Tangential Film Verification for Lung Volume Involvement in Breast Cancer Radiation Treatment: East Coast Malaysia Experience

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ABSTRACT: Post mastectomy or lumpectomy irradiation of the chest wall or breast is common practice to minimize the local recurrences. Chest wall irradiation is a complicated technical procedure as the pathological target volume involves the normal structures like lung, heart, and head of humerus, esophagus and trachea known as organ at risk. The aim of this study was to verify the cases of the conventional tangential field technique among the breast cancer patients from year 2006 to 2011. In this study, the previous data of breast cancer patients treated with radiation from 2006 to 2011 were evaluated. Conventional 2D planning was done by taking body contour of the patient. Tangential verification films were taken in patients where excess of lung volume was suspected. The data was analyzed to verify the real lung volume irradiated. From a total 112 patients underwent tangential verification films during that period, 33% of patients underwent breast conservative surgery (BCS) while the rest underwent mastectomy. The depth of the field from the skin to 90% isodose ranges from 2.0 to 8.0 cm. However, 15 (13.4%) out 112 patients needed a replanning. As a conclusion, from 112 cases, the numbers of re-plan cases for year 2006 to 2011 were only 13 (11.61%) which is less than 15%. This result can be used by the centre who no dot have the facilities for simulation to verify the depth dose in 2D planning.

Keywords: Breast cancer, radiotherapy, mastectomy, tangential field, lung volume, breast conservative surgery

Introduction

Breast cancer is the second most common cancer throughout the world, and is the most common cancer in women, according to the World Health Organization (WHO) . In 2006, Breast Cancer was the most common cancer among female and the most important cancer among population regardless of sex in Peninsular Malaysia (Malaysian Cancer Statistics, National Cancer Council Malaysia (MAKNA). There were 3525 female breast cancer cases registered in National Cancer Registry (NCR) for that year, accounted for 16.5% of all cancer cases registered.

Surgery in the form of mastectomy or breast conservation surgery (BCS) is the one choice of treatment for the breast cancer patients depending on operability and the stage of the disease. In worldwide, women with stage I and II breast cancer usually undergo the breast conserving surgery. Then, the patients need radiotherapy and chemotherapy as adjuvant treatment following the surgery. Radiotherapy plays an important role in the local control of the disease and axillary lymph node recurrence.

The treatment planning for the breast cancer treatment is the most complex and difficult to execute in daily treatment (Figure 1). The common technique used in breast cancer treatment is tangential field technique. The main advantage of this technique is less time consuming and short waiting period for starting the treatment. Besides that, various complex techniques such as CT planning, 3D CRT, IMRT planning was also in practice in selected centers. However, most of the techniques were time consuming and need special equipment for the execution of treatment. The important consideration while planning is how to match the fields to avoid the hot spot inside the target area and reduce dose to normal structures like lungs, heart, and head of humerus, trachea, and esophagus and opposite breast. This study will be a reference for the center without the latest facilities for CT simulation planning and the center which their work load is more for doing the verification routinely.

