PTV was 5 mm, except for superficial areas where PTV was never closer than 5 mm to the skin. The body was delineated on the CT scans and Boolean operations were used to construct a modified body volume that operations were used to construct a modified volume that excluded breast PTV.

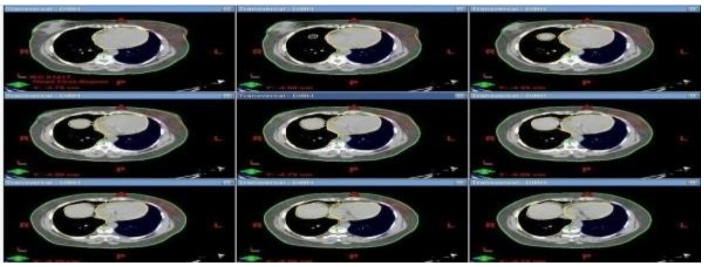

Figure 2.1: Illustration of Post Lumpectomy Target Delineation

Prescribed Dose and Fractionation

Standard WBRT consists of 4500–5000 cGy in 25–28 fractions of 1.80–200 cGy. Long-term data from multiple large randomized trials also demonstrate the non-inferiority of hypo-fractionated WBRT (HF-WBRT) consisting of 4005–4256 cGy in 15–16 fractions of 266–267 cGy for early stage breast cancer with equal or lesser acute and long-term toxicity. The prescription dose to the whole breast was 5002 cGy in 25 fractions (D50 = 5000 cGy) in this study according to the RTGO-1005, 1305 and ICRU report number 83 recommendations. The Boost dose of 1000 cGy at 200 cGy per fraction was delivered to the tumor bed after delivery of 5002 Gy using 6 MV Photon beams to the entire breast.

IMRT Treatment Planning Techniques

For each patient, CT scans were contoured by radiation oncologist and were carried out by medical physicist to ensure plan uniformity. IMRT plan was executed, and the afflicted breast was exposed to 40.5 Gy in 15 fractions of 2.67 Gy to cover the PTV. All the treatment plans were generated using an Eclipse treatment planning system (V13.7). The treatment plans were planned to deliver with 6-MV photon beams on a 2300 C/D linear accelerator that is mounted with a 120-leaf of Millennium multi-leaf collimator (MLC)(maximum leaf speed of 2.5 cm/s). While executing the plan on each patient, the same isocenter and tangential beams were applied. The hybrid technique consisted of a two-step process in which one step is 3DCRT and second step is IMRT.

In the first planning step (3DCRT), two opposing 6 or 10 MV tangential fields [Figure 2.2] atone isocenter were added conforming the CTV whole breast. A margin of 3cm anteriorly was added. This ensures entire breast coverage in spite of breathing. The beam angles and beam weighting (usually minimal) were chosen to optimize coverage of the CTV whole breast, while minimizing exposure to the ipsilateral lung, heart and contralateral breast Gantry angles ranged from 310° to 350° for the medial fields and from 110° to 125° for the lateral fields for patients treated on the left side. The fields extended 2 cm anteriorly of the chest to provide coverage of the "flash" region. All other plans were normalized to achieve isodose coverage of the breast tissue at least as good as the tangent plan. A portion of the total breast dose in 3DCRT, that is, 80%, was calculated to a reference point as per ICRU 50 and 62 guidelines, and weightings were used to provide an even distribution of dose across the whole breast.

