Left Breast Cancer Treated in Isocentric Lateral Decubitus (ILD) Position: An Alternative Technique Sparing Organs at Risk (OAR)

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Abstract: Purpose: This study was designed to evaluate the doses delivered to two main organs at risk (OAR): the heart and left lung.

Materials and Methods: Field design is as follows: the upper border is situated above the upper limit of the breast; the medial border is in the midline, adapted to the individual patient’s anatomy. The lateral (posterior) border is placed 1-2 cm beyond any palpable breast tissue. The inferior border is 1-2 cm below the inframammary fold. This field design allows the treatment of the whole breast, defined clinically by palpation plus a 1-2 cm margin. The isocenter is placed at mid-thickness of the flattened breast. For the medial field, the gantry is usually inclined up to 10°. A simulator computed tomography (CT) scan (Toshiba LB Aquilion) is used to perform localization films of both fields and several CT slices. The CT images are transferred to the Eclipse three-dimensional (3D) treatment planning system allowing graphic verification of the beam position. Using virtual simulation, two medial and lateral isocentric tangential beams with matching posterior borders are set up. In all patients, the breast volume, heart and lung were delineated and dose-volume histograms (DVH) were evaluated. Day-to-day reproducibility was easily verified by using the distance from the top of the treated breast to the corner of the epoxy disposer. Weekly portal imaging controls of both fields were performed in all patients. Individual dosimetric planning was performed with Eclipse V10 software (Varian) and a photon_AAA_100282 algorithm (calculated grid size: 0.25 cm).

Results: From March 2012 to February 2013, fifty consecutive patients with early left breast cancer were studied: 33 received a total dose of 66 Gy dose /33 fractions (50 Gy to the breast and 16 Gy boost to the tumor bed), 17 pts received a dose of 41.6 Gy/13 fractions/ 5 weeks. In the 33 pts who received a total dose of 66 Gy, the heart received a mean dose of 1.71 Gy [1.28;2.69]. In the 17 pts who received a total dose of 41.6 Gy, the heart received a mean dose of 0.77 Gy [0.33;1.60]. In the 33 pts who received a total dose of 66 Gy, the lung received a mean dose of 0.97 Gy [0.57;1.61]. In the 17 pts who received a total dose of 41.6 Gy, the lung received a mean dose of 0.71 Gy [0.23;1.90].

Conclusions: Irradiation of the heart and lungs is extremely low in the lateral position using the 3D isocentric technique, despite the good coverage of the breast. This technique appears to be associated with a limited risk of heart and lung complications.

Keywords: Left side breast cancer, radiotherapy, organs at risk, lateral.

INTRODUCTION

Radiation therapy to the intact breast is an integral component of breast conservation management, as adjuvant radiation therapy has been clearly demonstrated to improve local tumor control [1]. However, increased cardiac mortality among irradiated patients may offset the potential benefit in terms of a reduced risk of recurrence or death from breast cancer [2-5]. A report from Canada described a 2% incidence of fatal cardiac toxicity for left breast radiation and 1% for right breast radiation [4]. As many as 9% of irradiated breast cancer patients also suffer from radiation-induced lung sequelae [2,3].

A treatment setup using only opposed tangential beams is now the beam arrangement most commonly used for intact breast radiation in the dorsal supine position. The possibilities and limits of commonly used techniques for breast irradiation with two tangential fields in the supine position have been discussed over recent years [6,7]. Optimized radiation treatment planning plays a critical role in the care of breast cancer patients. The volume of irradiated heart, lung and contralateral breast must be considered. Treatment-related complications include cardiovascular morbidity that can result in an increased risk of long-term mortality and chronic radiation-induced pneumonitis [8]. This potential toxicity represents a real challenge for radiation oncologists, especially in patients with heart and lung disease. Radiation mortality and morbidity are technique- and dose-volume-dependent. The early and late complications of radiation are directly related to the patient’s anatomy,
total dose delivered, fractionation scheme and radiation technique.