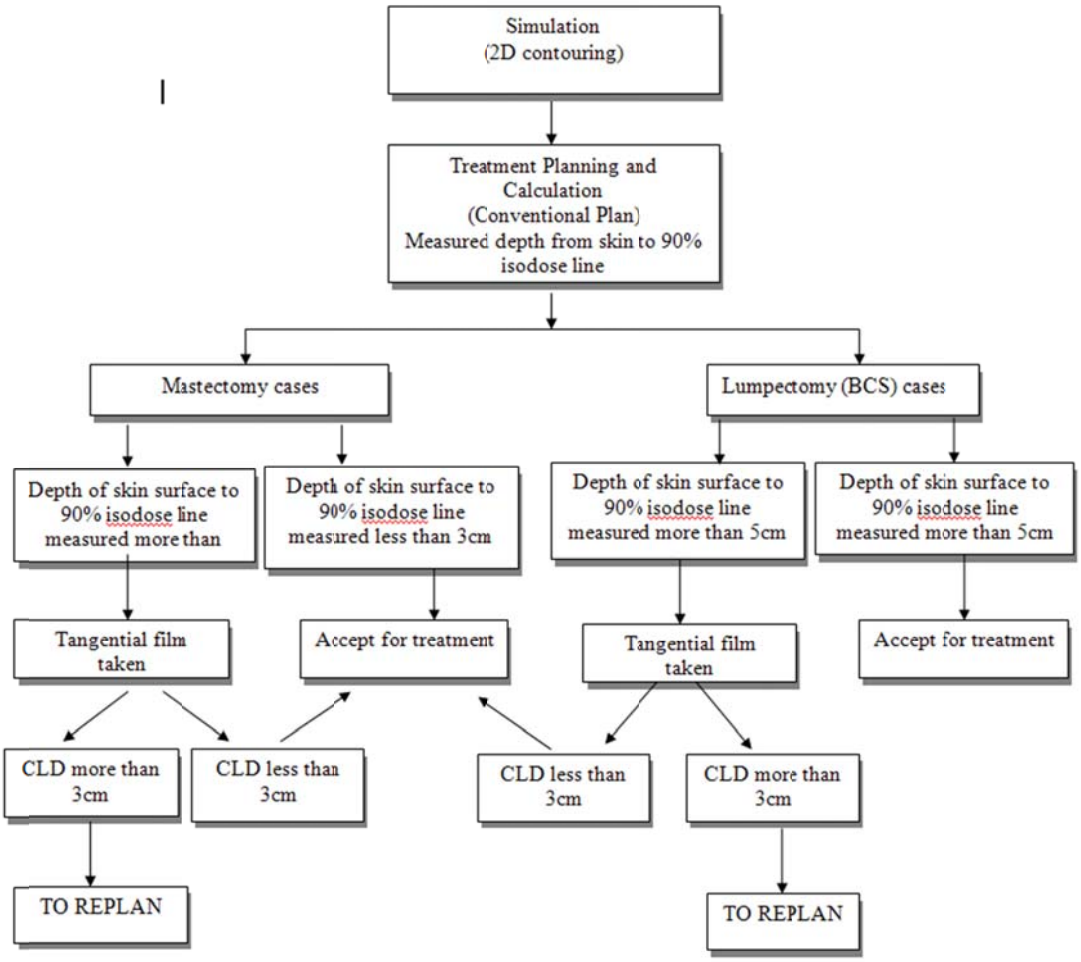

Figure 1: The diagram of conventional breast treatment planning process for mastectomy and lumpectomy (BCS) cases.

The major limiting factor in the treatment of breast cancer is the involvement of the lung in the field of radiation. As the chest wall along with inter costal muscles forms the target volume, part of the lung will definitely come into the field. However, we cannot include more than 3 cm of the lung volume which is equivalent to approximately 20% of lung volume. A previous study done by Shah *et al*. (2008) proved that, the dose to ipsilateral lung tissue irradiated varied from 0% to 6.6% which is 0 to 3.3 Gy in case of mastectomy while 0% to 13.54% which is 0 to 6.77 Gy in case of BCS for a prescribed dose of 45 Gy at 2 Gy per fraction ,five fractions a week using medial and lateral tangential beams for a linear accelerator (6 MV) as regard to possibility of stochastic effect at more than 20 Gy[3]. A study done by Nielson *et al*., (2003) concludes that the

best predictor for the percent of ipsilateral lung volume treated by tangential fields is the central lung distance (CLD). CLD is the perpendicular distance from the posterior tangential field edge to the posterior part of the anterior chest wall through the isocentre (Figure 2) .The CLD is directly correlated to the percent-irradiated lung volume which is 0.6%/mm for left breast lung and 0.5%/mm for the right lung. It was also means that 18% of left lung and 15% of right lung are irradiated using 3 cm as a maximum for CLD. For CLD is less than 3 cm, it is mean less than 20 % of the lung volume was irradiated. The different of thickness for BCS and mastectomy breast made the CLD for each breast is different and further dose received by sensitive organs are different.