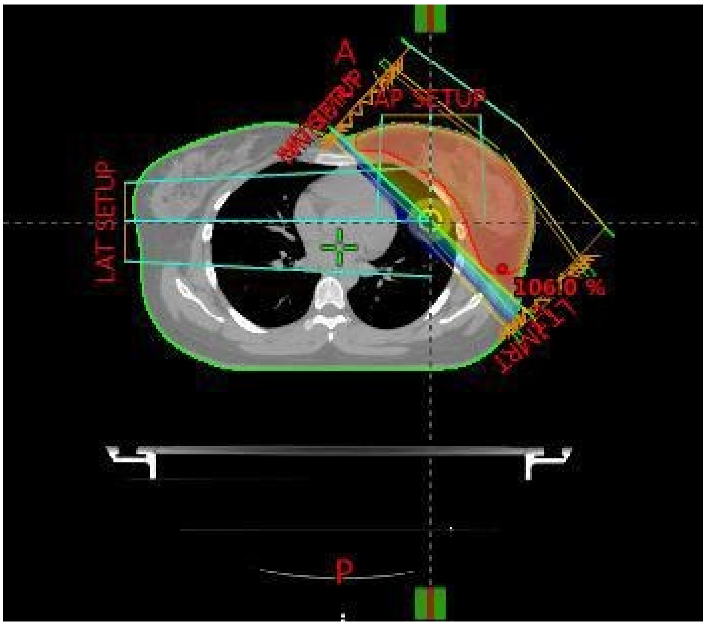

Figure 2.2: Illustration of 3DCRT of IMRT

As the second step, two IMRT fields [Figure 2.3] were added at the same isocenter; two tangential fields at the same gantry angle as the original two tangents and two fields' angled to best access the boost cavity. The two non-tangential fields were dedicated to treat reflecting a conventional tangent plan. A portion of the total breast dose in IMRT, that is, 20%, was calculated to a reference point as per ICRU 83 guidelines, and weightings were used to provide an even distribution of dose across the whole breast. No additional field's or beam modifiers were used in this plan. A second IMRT plan was created at the same isocenter as the conventional plan and comprised of two fields; two tangential fields at the same gantry angle as the original two tangents and two fields angled to best access the boost cavity. The two non-tangential fields were dedicated to treat the boost cavity by locking the jaws around the whole CTV-boost during the optimization process. The IMRT plan was optimized using a standard optimization template employing sliding window dynamic IMRT with Eclipse optimization software to achieve dose constraints and utilize avoidance volumes to reduce undesirable excess dose. A basic level of planning experience was simulated by limiting optimization calculations and use of avoidance structures to two. The plan was dose with the remaining, that is, 20%, of the total breast dose and 10 Gy additionally for the boost cavity.

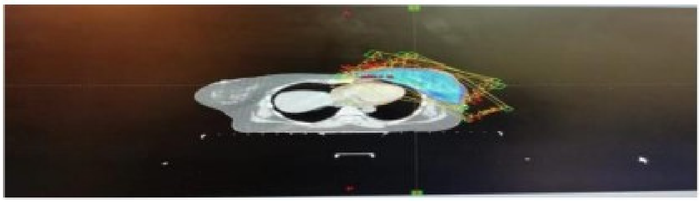

Figure 2.3: Illustration of IMRT

VMAT Treatment Planning Techniques

Volumetric modulated arc therapy (VMAT) is a type of IMRT where the radiation delivery is much faster and requires considerably fewer monitor units (MU), making it a more convenient modality for radiotherapy planning and delivery. The intensity of the beam in VMAT is modulated as a function of gantry angle, MLC speed, and the dose rate of the linear accelerator (LINAC). Treatment can be delivered within 1 arcs of rotation, with each arc taking under 2 min to deliver. PTV and OAR contours are the same as in multi-beam IMRT. The angle at which the largest separation of the PTV is projected in the beam's eye view (BEV) is chosen. The largest separation often tends to be >15 cm. Due to limitations on the MLC leaf travel within an individual field (which is a maximum of 15 cm on certain linear accelerators), the PTV needs to be covered by a minimum of two fields. To allow for a smooth transition of dose, the fields overlap at the isocenter by 2 cm. The collimator angle is set to 0°.VMAT can achieve similar PTV coverage [Figure 2.4] and spare organs at risk with a much shorter delivery time and MU compared to IMRT. VMAT is approximately one-third of that required for IMRT. The reduced MU and number of treatment fields contribute toward a faster treatment delivery with VMAT, which enables the utilization of this modality with respiratory gating techniques. There are additional considerations when choosing between IMRT and VMAT.