Several institutions have reported the use of various techniques designed to improve dose distribution within the breast, decrease acute toxicities, decrease the dose to normal tissues and improve the daily reproducibility of radiation therapy in women with large breasts [9,10]. In patients with large pendulous breasts, irradiation in the lateral decubitus position has been performed at our institution for more than 40 years [11]. The isocentric lateral decubitus position (ILD) is an original radiotherapy technique developed at the Institut Curie over the last 17 years and one thousand patients have now been treated with this technique. Computed tomography (CT) planning has been introduced for all patients treated in the ILD position [12, 13]. This study was designed to evaluate the doses delivered to two main organs at risk (OAR): the heart and left lung.

MATERIALS AND METHODS

Description of the Breast Irradiation Technique

Target Volume

The whole mammary gland is treated, together as the dermal lymphatics and nipple and areola. A boost to the tumor bed may be delivered in some instances and is always given when the primary tumor is not surgically removed.

Patient Position

The patient is placed in the lateral decubitus position, as shown in Figures 1 and 2. The dedicated immobilization device consists of a table on which the patient is told to relax and elastic straps attached to supports using Velcro, to keep the contralateral breast outside of the irradiation fields. The contralateral arm is placed in a dorsal support to ensure maximum comfort and minimum mobility. Patient alignment is obtained by using laser projections marked on the patient’s skin. A 6 or 7 cm carbon fiber device is placed under the left breast. The support device comprises a flat surface to support the breast and a curved surface adapted to the convexity of the chest. The horizontal part is only 0.3 mm thick, allowing good preservation of the skin by limiting the bolus effect.

Treated Volume

The breast is treated with two opposed photon beams tangential to the chest wall. Field design is as follows: the upper border is situated above the upper limit of the breast; the medial border is in the midline, adapted to the individual patient’s anatomy. The lateral (posterior) border is placed 1-2 cm beyond any palpable breast tissue. The inferior border is 1-2 cm below the inframammary fold. This field design allows the treatment of the whole breast, defined clinically by palpation plus a 1-2 cm margin.

The isocenter is placed at mid-thickness of the flattened breast (SAD 100 cm). For the medial field, the gantry is usually inclined up to 10°.

A simulator computed tomography (CT) scan (Toshiba LB Aquilion) is used to perform localization films of both fields and several CT slices (Figures 1 & 2). The CT images are transferred to the three-dimensional (3D) treatment planning system (Eclipse Varian) allowing graphic verification of the beam position. Using virtual simulation, two medial and lateral isocentric tangential beams with matching posterior
borders are set up (Figure 2). The upper border of contouring of the heart is the conus arteriosus and/or right and/or left atria depending on the anatomy, the lower limit of heart contouring corresponds to the lower part of the myocardium and should be excluded from the inferior vena cava. The lateral limit corresponds to the lateral limits of the myocardium. The pericardium can be excluded by a 1 cm medial boundary area contouring the myocardium [14].

In all patients, the breast and boost volume, heart and lung were delineated (Figure 3) and dose-volume histograms (DVH) were evaluated. Day-to-day reproducibility was easily verified as already reported [13]. Individual dosimetric planning was performed with Eclipse V10 software (Varian) and a photon_AAA_100282 algorithm (calculated grid size: 0.25 cm) (Figure 4).

**Dose and Fractionation**

A dose of 50 Gy is delivered to the entire breast in 25 fractions over 5 weeks (single dose of 2 Gy daily, five weekly fractions), followed by a tumor bed boost of 16 Gy in eight fractions. The boost reduced volume was treated in the same position. Other scheme administered a total dose of 41.6 Gy in 13 fractions (single dose of 3.2 Gy daily, three weekly fractions) have been used in patients older than 60 years, node negative tumors who did not need a boost (small, low grade lesions).

**Energy**

Treatment is delivered by photons with an energy of 6 MV or 4 MV both fields are treated each day.