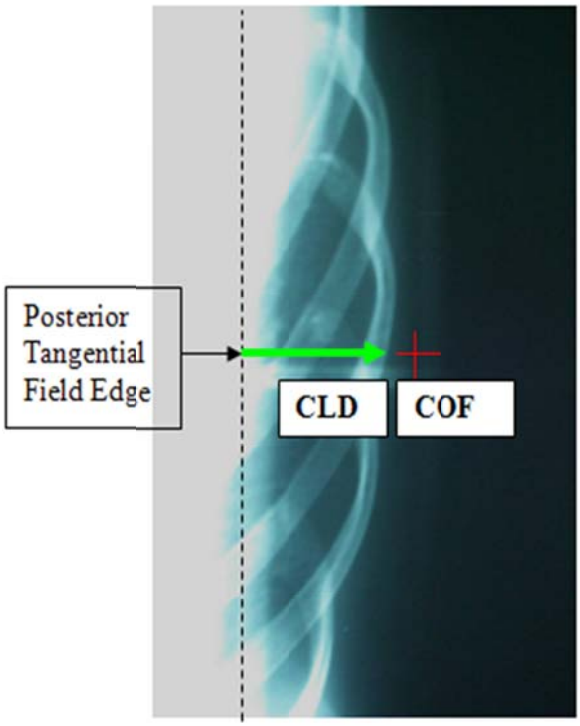

Figure 2: Measurement of lung volume involvement from tangential verification film.

Materials

This retrospective study was carried out at the Radiotherapy Department, School of Medical Science, Hospital Universiti Sains Malaysia (HUSM) based on the previous data from 112 cases of breast cancer radiotherapy treated patients from year 2006 to 2011.

Methods

Conventional treatment planning was done based on patient's body contour from the simulation process. Important information such as separation of the body for anterior-posterior and right-left lateral was taken. The patient's body's contour was traced and the information was digitized by treatment planning computer system and treatment based on tangential technique was planned by a physicist (Figure 3).

From the planning, the depth from skin surface to 90% of isodose line was measured. For mastectomy cases, for patient with depth of skin to 90% isodose line more than 3 cm, tangential verification film were taken in these cases, they were suspected to get an excess of lung volume involvement. Central lung distance (CLD) was measured from the digitized data for these cases (Figure 3). For CLD less than 3 cm, the treatment was accepted but for CLD more than 3 cm, the RE-PLAN procedure was carried out. In case of mastectomy patient with a depth from skin surface to 90% of isodose line less than 3 cm, the treatment planning was accepted (Figure 1).

