Evaluation of conformal radiotherapy treatment planning of breast cancer patients: Preliminary case study patients from Persahabatan Central Hospital

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Abstract. Persahabatan Central Hospital has served radiotherapy treatment for cancer patients using linac, Elekta Precise and XiO treatment planning system (TPS) since May 2017. This study collected 91 breast cancer patients treated from May 2017 until January 2019. Most patients were preceded by surgery either mammae radical mastectomy (MRM) (83.5%) or breast conservative surgery (BCS) (16.5%). Conformal treatment planning generally performed with 2 tangential fields and most included oblique fields for treating axillary lymph nodes. Percentage of patients with clinical tumor volumes >400 cm³ was 29%, in the range of 200 – 400 cm³ was 36%, and the rest was <200 cm³. The lung volume irradiated with dose ≥20 Gy was used as one of parameters for treatment optimization. The mrm patient number with lung volume irradiated >30% was 9 persons (11.8%), in the range of 20 – 30% was 65 persons (85.5%), and <20% was 2 persons (2.6%). For the bcs patients, the number followed these criteria with lung volume of 20 – 30% was 13 persons (86.7%), and <20% was 2 persons (13.3%). Most breast cancer patients treated with radiotherapy were advanced stage preceded by mrm, treatment planning was difficult for achieving lung volume <30% that irradiated with the dose ≥20 Gy.

1. Introductions

Breast cancer is the most common malignancy in women all around the world. According to WHO in 2018, approximately 2.1 millions of women suffered from breast cancer and 627,000 died [1]. One of several breast cancer treatment modalities is radiotherapy. Generally, radiotherapy is treated to breast cancer patients who had undergone surgery. There are 3 types of surgery for breast cancer patients, they are: a) breast conservative surgery (bcs), b) modified radical mastectomy (mrm), and c) further surgery that is performed after radiotherapy for patients with advanced and locally unresectable cancer.

Breast cancer radiotherapy treatment at Persahabatan Central Hospital uses 3DCRT technique. During the planning of breast cancer treatment, organ at risk which requires high attention is the lung. This organ has clinical tolerance which highly depends on the volume exposed to radiation and it is very sensitive to radiation if the whole volume is exposed to radiation. Lung’s function will not be damage if the damage volume does not exceed the critical limit of the functional subunits (FSUs).
Therefore, to optimize the treatment planning, it is recommended that no more than 30% of the lung volume is exposed to radiation of ≥ 20 Gy dose [3].

2. Breast cancer radiotherapy patients at Persahabatan Central Hospital
Persahabatan Central Hospital is equipped with Linac Elekta Precise and XiO 5.10 treatment planning system (TPS). From May 2017 until January 2019, 91 breast cancer patients had been treated. The age distribution of patients can be seen in Figure 1.

![Figure 1. Breast cancer patient’s age group at Persahabatan Central Hospital, May 2017 – January 2019.](image1)

It can be seen that most breast cancer patients came from 41 – 50 years old group (37.4%) and followed in second by 51 – 60 years old group (26.4%). The numbers of post mrm and bcs surgery radiotherapy patients are shown in Figure 2. The numbers of post-mrm patients (83.5%) was higher than post-bcs surgery (16.5%). Mrm surgery indicated that there has been a cancer infiltration on lymph node and a surgery treatment might not be able to provide regional-local healing, thus, radiotherapy treatment on breast area and lymph node became essential.

![Figure 2. Post mrm and bcs surgeries breast cancer patients who underwent radiotherapy at Persahabatan Central Hospital, May 2017 – January 2019.](image2)

3. Radiotherapy Treatment Planning
Breast cancer radiotherapy generally uses 2 tangential fields and supraclavicular fields which consist of 1 anterior oblique and 1 posterior oblique fields, and also performed similarly at Persahabatan Central Hospital. The planning of both fields generally used one of the coinciding field edges, which can be done with half closed fields as shown in Figure 3 and 4.
Figure 3. Tangential and supraclavicular fields with one of its edges coincides in a coronal plane.

Figure 4. Tangential and supraclavicular fields with one of its edges coincides in sagittal plane.

The tangential fields were determined by several factors such as the patient’s size, pre-radiotherapy treatment (mrm or bcs), breast size and shape, patient’s ability to extend the arms upward, incision size and location, and the thickness of the patient’s chest wall [4].

Figure 5. Radiotherapy treatment planning for breast cancer patients with tangential fields post modified radical mastectomy (mrm) surgery.
Figure 6. Radiotherapy treatment planning for breast cancer patients with tangential fields post breast conservation surgery.

Figure 7. Breast cancer radiotherapy treatment planning with supraclavicular fields.

