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RESEARCH ARTICLE
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A Evaluation Result of Treatment Plans Used In the Treat of Right Breast Tumors After Mastectomy

[1,*]Saif Ameer Rashid Al-Hakkak, [2] Mustafa Al-Musawi, [3] Ammar Rasoul Mohammad
[1](Mustansiriyah University , College of Medicine) Email: hakako88@yahoo.com
[2](Mustansiriyah University , College of Medicine) Email: Laser_mu@yahoo.com
[3](University of Kufa, College of Medicine)Email: ammar.alsaachi@uokufa.edu.Iq

*Corresponding Author: Saif Ameer Rashid, (Email: hakako88@yahoo.com) Mobile: +964 772 655 8366

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ABSTRACT

Breast cancer is the most frequent cancer among women. Surgery, chemotherapy and radiotherapy are the main aspects of breast cancer management. External beam radiotherapy has an effective role in local recurrence control. The goal of this research is to determine if the volumetric arc therapy (VMAT) technique achieved a greater advantage in terms of homogeneous dose distribution for the tumor in comparison with intensity modulated radiotherapy (IMRT) technique and also in terms of reducing the dose on organ at risk in treatment patients with right breast cancer. Patients with right-sided breast cancer who underwent modified radical mastectomy were eligible for the study. Dose volume histograms were used to examine the dose distribution for both the planning target volume and the organs at risk. VMAT plans increase dose for PTV where 95% of prescribed dose cover 95% (V95) of Chest wall (PTV C. W) when compared with IMRT plans (P-Value 0.00387). Mean dose of heart was significantly decreased in IMRT plans when compared with VMAT plans (P – Value 0.00988)**.**

The dose distribution of VMAT plans was the same as or better than IMRT plans, and it was linked to a significant benefit in ipsilateral lung sparing (P – Value 0.00318). Based on our data, patients with right-sided breast cancer who are candidates for modified radical mastectomy may benefit more from VMAT. Our results revealed that VMAT should be the first choice for patients with right-sided breast cancer who are undergoing modified radical mastectomy.

Keywords: breast cancer, dosimetry characteristics, IMRT organs at risk, VMAT

INTRODUCTION

The breast is an organ that can be found on either side of the chest's midline, making it a symmetrical structure. It is located between the third and seventh ribs, as well as between the sternal border and the armpit (De Benedetto et al., 2016). One of the types of cancer that affects women more frequently than any other around the globe is breast cancer (McGuire, 2016)(Siegel, Miller and Jemal, 2019). Breast cancer usually spreads to distant organs like the bone, liver, lung, and brain since it is a type of metastatic cancer. This is the primary reason why breast cancer cannot be cured (DeSantis et al. 2016). Many women with early-stage breast cancer are able to undergo a mastectomy to remove all outward indications of the illness. It's possible that there are still tumor foci in the chest wall or adjacent lymph nodes, which, if addressed, could lead to the cancer returning and killing the patient. Such tumor foci may be eliminated with radiation therapy(Goldhirsch et al., 2013).The treatment protocols of breast cancer include surgery, radiotherapy and chemotherapies (Mestre's et al. 2017). Radiotherapy can be external beam radiation therapy (linear accelerator) or internal radiation by implanted radioactive catheters (brachytherapy) in the site of tumor (Baskar et al., 2012). However, the radiation therapy includes many interrelated steps, immobilizing the patient, imaging, contouring, and planning. To ensure the patient receives the appropriate dose of radiotherapy, quality assurance must be performed at every stage (Low, Chen and Wu, 2011). Radiation therapy is used to treat breast cancer in a variety of ways, including intensity-modulated radiation therapy (IMRT), which uses a non-uniform fluence delivered to the patient from any position of the treatment beam to enhance the composite dose distribution. Inverse planning is used to identify the best fluence profiles for a set of given beam directions after the planner defines the treatment needs for plan optimization. (Shimm, 2008). On the other hand, A unique treatment approach called volumetric-modulated arc therapy