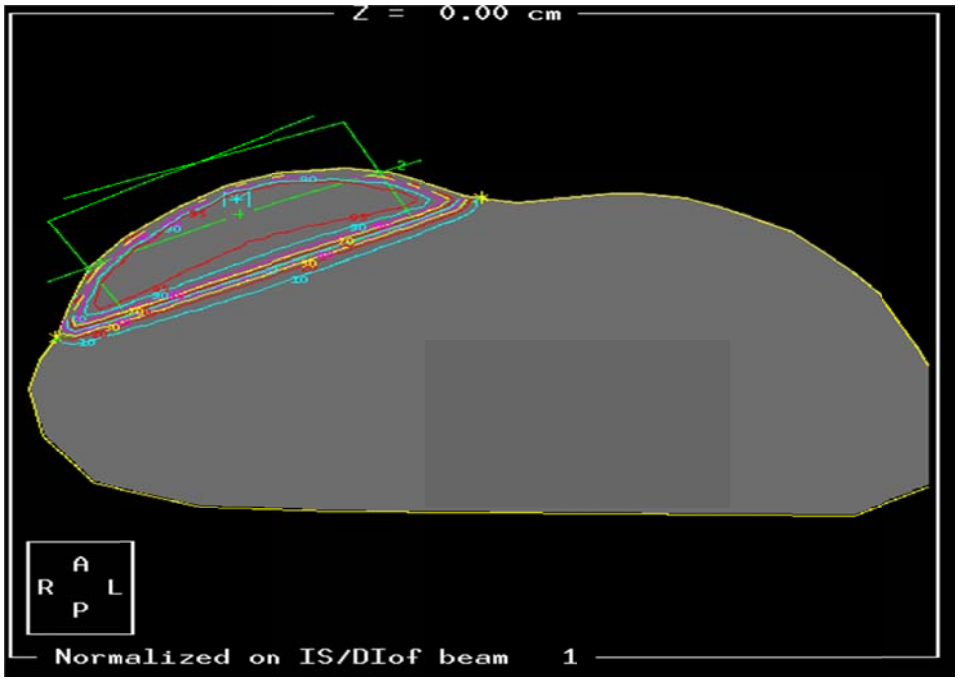

Figure 3: The distance from skin to 90% isodose line measurement from 2D plan for tangential technique for breast cancer treatment.

For lumpectomy (intact) cases, the procedure was almost same with mastectomy cases except the acceptance depth of skin to 90% isodose line must be less than 5 cm. For the cases of depth more than 5 cm, tangential verification film was taken. For CLD less than 3 cm, the treatment was accepted but for CLD more than 3 cm, the RE-PLAN procedure was carried out. All the data were analyzed to verify the real lung volume irradiated (Figure 4).

Figure 4: Treatment of breast cancer with Siemens Mevatron Linac in HUSM

Results and discussion

Table 1 shows a total of 112 patients undergo breast irradiation during this six years study. 33% of patients underwent breast conservative surgery (BCS)/ lumpectomy and rest underwent mastectomy surgery. Measurement of depth from skin to 90% of isodose level for conventional planning ranges from 2.0 to 8.0 cm due to variation of the breast thickness. For mastectomy cases; 37.5% of these measured patients have depth of skin to 90% isodose line more than 3 cm which were 8% higher than depth of skin to isodose same or less than 3 cm. For patients underwent breast conservative surgery which have intact breast, depth of skin to 90% isodose line less than 5 cm was considered acceptable to minimize the volume of lung irradiated. The numbers of patient with depth more than 5 cm were 18 cases while for the depth less than 5 cm were 19 cases.

Table 1: Summary data of the depth (cm) from skin surface to 90% isodose for mastectomy and lumpectomy (intact) cases

Case	No. of patients	Depth (skin surface to 90% isodose)	
Mastectomy		≤ 3cm	>3cm
	75	33	42
Lumpectomy (intact)		≤ 5cm	>5cm
	37	19	18
Total	112	52	60

For mastectomy which distance from skin to 90% of isodose line more than 3 cm, tangential verification films were taken to measure CLD that reflected the volume of lung irradiated. For mastectomy patients, 13 cases of re-plan were identified because 56% of them have CLD more than 3 cm. Maximum CLD measured from film verification was 3.68 cm. Besides that, the maximum volume of lung included in the treatment field for BCS patient was 2.96 cm. From 25 of verification films, there were 2 re-planned cases identified (Figure 5). CLD measured by the physicist to make sure that less than 20% of lung volume involve in treatment fields. If the CLD measured more than 3 cm, some changes were done to original plan.