**RESULTS**

From March 2012 to February 2013, fifty consecutive patients with early left breast cancer were studied: 33 received a total dose of 66 Gy dose /33 fractions (50 Gy to the breast and 16 Gy boost to the tumor bed), 17 pts received a dose of 41.6 Gy/13 fractions/ 5 weeks.

**Heart Dose**

In the 33 pts who received a total dose of 66 Gy, the heart received a mean dose of 1.71 Gy [1.28;2.69]. In the 17 pts who received a total dose of 41.6 Gy, the heart received a mean dose of 0.77 Gy [0.33;1.60].

**Lung Dose**

In the 33 pts who received a total dose of 66 Gy, the lung received a mean dose of 0.77 Gy [0.33;1.60]. In the 17 pts who received a total dose of 41.6 Gy, the lung received a mean dose of 0.71 Gy [0.23;1.90].

The dose-volume histograms (DVH) were always normal and dose limits to the two main organs at risk, heart and lung, are always respected.
DISCUSSION

Breast cancer is the most common cancer in women worldwide, with more than 1 million new diagnoses each year. The 5-year overall survival rate is approximately 90% and the survivors will have received radiotherapy. Radiotherapy for breast cancer exposes the heart and lung to late radiation-induced complications [15,16]. The ILD treatment technique is a simple and easily reproducible breast irradiation technique suitable for a variety of patients (patients with large breasts or pendulous breasts or presenting certain risk factors). It is indicated for breast irradiation only. This isocentric technique delivers a homogeneous dose distribution and spares the underlying lung and heart.

The dose-volume histograms (DVH) were always normal and dose limits to the two main organs at risk, heart and lung, are always respected.

With this technique, the heart was almost always situated outside of the treatment fields. The mean value of MHD, was 0.4 cm (with a maximum distance of 0.6 cm)

Deep-breathing maneuvers are responsible for lung expansion, inducing a shift of the inferior-medial aspect of the heart, an increase in heart-chest wall distance and an upward shift of the breast [15]. Therefore, cardiac volume, which was included in the treatment fields in only a few cases with the ILD technique, could have been further reduced during deep inspiration.

Even the left lung was situated outside of the treatment fields in 36 patients. A minimum percentage of left lung was included in the treatment fields in only 14 patients (28%), but CLD could be calculated in only 5 out of 14 patients.

In the other 9 patients, a small part of the lung was included in the treatment field, but did not correspond to the central axis: CLD was then positive, i.e. greater than 0 cm.

Cardiac toxicity after breast cancer is the most commonly reported radiation-induced complication. The most common clinical complications are pericarditis, congestive heart failure and myocardial infarction. Correction of cardiovascular risk factors plays an important role in prevention of cardiac complications. Total dose delivered to the target volume, dose per fraction and irradiated volume are correlated with the risk of cardiotoxicity. Conformal beams decrease the risk of complications in healthy tissue (Normal Tissue Complication Probability [NTCP]) for late cardiac toxicity [18] MHD is correlated with the mean dose to the heart.

Irradiation of the heart and lungs is extremely low in the lateral position using the 3D isocentric technique, despite the good coverage of the breast. This technique appears to be associated with a limited risk of heart and lung complications. In many cases, the dose received by the organs at risk is delivered outside the irradiation field, so it is important to validate the accuracy of the dose calculation model of the TPS in these low-dose regions.
The described technique provides good flexibility and adaptability to various clinical situations (elderly, large breast volume, pendulous breasts or pectus excavatum) and appears to be particularly suitable for patients with a history of lung and heart disease, patients receiving anthracycline chemotherapy, other cardiotoxic chemotherapies and targeted therapies [11-13, 19, 20].

CONCLUSIONS

Irradiation of the heart and lungs is extremely low in the lateral position using the 3D isocentric technique, despite the good coverage of the breast. This technique appears to be associated with a limited risk of heart and lung complications.

REFERENCES