The patients were categorized based on the clinical target volume (CTV) into 5 groups, as shown in Figure 8. The result displayed that the patient with the highest CTV was group 5 with $CTV > 400 \text{ cm}^3$, the patients post-mrm and bcs surgeries reached 38 % and 53 %. It showed that the number of patients who were in the advances stage was relatively high. Also, for mrm patients, the number of patients in group 3 and group 4 were the same, which were 18 patients or 24 %. The numbers for group 2 and group 1 were relatively small with 10 % and 4 % respectively. While for bcs patients, the rest of the 47 % was distributed into group 4, 3, 2, and 1 with their respective values at 7 %, 20 %, 13 %, and 7 %.

One of various factors which determine the radiation-exposed lung’s volume is the length of the field’s lower edge which intersects the lung. Table 1 presents the number of patients who received dose $\geq 20 \text{ Gy}$ with variations of tangential field lengths for mrm and bcs patients. The distribution of mrm or bcs patients was dominated by the patients from group II and III, 40 patients (53 %) and 28 patients (37 %) for mrm, and 8 patients (53 %) and 5 patients (33 %) for bcs. The other 8 patients (10 %) were in group IV, for mrm patients, with relatively long tangential field, which were most likely patients whose cancer already advanced. For bcs patients, group I and IV respectively had 1 patient (7 %).
Figure 8. Breast cancer CTV of radiotherapy patients at Persahabatan Central Hospital, May 2017–January 2019.

Table 1. The number of patients in lung volume’s percentage which received ≥ 20 Gy dose with variation of tangential field lengths.

| Type of Surgery | Group (Length of Tangential Field in cm) | Group (Number of Patients received ≥ 20 Gy in Lung Volume) | Total |
|-----------------|------------------------------------------|----------------------------------------------------------|-------|
|                 | A (<20%)                                 | B (20–25%)                                               | C (25–30%) | D (>30%) |       |
| mrm             |                                         |                                                         |       |       |       |
| I (<10)         | 0                                        | 0                                                       | 0      | 0      | 0     |
| II (10–15)      | 2                                        | 14                                                      | 22     | 2      | 40    |
| III (15–20)     | 0                                        | 8                                                       | 16     | 4      | 28    |
| IV (>20)        | 0                                        | 2                                                       | 3      | 3      | 8     |
| **Total**       | **2**                                    | **24**                                                   | **41** | **9**  | **76** |
| bcs             |                                         |                                                         |       |       |       |
| I (<10)         | 1                                        | 0                                                       | 0      | 0      | 1     |
| II (10–15)      | 1                                        | 7                                                       | 0      | 0      | 8     |
| III (15–20)     | 0                                        | 2                                                       | 3      | 0      | 5     |
| IV (>20)        | 0                                        | 0                                                       | 1      | 0      | 1     |
| **Total**       | **2**                                    | **9**                                                   | **4**  | **0**  | **15** |

The percentage of lung volume which received dose ≥ 20 Gy was divided into 4 groups, A (< 20%), B (20 – 25%), C (25 – 30%), and D (>30%). Table 1 demonstrated that the highest number for mrm patients came from group C, which was 41 patients (54%), followed by 24 patients from group B (32%). On the contrary, for bcs patients, the highest number came from group B which was 9 patients (60%), and followed by 4 patients from group C (27%). For group A, the possibilities that might happen to the patient were not found among the mrm patients, and found only on 1 bcs patient. Meanwhile in group D, it occurred only to mrm with 9 patients (12%) and who might have advanced cancer.
4. Discussion and Conclusion
This pre-research provides example of the condition of breast cancer patients who underwent radiotherapy in country. If the percentage of patient number is assumed represent the risk factor of women suffering from breast cancer, it appears that the risk factor is high (78.1%). It happens to women whose age ranges from 40-70 years old and unequally distributed. The risk factor is lower for young women (<30 years old) or elderly women (>70 years old).

Out of 91 patients who went through radiotherapy, 76 patients (84%) underwent the mrm surgery treatment beforehand, while the rest experienced bcs surgery. It shows that patients who come for radiotherapy are mostly in advanced stage. For advanced stage patient, commonly internal mammary lymph nodes were included into the CTV. As the consequences, it becomes difficult to administer the prescription dose and at the same time to save the lung OAR. Lung damage is initially signed by acute pnaeumonitis which occurs approximately 2-6 months after radiation, and then followed by slowly growing fibrosis in several months or years after the treatment. The severity depends on several factors, such as volume and dose. Lung is highly sensitive to radiation for all the volume, but a small fraction of volume can hold relatively higher dose without reducing its function [5].

There were 78 patients (85.7%) whose 20-30% of their lung volume fractions were treated with dose ≥ 20 Gy. In addition, there were 9.9% patients whose >30% of their lung volumes had to receive dose ≥ 20 Gy, and all of them were from mrm patient group. For bcs patients, who were commonly patients in early stages, the planning optimization resulted with <30% of the lung volume fraction to receive dose ≥ 20 Gy. From this preliminary study, it is shown that the success of planning optimization will be achieved if the patient is at early stage. Therefore, the importance of early breast cancer detection shall be widely informed in order to maximize the success of the radiotherapy treatment.

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