(VMAT) optimizes target volume coverage while safeguarding healthy tissues during radiation.(Wang et al., 2022). The probability of acquiring a second cancer in the opposite breast does not significantly increase as a result of radiotherapy for breast cancer this shown by a study prepared by Boice Jr et al. 1992 this study revealed that only 3% of incidences of second breast cancer can be linked to radiotherapy. However, radiation for young women greatly increased the risk (45 years of age). Radiation exposure is exceedingly rare to result in breast cancer after the age of 45. In contrast, Dumane et al, concluded that VMAT, which spared more of the patient's lungs and took less time to finish without sacrificing target coverage, was the best therapeutic option and delivery technique for this patient Dumane et al. 2014. According to another study, VMAT plans had a marginally higher chance of sparing the heart and coronary arteries than IMRT plans and were on par with or even outperformed in terms of dose distribution Wang et al. 2022. The goal of this research is to determine if the volumetric arc therapy (VMAT) technique achieved a greater advantage in terms of homogeneous dose distribution for the tumor in comparison with intensity modulated radiotherapy (IMRT) technique and also in terms of reducing the dose on organ at risk in treatment patients with right breast cancer

METHODS

Data Twelve patients with right-sided breast cancer who underwent modified radical mastectomy were examined. The Mustansiriya University local Ethics Committee gave their approval to the current analysis.

2.1 Identification of appropriate patients, determination of treatment volumes, and delineation of OAR.

The research has done at Najaf Teaching Hospital, Iraq. Select 12 women diagnosed with right breast cancer had a mastectomy. Patients were placed on their backs with their arms raised over their heads and immobilised with breast boards. Computed tomography (CT) scans were utilised during the planning stages of treatment and were acquired using a helical scanner (Philips CT scan device). The CT workstation sent all of the images to the treatment planning system (MONACO sim from ELEKT). The breast cancer clinical target volume (CTV) and Planning target volume (PTV) as shown in Fig 1 will delineations are according to the recommendation of the International Committee for Radiological Units (ICRU) report #83. The PTV will designed to account for daily setup error and motion. Also, will delineation The normal structures and organ at risk (OARs) including heart, contralateral breast, ipsilateral lungs, and contralateral lungs, Thyroid gland will contour by experienced radiation oncologist.

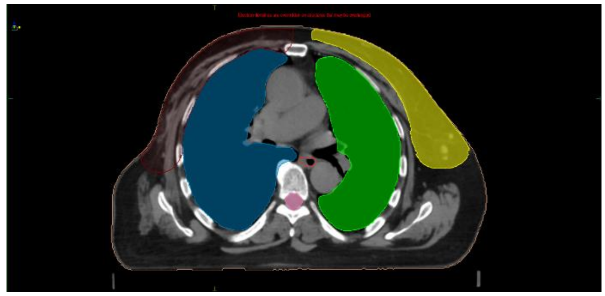

Figure (1) showed the PTV, heart, left and right lungs, and contralateral breast for IMRT and VMAT.

2.2 Techniques for planning and dose limitations

Using Elekta linear accelerators (Infinity, Elekta) producing 6 MV photons, each treatment plan is intended to provide 40.5 Gy to the PTV over the course of 15 fractions. Treatment plans were required to cover at least 95% of the planned treatment volume (PTV) with at least 95% of the planned dose, while minimising radiation exposure to OARs, Fig 2 and Fig 3 represent VMAT and IMRT plans .