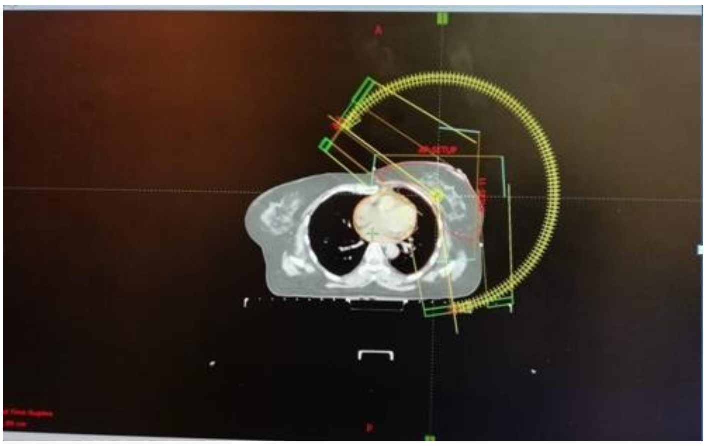

Figure 2.4: Illustration of VMAT

The full arc frame can rotate about 360°. The arc consists of 177 control nodes, whereby the rotating speed of the frame is 4.8°/s. The maximum dose rate is 600 MU/min. MLC blade's maximum speed is 2.5 cm/s and gantry rotation speed 0.5 to 4.8 degrees/s. Gantry rotation takes about 75 s per circle. Many scholars have done researches on VMAT in the body, the head, and the neck. The results show that VMAT can reduce the total time of radiotherapy plan for patients and the beam-on time of the accelerator. The greatest advantage of VMAT technology is to further reduce the treatment time and the number of MU without reducing dose distribution, so as to improve the treatment target of biological effects and the number of patients treated in a unit of time. Because the number of MU reduces obviously, thereby reducing the number of scattering lines of the accelerator head collimator, the risk of cancer reoccurrence is reduced theoretically. The VMAT treatment plans were designed using partial, arcs in the Eclipse TPS to achieve optimal PTV coverage and minimal OAR dose. High definition multi leaf collimation was optimized using beam-s-eye-view for each arc of every patient's plan. The constraints for the OARs included a maximum dose of 2499 cGy, 3752 cGy, and 4549 cGy to the spinal cord, heart, and lung, respectively.

VMAT is a form of IMRT in which the treatment is delivered in one or more dynamically modulated arcs. This plan was designed for each patient. The prescribed dose to the PTV was 5002 cGy in 25 fractions. The plans were normalized to cover 95% of the PTV with 100% of the prescribed dose. Eclipse 10.0 (Varian, Palo Alto, CA) treatment planning system was used for all treatment planning, utilizing 6 MV photon beams generated from Varian Trilogy linac equipped with a 120 leaf Millennium Multileaf Collimator (MLC). All VMAT plans were generated using 1 partial arc. The collimator angle varied between 0° and 90° according to the shape of the target while minimizing the leakage, tongue, and groove effects.

The VMAT treatments were planned using the analytic anisotropic algorithm (AAA), Modified Batho algorithm for tissue heterogeneity corrections, and AAA field volume dose algorithm for ARC calculations. Partial ARC, full ARC, and dual ARCs were used for planning to yield the best target coverage possible.

Results

Dosimetric Comparison

In this section, the Dosimetric results of the two modalities for the OARs and PTV will be discussed involving statistical significances. It has been tried to use the common notations in the literatures as following: V5, V10, V20, and V30, represent the percentage of the volume of the organ that receives 500, 1000, 2000, and 3000 cGy respectively. D5% and D33% represent the amount of the dose (cGy) that has been delivered to 5 and 33 percent of the volume of the organ in order. Dmin, Dmax and Dmean represent the minimum, maximum and mean amount of dose (cGy) that has been delivered to the whole volume of the organ in order.

Dose Analysis of Target Volume

In comparison between the two plans, IMRT plans will show significantly higher mean dose coverage to the PTV than that of VMAT plans. The IMRT plans demonstrate significantly lower mean doses to OARs than that of VMAT plans. The IMRT plans have better CI and HI than the VMAT plans. The mean dose to the heart and maximum dose to the spinal cord can lower with IMRT.The minimum and mean doses were higher in VMAT for the heart and spinal cord. VMAT can be reduced the number of monitor units and the treatment time, as compared to IMRT. Representative dose distributions between VMAT treatment plans and IMRT plans are presented in (Figure 3.1)

