RESEARCH ARTICLE

Effect of using bolus on the efficiency of the 3DCRT of the breast cancer after mastectomy

Iman Ghali Hassan, Nabaa Abdulateef Rasheed Naji, Hadeel Kamil Abdullah

Abstract

Objective: To assess the effect of using bolus on the efficiency of three-dimensional conformation radiation treatment of breast cancer post-mastectomy.

Method: The prospective, clinical study was conducted at Al-Amal Center for Radiation Therapy and Nuclear Medicine, Iraq, from November 2020 to April 2021, and comprised patients with synchronous bilateral breast cancer with regional lymph nodes who underwent mastectomy. The three-diensional conformation radiation treatment technique was used to evaluate the dose received by the planning target volume and the organs at risk. The plans were generated using a treatment planning system, the plans were then fed into a linear accelerator. The plans had one isocenter for both breasts to avoid the errors that may cause the overlapping of the radiation fields with and without the use of bolus. Data was analysed using SPSS 24.

Results: There were 23 female patients with mean age 49.28±8.79 years (range: 35-62 years). There were 7(30.4%) females residing in rural areas, while 16(69.6%) lived in urban areas. The use of bolus increased the radiation dose coverage percentage of the planning target volume of the right (p=0.0002) and left (p=0.0164) breasts, while the right (p=0.3977) and left (p=0.7940) supraclavicular nodes were not significantly covered by the radiotherapy dose. The use of bolus showed a strong significant decrease of the mean dose that was received by the left lung (p=0.00001). Also, the use of bolus caused significant reduction in the amount of the mean scattered dose that reached the heart (p=0.00001) and larynx (p=0.00004).

Conclusion: The use of bolus provided a complete radiotherapy dose coverage for the right and left breasts, as well as an excellent protection for the left lung, heart and larynx.

Key Words: Mastectomy, Breast, Nuclear, Lung, Lymph Nodes, Radiation, Larynx

(JPMA 74: S336 (Supple-8); 2024) **DOI: https://doi.org/10.47391/JPMA-BAGH-16-77**

Introduction

Synchronous bilateral breast cancer (SBBC) is considered uncommon. The registered cases are 1-2.6% of all patients with breast carcinoma[1]. Mastectomy is a surgical procedure used to treat breast cancer (BC) that involves the removal of the breast and possibly surrounding tissues. For a while, the usual therapy for BC was a radical mastectomy, which included the complete removal of the breast, lymph nodes (LNs) in the underarm, and a portion of the chest muscles under the breast. Radiation treatment may be indicated after mastectomy to eliminate any cancer cells that remain after surgery. During mastectomy, it is difficult for surgeons to remove every cell of the breast tissue. The evaluation of BC recurrence can be determined based on the pathology report and the number of other factors, like the breast size, the number of the involved LNs and positive margins. Post-mastectomy radiation therapy (PMRT) is necessary if there is a high risk of recurrence in the area where the breast tissue used to be, and sometimes to the nearby LN areas[2]. It has been shown that PMRT improves local control and overall survival. PMRT is aimed at the chest wall, and often involves LNs that drain the breast regionally[3]. It reduces locoregional recurrence by 19% which translates into a 9% reduction in BC mortality[4].

Three-dimensional conformal radiation therapy (3DCRT) and intensity-modulated radiation therapy (IMRT) are two of the most often utilised PMRT methods. There are distinct consensus criteria for delineating goal volumes[5]. The forward-planning method, and 3DCRT employ photons to treat the chest wall and area lymphatics. The dosimetrist and radiation oncologist often utilise 3-5 beams to treat the chest wall and regional lymphatics. They calculate the optimal beam angle, field size, blocks, beam intensity, and weighting for each patient to produce a personalised plan. When the conventional field is applied to SBBC, it is possible that the radiation therapy (RT) fields may overlap, reducing target coverage. Additionally, there is an issue with the daily setup of patients, particularly in the event of RT that includes regional node irradiation (RNI). Due to the fact that this technique utilises several isocenters, positioning the

Department of Radiation Oncology, Al Amal Cancer Centre, Baghdad, Iraq

Correspondence: Iman Ghali Hassan

Email: emangali55@gmail.com

patient's posture is often incorrect. Additionally, since SBBC requires a higher treatment volume, the radiation dosage to organs at risk (OARs), such as the lung and heart, is significant[6].

A chest wall bolus may be utilised to augment the skin dosage in individuals at higher risk of chest wall recurrence, like patients with big tumours, positive/close margins, or inflammatory BC. In general, a 0.5cm tissue-equivalent bolus every other day may be used to raise the skin dosage to 85% of the recommended dose, or a daily bolus can be used to guarantee the skin dose reaches 95% of the specified dose in instances with inflammatory BC[3].

The current study was planned to assess the effect of using bolus on the efficiency of 3DCRT of BC post-mastectomy.