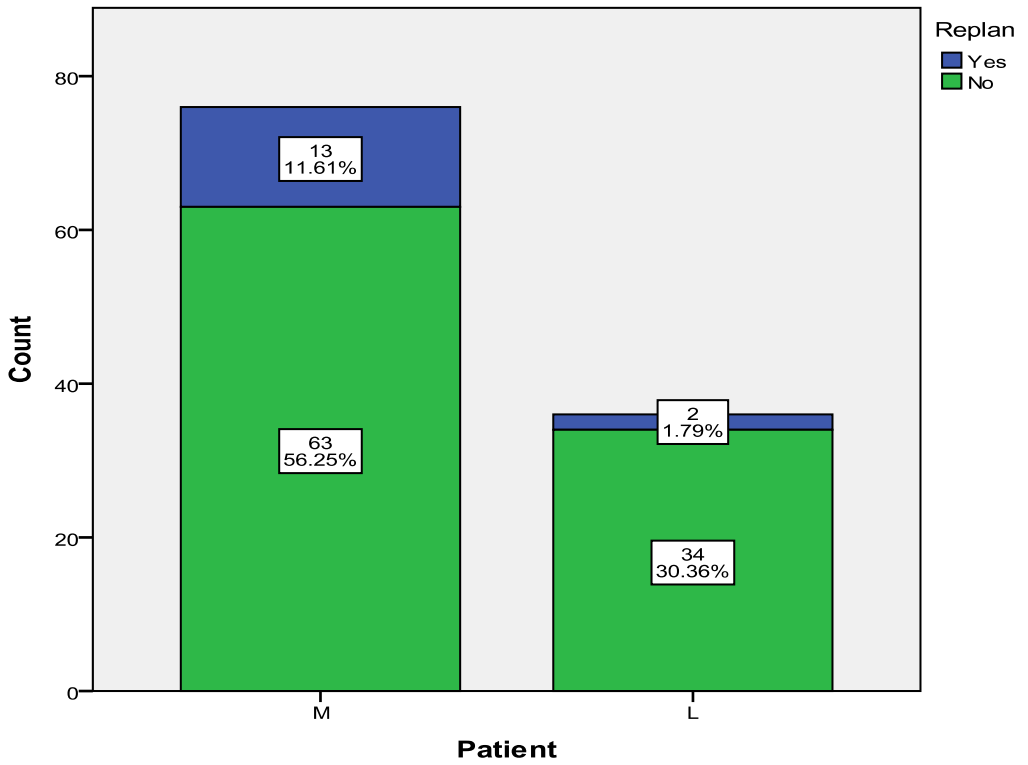

Figure 5: The histogram of re-planned cases for mastectomy (M) and lumpectomy (L) (intact) breast

According to Table 2.0, distance from skin to 90% isodose line was re-measured when the original plan has been changed. The distance for the new plan was reduced by 0.7 cm in average. The highest CLD value that has been measured was 3.68 cm which AP/PA and lateral body separation of that patient was 20 cm and 30 cm respectively. From the data, the lowest CLD value from the table was 3.05 cm for 2 patients but the AP/PA and lateral body separation of those patients were slightly same with the highest CLD patient. So that, CLD was not affected by anterior-posterior and lateral body separation.

Table 2: The data of re-planned cases for mastectomy

No.	Depth to isodose from original plan (cm)	CLD (cm)	Depth to isodose after replanning (cm)	Separation (cm)	
				AP/PA	Lat.
1	3.7	3.08	3.4	20.0	29.8
2	**4.0**	**3.05**	**3.5**	**21**	**31.4**
3	4.7	-	3.2	20	31.5
4	4.7	3.20	3.2	19.0	31.5
5	4.6	3.33	3.2	21.3	34.4
6	5.0	3.59	4.5	17.5	28
7	4.4	3.52	3.5	18	34.8
8	3.5	2.93	3.5	23.5	37.2
9	3.7	3.5	3.4	18.4	25.2
10	**5.0**	**3.68**	**4.0**	**20**	**30**
11	6.0	2.94	5.5	19	32
12	3.4	3.2	3.0	-	-
13	**4.0**	**3.05**	**3.5**	**20**	**31**