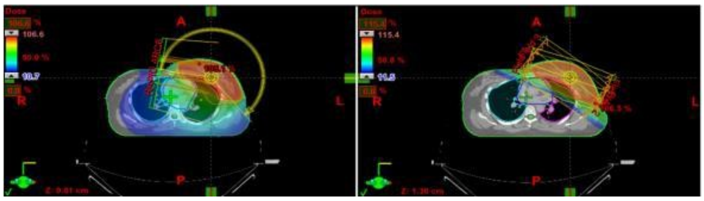

Figure 3.1: The dose distribution between VMAT and IMRT for Left Breast Case

Dose distribution color washes from the treatment modality of IMRT and VMAT for two representative patients in this study. Figure 3.2 (a, b) and 3.3 (a, b) shows axial and frontal dose distributions with IMRT and VMAT using by color wash.

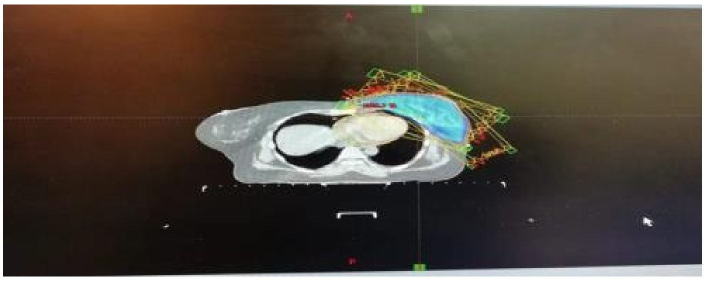

Figure 3.2 (a): Dose-color wash distributions of IMRT for Breast case.