Patients and Methods

The prospective, clinical study was conducted at Al-Amal Center for Radiation Therapy and Nuclear Medicine, Iraq, from November 2020 to April 2021. After approval from the ethics review committee of the Department of Physiology, College of Medicine, MustansiriyahUniversity, Iraq, the sample size was calculated using the formula: N=(Z2-α/2 * σ2)/d2, where n = sample size, α = first type, Z = table-based normal distribution index considered at 5% type one error (p<0.05), and σ = small variable variance(7). The sample included females with SBBC with regional LNs who underwent mastectomy. Written consent from the patients was taken to use their computed tomography (CT) images for RT planning. Those who had unilateral BC, and those who were subjected to a lumpectomy were excluded.

The planning CT was conducted with the patients were immobilised in a supine position on a breast rest board with both arms up abducted above the head. Three points were marked on the patient's chest, one on either side of the sternum and one in the centre. The skin marks were matched with the CT space by a laser localisation device.

The 3DCRT planning technique was used to evaluate the dose received by the planning target volume (PTV) and OARs heart, lung and larynx. The RT plans were generated using XiO5.10 treatment planning system (TPS), and they were fed into a linear accelerator (Agility, Elekta , Sweden). Energy of 6MV and 10MV photons were used. The used plan included bilateral opposed medial and lateral tangents, right and left anterior-posterior (AP) oblique supraclavicular fields, with 6 main fields; 2 each side (left and right breasts) from the midline and tangential field, and subfields to reduce the hot area. For supraclavicular LNs, the fields were set from the anterior and posterior.

The 3CDRT plan was designed by using one isocenter for both breasts to avoid the errors that may cause the overlapping of the radiation fields, The contoured regions included the bilateral breasts, right and left supraclavicular nodal regions, right and left axillary LNs, and key OARs. The dose was set as 4050 cGy/15 fractions to the target mastectomy. Each plan was evaluated by dose-volume histogram (DVH) analysis with and without the use of bolus.

Data was analysed using SPSS 24. Data was presented as frequencies and percentage, or as mean ± standard deviation, as appropriate. The significance of the difference of dependent means of quantitative data was tested using paired t-test. P<0.05 was considered statistically significant.

Results

There were 23 female patients with mean age 49.28±8.79 years (range: 35-62 years). There were 7(30.4%) females residing in rural areas, while 16(69.6%) lived in urban areas.

The use of bolus increased the radiation dose coverage percentage of the planning target volume of the right

Table-1: Mean percentage of dose coverage to the planning target volume (PTV) for mastectomy of right and left breasts with and without bolus.

	With Bolus	Without Bolus	*P – value*
Right Breast	96.49 ± 0.0177	90.90 ±0.0363	0.0002
Left Breast	96.29 ± 0.0117	91.28 ±0.0559	0.0164

Paired t-test at 0.05 p-value.

Table-2: Mean percentage of supraclavicular dose coverage for mastectomy cases of the left and right breasts with and without bolus.

	With Bolus	Without Bolus	*P – value*
Right Side	97.26 ± 0.014	96.96 ± 0.013	0.3977
Left Side	97.02 ± 0.014	96.99 ± 0.013	0.7940

Paired t-test at 0.05 p-value

Table-3: Mean dose delivery to organs at risk (OARs) for mastectomy cases with and without bolus.

	Mean dose wiith Bolus (cGy)	Mean dose without Bolus (cGy)	*P – value*
Left lung	1322.09 ±109.13	1339.39 ± 109.4	0.00001
Right lung	1411.07 ± 139.48	1416.69 ± 108.35	0.8475
Heart	680.09 ± 116.69	694.91 ± 463.23	0.00001
Larynx	694.91 ± 463.23	778 ± 464.03	0.00004

Paired t-test at 0.05 p-value.

(p=0.0002) and left (p=0.0164) breasts (Table 1), while the right (p=0.3977) and left (p=0.7940) supraclavicular nodes were not significantly covered by the RT dose (Table 2).

The use of bolus showed a significant decrease of the mean dose that was received by the left lung (p=0.00001), heart (p=0.00001) and larynx (p=0.00004). The decrease was not significant for the right lung (p=0.8475) (Table 3).

Discussion

The current study assessed the effect of using bolus on the efficiency of 3DCRT of BC post-mastectomy. Since a large amount of skin and tissue has been exposed to radiation, therefore, an additional tissue-equivalent substance (bolus) could show a benefit[8], where both of the breasts were significantly covered by the radiation dose compared to cases that did not include a bolus usage.

On the other hand, the dose coverage of the supraclavicular nodes of the left and right sides were not affected by the presence of bolus. This finding was in line with those of Andric et al., who introduced a suggestion that, based on statistical evidence, the use of bolus was not needed in every RT fraction, and that it could be used frequently[9].

The effect of the bolus on the amount of the mean dose that reached the left lung was clear, where the left lung received a larger mean dose before using the bolus than after using it. Similar to the left lung, the heart received a larger mean dose without using the bolus in the 3DCRT planning, keeping in mind that these increased doses to the left lung and the heart were still within the tolerance doses, as recommended by the Radiation Therapy Oncology Group (RTOG) for these two OARs. These results were in line with those of Turner et al.[10].