There were 15 (13.4%) re-planned cases in this study since June 2006 to March 2011 (Table 3). 13 (11.61%) out of 15 were from mastectomy patients and the other 2 were from lumpectomy patients. The result shows, mastectomy patients are more often re-planned than BCS patients. The chest wall thickness is dependant in various factors. The chest wall with certain thickness plays important roles in the underlying lung depth involvement. The highest cases were recorded in the year 2008 (4 cases). There are 2 re-planned cases that involved BCS in 2007 and 2009. In 2011, there was no re-planning procedure from 8 cases. From the data, 15 out of 112 patients required re-planning due to excessive involvement of lung volume. From 15 re-planned cases, 13 of them were mastectomy patients which reflect 86.7% from overall re-planned cases. From the data, there was a significant relationship between depths of lung included in the field with number of cases re-planned for mastectomy patients. For the depth more than 3 cm, patient required a re-planning procedure. This trend cannot clearly be seen in BCS patients. The table also shows there were 63 cases of left breast cancer patients and 49 cases of right breast cancer

patient. Patients with left breast cancer are more risky to cardiac complication because of anatomy of the heart. During the treatment planning procedure, all the precautions taken to avoid any risk of cardiac complication to the patient.

Table 3: The summary of re-planned cases at HUSM from year 2006 to 2011

Year	Numbers of Cases	Rt. Breast Cancer	Lt. Breast Cancer	Numbers of Re-Planned Cases		
				Mastectomy	BCS	Total
2006	12	4	8	2	0	2
2007	49	24	25	3	1	4
2008	24	11	13	4	0	4
2009	8	4	4	3	1	4
2010	11	2	9	1	0	1
2011	8	4	4	0	0	0
Total	**112**	**49**	**63**	**13**	**2**	**15**

Due to the complex geometry of the target area of breast cancer, its treatment and dose distribution is complicated and inclusion of a small portion of underlying lung area in the treatment field while treating the breast cancer is inevitable risk of late toxicities which related to volume receiving the dose higher than 20-25 Gy or more. By measuring CLD, the physicist made some changes to the original plan to spare the lung tissue from getting excessive dose. Adjustment to the lateral border has been done by shifting it up 1 cm from the previous border with permission from the oncologist. If the thickness of chest wall was very small, 0.5 cm to 1.0 cm bolus were applied to extend the depth and prevent high dose to lung tissue but the dose to the skin will be increased. For breast cancer patients who have undergone mastectomy and be treated with external beam radiotherapy, there was unavoidable presence of lung tissue in the treatment field. It was because radiotherapy treatment planning of the chest wall is complex due to missing tissue, the thin chest wall (less than 2.5 cm) and the presence of lung.As the result, there was higher dose received by the low density of lung in mastectomy breast compared to BCS. The near position of normalization point to the lung, contributed to the higher lung dose especially for the nearest point to the treatment field. Lung tissue has a lower electron density

than muscle and fat, resulting in less attenuation of the primary beam. This made the high radiosensitive of lung tissue received high dose during radiotherapy. The lateral tangential fields that enter laterally to the target volume also increased the dose by producing high internal scatter to that point.

Conclusion

From the study, we noticed several factors such as the contour of the chest wall, thickness of the chest wall; surgical procedure and general condition of the patient play a very important role. Tangential planning shows if the depth is less than 3 cm, lung volume involvement will be less. In our study, the re-planned for mastectomy cases were only 13 (11.6 %). In the other hand, only 2 out of 37 BCS patients with lung depth calculation more than 5 cm were subjected to re-planning. Overall, only 15 patients (13.4%) out of 112 patients needed a re-planning.

As a conclusion, from 112 cases, the numbers of re-planned cases for year 2006 to 2011 were only 15 (13.4%).This is less than 15%. Furthermore, our study will help more centers who do not have the facilities for simulation to verify the depth dose in 2D planning.

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