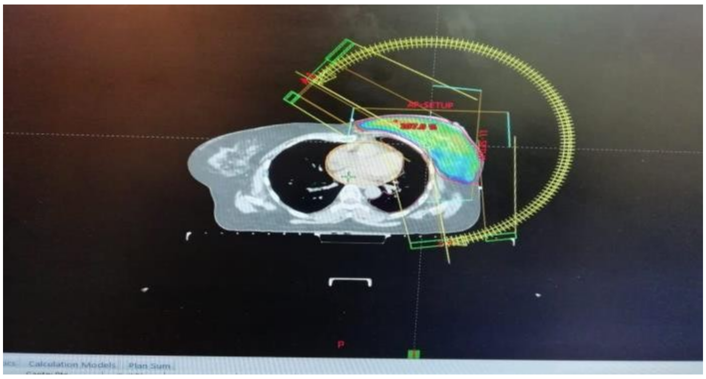

Figure 3.2(b): Dose-color wash distributions for VMAT of treatment plan

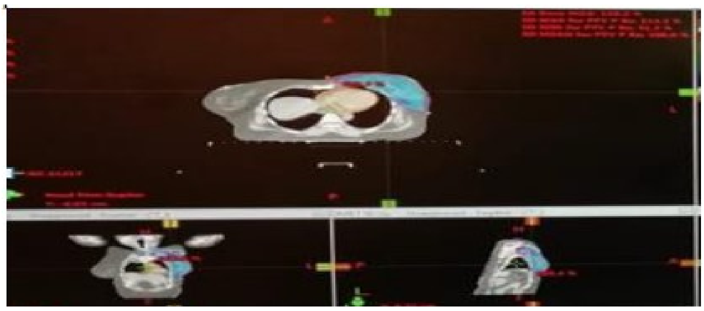

Figure 3.3 (a): Dose-color wash for IMRT of frontal and axial view

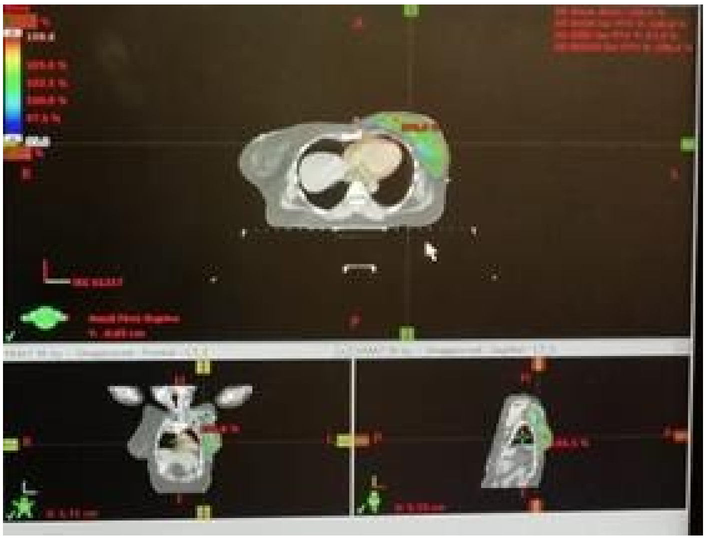

Figure 4.3 (b): Dose-color wash for VMAT of frontal and axial view

Planning Target Volume

The results in table 3.1 show that except for Dmax, Dmean, and Dmin all other means are significantly different. In comparison between the two plans, IMRT plans will show significantly higher mean dose coverage to the PTV than that of VMAT plans. The IMRT can be a better Conformity Index, Homogeneity Index, and even Dmax , Dmin value where better results for VMAT.The advantage of VMAT can be a Better Monitor unit value where Compare then the IMRT.

Table 3.1: The comparison of mean values for PTV (left breast) parameters for IMRT and VMAT

Organ	Parameter	IMRT	VMAT	RTOG 1304 & ICU-83	
				Ideal Value	Accepte d Value
PTV (L Breast)	Conformity Index	0.93 ± 0.04	0.92± 0.05		
	Homogeneity Index	0.15±0.33	0.17± 0.37		
	MU	1779.4± 584.1	502.8± 124.5		
	Dmin(cGy)	4752.8.3 ± 63.47	4732.5±66.23		
	Dmax(cGy)	5324.2±55.6	5348.28±48.2	<115%	<120%
	Dmean (cGy)	5031.4±37.45	5056.8±28.7		
	V95	97.05±3.43	98.44±2.71		

Dose Analysis in OAR (Ipsilateral Lung)

As seen in table 3.2, the mean of all the parameters is significantly different for the two modalities. The mean dose of the ipsilateral lung (cGy) for IMRT, and VMAT were 1356.2±48.77and 1459.5±36.99 respectively. The mean dose of the right lung was highest in VMAT and lowest in IMRT. The IMRT plan for the ipsilateral lung is the lower values for Dmax. Table 3.2. The comparison of mean values for ipsilateral lung parameters for IMRT and VMAT.

Table 3.2

Organ	Parameter	IMRT	VMAT	RTOG*1304*	
				IdealValue	Accepted Value
Ipsilateral Lung	V10	35.57%±0.4%	36.5%0.96%	V10 Gy≤50%	V10 Gy≤60%
	V20	18.27%±0.64%	19.1%±0.51%	V20 Gy≤30%	V20 Gy≤35%
	Dmin(cGy)	102.6±0.87	371.81±18.75		
	Dmax(cGy)	4549.8±75.12	4777.6±42.61		
	Dmean(cG y)	1356.2±48.77	1459.5±36.99		

Dose Analysis in OAR (Contralateral Lung)

As the values in Table 3.3 show, the two modalities are significantly different for the concerned constraints. In IMRT plans, the percent volume that receives 5, 10, 20 cGy is zero versus Zero volume for VMAT plans. By looking at all the values, with concern about contralateral lung, it can be concluded that there would be no advantage of using IMRT. The mean dose of the right lung was lowest in IMRT and highest in VMAT.

Table 3.3: The comparison of mean values for contralateral lung dose parameters for IMRT and VMAT

Organ	Parameter	IMRT	VMAT	*RTOG 1304*	
				Ideal Value	Accepted Value
Contralateral Lung	V5	0%±0%	0%±0%	V5Gy ≤ 10%	V5Gy ≤ 15%
	V10	0%±0%	0%±0%		
	V20	0%±0%	0%±0%		
	Dmin(cGy)	12.2±2.86	21.8±1.92		
	Dmax(cGy)	1182±39.62	2169.4±60.39		
	Dmean(cGy)	81.54±1.55	162.14±3.77		

Dose Analysis in OAR (Heart)

The results in Table 3.4 show a significant difference for each constraint. In IMRT plans, the percent volume that receives 33 cGy is 0.016% versus 0.19% volume for VMAT plans. By looking at all the values, with concern about Heart, DMIN, and DMAX better than that VMAT. The IMRT can be a Better mean heart dose where Compare then the VMAT.