The mean dose of the right lung did not show a significant difference with those without the bolus. This result was in agreement with the findings of Tyran et al.[11]

The significant effect of using bolus on the mean dose of the left lung compared to the right lung may be explained by the anatomical differences between them, where the left lung is pushed up by the heart, and this may cause more radiation dose exposure by the left lung. The other cause may be the difference in the number of lobes in the left and right lungs. The left lung is also subjected to the effect of diaphragm movement, as it is more elevated by the diaphragm[12].

The larynx as well as the right lung and heart were well protected when using the bolus, where the mean dose that was received showed a decrease compared to the value without bolus in the current study. No comparable results could be found in previous literature related to the dose received by the larynx. Using one isocenter radiation field in the current study may be a cause of reducing the value of the mean dose that reached the larynx.

Limitation: The current study has limitations as the duration of the study was only 8 months, and the inclusion of only bilateral breast cancer, which is one of the rarest types of BCs in the Iraqi females.

Conclusion

Using of bolus during the 3DCRT planning of bilateral breasts post-mastectomy provided a complete RT dose coverage for the right and left breasts, as well as an excellent protection for the left lung, heart and larynx. The use of bolus is not a necessity for each RT post-mastectomy cases, and the decision is influenced by many parameters of the used technique, like using one radiation isocenter.

Acknowledgment: We are grateful to the Al-Amal Hospital for facilitating the study.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Khairy GA, Guraya SY, Ahmed ME, Ahmed MA. Bilateral breast cancer. Incidence, diagnosis and histological patterns. Saudi Med J 2005;26:612–5.
2. Arthur DW, Winter KA, Kuerer HM, Haffty B, Cuttino L, Todor DA, et al. Effectiveness of Breast-Conserving Surgery and 3-Dimensional Conformal Partial Breast Reirradiation for Recurrence of Breast Cancer in the Ipsilateral Breast: The NRG Oncology/RTOG 1014 Phase 2 Clinical Trial. JAMA Oncol 2020;6:75–82. doi: 10.1001/jamaoncol.2019.4320.
3. Remick J, Amin NP. Postmastectomy Breast Cancer Radiation Therapy. Treasure Island, FL: StatPearls Publishing, 2024.
4. McGale P, Taylor C, Correa C, Cutter D, Duane F, Ewertz M, et al. Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: Meta-analysis of individual patient data for 8135 women in 22 randomised trials. Lancet 2014;383:2127–35. doi: 10.1016/S0140-6736(14)60488-8.
5. Darby SC, Ewertz M, McGale P, Bennet AM, Blom-Goldman U, Brønnum D, et al. Risk of ischemic heart disease in women after radiotherapy for breast cancer. N Engl J Med 2013;368:987–98. doi: 10.1056/NEJMoa1209825.
6. Cho Y, Cho YJ, Chang WS, Kim JW, Choi WH, Lee IJ, et al. Evaluation of optimal treatment planning for radiotherapy of synchronous bilateral breast cancer including regional lymph node irradiation. Radiat Oncol 2019;14:1–8. doi: 10.1186/s13014-019-1257-5.
7. Pham PN, Johnston LG, Keegan K, Wei C, Vinck P. Innovative Strategies for Remotely Sampling Hard-to-Reach Populations: Assessing Phone Versus Internet Respondent-Driven Sampling Approaches Among Venezuelan Refugees and Migrants in Colombia. Am J Epidemiol 2023;192:1613-23. doi:

10.1093/aje/kwad116.

8. Madlool SA, Abdullah SS, Alabedi HH, Alazawy N, Al-Musawi MJ, Saad D, et al. Optimum Treatment Planning Technique Evaluation For Synchronous Bilateral Breast Cancer With Left Side Supraclavicular Lymph Nodes. Iran J Med Phys 2021;18:414-20. DOI: 10.22038/IJMP.2020.49211.1791.
9. Andic F, Ors Y, Davutoglu R, Cifci SB, Ispir EB, Erturk ME, et al. Evaluation of skin dose associated with different frequencies of bolus applications in post-mastectomy three-dimensional conformal radiotherapy. J Exp Clin Cancer Res 2009;28:1-7. doi: 10.1186/1756-9966-28-41.
10. Turner JY, Zeniou A, Williams A, Jyothirmayi R. Technique and outcome of post-mastectomy adjuvant chest wall radiotherapy-the role of tissue-equivalent bolus in reducing risk of local recurrence. Br J Radiol 2016;89:e20160060. doi: 10.1259/bjr.20160060.
11. Tyran M, Tallet A, Resbeut M, Ferre M, Favrel V, Fau P, et al. Safety and benefit of using a virtual bolus during treatment planning for breast cancer treated with arc therapy. J Appl Clin Med Phys 2018;19:463-72. doi: 10.1002/acm2.12398.
12. Dahn HM, Boersma LJ, de Ruysscher D, Meattini I, Offersen BV, Pignol JP, et al. The use of bolus in postmastectomy radiation therapy for breast cancer: A systematic review. Crit Rev Oncol Hematol 2021;163:e103391. doi: 10.1016/j.critrevonc.2021.103391.