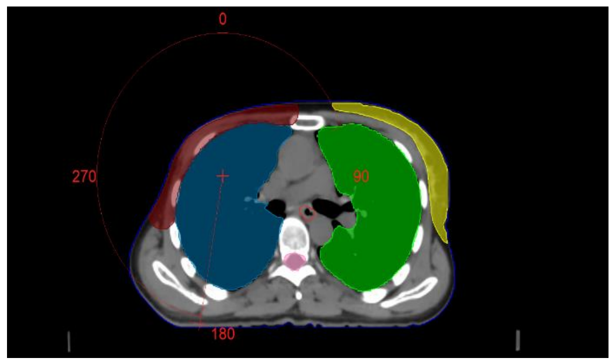

Fig. (2) represented the VMAT Plan technique

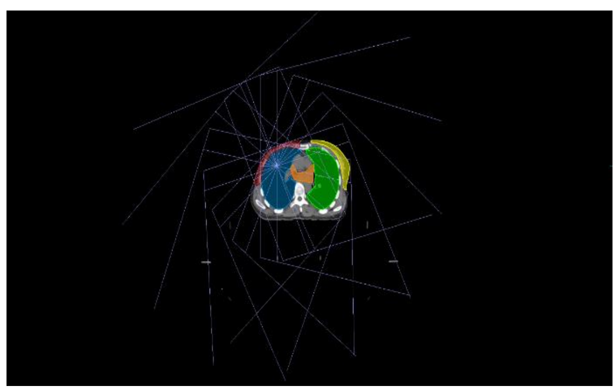

Fig. (3) represented the IMRT Plan technique

2.3 Evaluation tools

Quantitative evaluation of treatment regimens using dose volume histograms for the PTV, heart, Thyroid gland, and other important normal tissues (lungs and contralateral breast).

2.4 Appling plans

Apply all treatment plans IMRT and VMAT with Octavius phantom to ensure accurate dose distribution by recorded Gamma index before the actual start of the patient's treatment.

2.5 Statistical analysis

IBM SPSS Statistics (version 26) was applied for statistical analysis. Paired Samples Test used to compare the VMAT plans with the IMRT plans. The level considered statistically significant was set to 5% ($P<0.05$).

RESULTS

According to Table 1 and Figure 4 the VMAT plans increase dose for PTV where 95% of prescribed dose cover 95% (V95) of PTV Chest wall (C.W) when compared with IMRT plans PValue (0.00387). However, for Axillary and Supraclavicular lymph node target PTV AXI + SC) the results were almost the same P-Value (0.78637).

Table 1 represent Coverage of the tumor (PTV (C.W) & PTV (AXI + SC)

Parameters	IMRT	VMAT	p – value
PTV (C.W)	97.42 ± 1.44	98.44 ± 0.95	0.00387*
PTV (AXI+SC)	99.76 ± 0.22	99.78 ± 0.17	0.78637
*Significant difference at level ≤0.05			

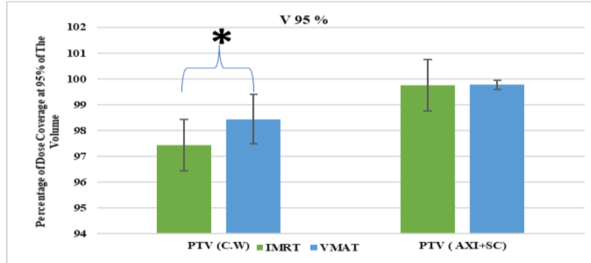

Figure (4) represent Coverage of the tumor PTV(C.W) & PTV(AXI+SC)

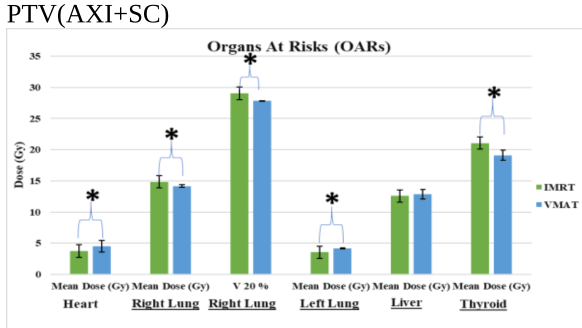

Fig (5) represent dose for organ at Risk (OAR)

Depending on table 5 and figure 5 and Figure 6 VMAT plans decrees dose (Right Lung, thyroid gland) when compare with IMRT plans were PValue (0.01377, 0.002800) respectively. However, for the (heart, the contralateral breast, and the contralateral lung) the IMRT technique decrees dose compared to the VMAT technique were PValue (0.00988, 0.001375, 0.025522), respectively.