Organ	Parameter	IMRT	VMAT	*RTOG 1304*	
				IdealValue	Accepted Value
Heart	V30	0.25%±0.11%	0.85%±0.06%	V25Gy ≤ 5%	V30Gy≤ 5%
	V33	0.016%±0.011%	0.19%±0.017%		
	Dmin(cGy)	78.7±1.03	341.8±9.88		
	Dmax(cGy)	3578.6±139.2	3752.5±79.39		
	Dmean(cGy)	421.7±48.6	453.7±75.5	≤4Gy	≤ 5Gy

Table 3.4: The comparison of dose for Heart dose parameters for IMRT and VMAT

Discussion

In this dosimetric study two different IMRT and VMAT techniques were investigated for left- sided breast cancer radiotherapy and IMRT were found to higher mean dose coverage to the PTV when compared with VMAT. Similarly, significant increases in dose homogeneity and coverage have been reported as IMRT or VMAT techniques have been treatment plans were planned for 50 Gy in 25 fractions. The VMAT and IMRT plans were compared using the planning target volume (PTV) dose and doses to the other organs at risk (OARs). For the PTV, comparable minimum, mean, maximum, median and modal dose as well equivalent sphere diameter of the structure (Equips) were observed between VMAT and IMRT plans and found that these values were significantly equal in both techniques.IMRT significantly reduce the mean heart dose, the mean lung dose, lung parameters and contralateral breast compared than VMAT.The right lung mean dose (cGy), were significantly reduced from 81.54±1.55 and with IMRT to 162.14±3.77 with VMAT, respectively. The Spinal Cord mean dose (cGy), were significantly reduced from 667.2±18.10 with IMRT to 852.9±8.65 with VMAT,

respectively. In the article, Overgaard et al. [36] the aim of the study was to evaluate the dosimetric benefit of applying intensity--modulated radiotherapy (IMRT) on the post-mastectomy left-sided breast cancer patients, with the involvement of internal mammary nodes (IMN).The prescription dose was 50 Gy delivered in 25 fractions, and the clinical target volume included the left chest wall (CW) and IMN. IMRT plans were created and compared with VMAT plans on Pinnacle treatment planning system. Comparative endpoints were dose homogeneity within planning target compared with conventional techniques.

Many studies have shown benefits of IMRT in left breast patients, especially in minimizing the cardiac complications. Discussion of the results for IMRT compared with literature of VMAT has been given below:In the article, Dah-Cherng Yeh et al. [21] compared the dosimetric performance of 2 different treatment techniques: (hybrid-VMAT), and (IMRT) for whole-breast irradiation of left-sided early breast cancer. Dosimetric parameters were calculated to evaluate plan quality. Total monitor units (MUs) and delivery time were also recorded and evaluated. The VMAT plan generated the best results in dose coverage of the target and the dose uniformity inside the target for conformal index [CI]; for homogeneity index [HI] of planning target volume [PTV] (50.4 Gy) and for HI of PTV (62 Gy)). Volumes of ipsilateral lung irradiated to doses of 20 Gy (V (20 Gy)) and 5 Gy (V (5 Gy)) by the VMAT plan were significantly less than those of the IMRT plans. The volume of ipsilateral lung irradiated to a dose of 5 Gy was significantly less using the VMAT plan than that using the IMRT or the pure-VMAT plan. The total mean MUs for the VMAT plan were significantly less than those for the MRT plan. In the article , Viren et al. [24] the evolution of radiotherapy machines and treatment planning systems, the advanced planning technique of intensity modulated radiation therapy (IMRT) wasproved to have the general benefits of target coverage conformity, homogeneity, organ at risk (OAR) sparing, compared to volumetric modulated arc therapy (VMAT).However, instead of reducing the high-dose regions of surrounding OARs, the low-dose area of IMRT represents a treatment planning challenge when the organs at risk (lungs and heart) are very close to the planning target volume (PTV; left breast The VMAT may not serve as first choice technique for breast cancer. To avoid the disadvantage of VMAT, IMRT technique was used for treatment planning in our institution. In the article, Mayo CS et al. [26] the clinically practical and implementable combination of VMAT and IMRT to see if there was improvement in conformity, better sparing of OARs, and to decrease treatment time and to avoid the low dose bath. This study revealed that IMRT could combine the benefits of IMRT and VMAT to deliver a faster, more conformal, homogeneous treatment in comparison to IMRT with less amount of breast to a lower dose in comparison to VMAT.

In the article, Evans et al. [29] IMRT treatments were generated using 4 to 5 tangential IMRT fields for the same patients. All volume (PTV), target dose coverage, doses to the critical structures including heart, lungs and the contralateral breast, number of monitor units and treatment delivery time. VMAT and IMRT plans showed similar PTV dose homogeneity, but, IMRT provided a better dose coverage for IMN than VMAT (p= 0.017). The mean dose (Gy), V30 (%) and V10 (%) for the heart were 13.5 ± 5.0 Gy, 9.9% ± 5.9% and 50.2% ± 29.0% by IMRT, and 14.0 ± 5.4 Gy, 10.6% ± 5.8% and55.7% ± 29.6% by

VMAT, respectively. The left lung mean dose (Gy), V20 (%), V10 (%) and the right lung V5 (%) were significantly reduced from 14.1 ± 2.3 Gy, 24.2% ± 5.9%, 42.4% ± 11.9%and 41.2% ± 12.3% with VMAT to 12.8 ± 1.9 Gy, 21.0% ± 3.8%, 37.1% ± 8.4% and 32.1% ±18.2% with IMRT, respectively. The mean dose to the contralateral breast was 1.7 ± 1.2 Gy withIMRT and 2.3 ± 1.6 Gy with VMAT. Finally, IMRT reduced the number of monitor units, as compared to VMAT. We found that the IMRT technique produces significantly better covering of the PTV than that of VMAT techniques. the mean dose (cGy), V30 (%) and V33 (%) for the heart were 0.85%±0.06% and 0.19%±0.017%by VMAT, and 0.25%±0.11% and 0.016%±0.011% by IMRT, respectively. The left lung mean dose (cGy), V20 (%), V10 (%) were significantly reduced from 36.5%±0.96 % and 19.1%±0.51%with VMAT to 35.7%0.49% and 18.27%±0.64 with IMRT, respectively. The mean dose to the contralateral breast was 244.16±16.29 cGy with VMAT and 45.2±2.01Gy with IMRT.The most important advantage of VMAT is MU & treatment delivery time better than IMRT.From the above discussion this study concluded that both the VMAT and IMRT Plan is good for Left. Breast case but here Comparatively IMRT resulted in even better PTV coverage than VMAT as well as CI & HI also good.

Conclusion

This study compared the dosimetric characteristics of Intensity-modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMAT) techniques to the left-side breast radiotherapy in the early stage of Breast Cancer. In this study, we first proved that the IMRT technology is the most innovative technology in conventional photon therapy and a widely used treatment technique. Dosimetric parameters were calculated to evaluate plan quality.

Total monitor units (MUs) & delivery time were also recorded and evaluated. As per our study, the two different treatment plans (IMRT, VMAT), helps in reducing the dose to different volumes of the heart as well as mean and maximum dose to the heart also the use of the current plan parameters in the IMRT technique in our study helps in making the best regarding higher mean dose coverage to the PTV. The dosimetric parameters equivalence is achieved from IMRT beams to the standard tangential conformal beams. In the present study, IMRT significantly reduces the heart dose, lung dose and contralateral breast compared to VMAT. This IMRT is also more flexible in terms of positioning repeatability. IMRT can achieve better CI, HI, values compared with VMAT. The prescription dose to the whole breast was 5000 cGy in 25 fractions (D50 = 5000 cGy) in this study according to the RTGO-1005, 1305, QUANTEC and ICRU report number 83 recommendations. Varian Eclipse 13.7 treatment plans were used for IMRT & VMAT treatment planning system. This study was compared the dosimetric aspects of IMRT plans with VMAT plans according to EMAMI, QUANTEC, and RTOG protocols. So from the overall consideration, we suggest that the IMRT plans typically had more favorable dose characteristics to the lung, heart. The IMRT for breast cases was slightly better PTV coverage. IMRT dose delivery technique is better conformal as compared to the VMAT plan.

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