Table (5) represent dose for organ at Risk (OAR)

OARs		IMRT	VMAT	*p* – value
Heart	Mean Dose (Gy)	3.75 ± 0.46	4.52 ± 0.75	0.00988*
Rt. Lung	V 20 %	29.05 ± 1.54	27.84 ± 1.63	0.01377*
Lt. Lung	Mean Dose (Gy)	3.53 ± 0.67	4.16 ± 0.47	0.025522*
Liver	Mean Dose (Gy)	12.58 ± 3.85	12.83 ± 4.23	0.521848
Thyroid	Mean Dose (Gy)	21.06 ± 4.98	19.11 ± 4.62	0.002800*
contralateral breast	Mean Dose (Gy)	2.86 ± 0.714	3.85 ±0.647	0.001375*
*Significant difference at level ≤0.05				

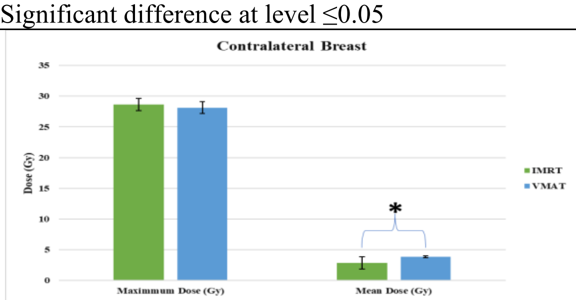

Fig (6) represent dose for Contralateral Breast

DISCUSSION

This study aims to lower the dose to the adjacent normal tissues while maintaining and enhancing PTV dose coverage for both approaches. When compared to the 3-dimensional conformal approach, IMRT lessens harm to healthy tissues, produces highly conformal dose distributions, and achieves great geometrical accuracy. Improved radiation methods, such as VMAT, a new technology evolved from IMRT that uses a single gantry rotation and produces an optimal 3-dimensional dose distribution, further limit the harm to organs at risk (Jagsi et al., 2010)(Ma et al., 2013).This study demonstrated that both the VMAT and IMRT plans were enough to cover the necessary clinical PTV, with the VMAT having a great advantage(P Value 0.00387). Moreover, the current study showed a significant advantage of the VMAT plan in sparing the ipsilateral lung, as shown in Table 2. This is consistent with earlier research that shown clinically symptomatic pneumonitis rare when the ipsilateral lung's V20 Gy was kept below 30% (Sun et al., 2017). However, i the dose to the heart was reduced by IMRT, as shown in Table 2, and in accordance with previous studies which showing when heart exposure to ionizing radiation during breast cancer radiotherapy it increases the subsequent rate of ischemic heart disease, the increase is proportional to the average heart dose, which begins within a few years after exposure, and it lasts for at least 20 years. Women with pre-existing cardiac risk factor absolutely increased risk of radiotherapy compared to other women(Darby et al., 2013) for this reason IMRT is the preferred choice for cardio protection during treatment of right breast cancer.

As for the contralateral breast, everal studies have assessed the relationship between risk of subsequent primary cancer in the contralateral breast (CB) and radiation dose (Delaney et al., 1992)(Basco et al., 1985). It was found through this study that the IMRT technique reduced the dose delivered to the contralateral breast so according to study by Basco et al, which involved more than 14,000 women treated for breast cancer in British and Columbia the number of CB cancers was small (n = 194, with only 30 occurring in women aged (Basco et al., 1985). The IMRT technique represent good option for CB sparing compare with VMAT. Patients treated with RT for breast cancer had a higher risk of developing hypothyroidism that persisted for years after treatment ended (Park et al., 2022). Based on the results of this study and the previous one .

Compared with IMRT technique, this study demonstrated the efficiency of VMAT technique in doses distributing for PTV in patients with right breast cancer after mastectomy PValue.(*0.00387)

While in the case of protecting the heart, find Both techniques did not exceed the tolerance but with highly advantage for IMRT when compared with VMAT technique PValue (0.00988*). However, for contralateral breast sparing IMRT technique better than VMAT PValue (0.001375*)

CONCLUSIONS

The VMAT technique achieved a greater advantage in terms of homogeneous dose distribution for the tumor in comparison with IMRT technique and also in terms of reducing the dose on the ipsilateral lung and thyroid gland. However, it was seen that both techniques were also able to accomplish the desired benefit in the case of minimizing the dose for the heart and the contralateral breast, with a little advantage for IMRT technique.

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