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# Helical tomotherapy for bilateral breast cancer: Clinical experience

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ABSTRACT

We report our initial clinical experience with using Helical tomotherapy to irradiate the bilateral breasts/chest-wall and regional nodes.

*Methods:* The records of patients who received bilateral irradiation of the breast/chest-wall and regional nodes with tomotherapy were retrospectively reviewed. Clinical outcomes for tumor and normal tissues were assessed.

*Results:* From August 2011 to January 2016, nine women were identified; median age 52 years (range 37–74), mean follow up was 10.3 months (range 0.3–34). In two patients, tomotherapy represented re-irradiation to one side. All received regional nodal irradiation. The average lung V20 was 29% (range 25–35), average lung V5 was 66% (range 51–75). Average heart mean dose was 20 Gy (range 13–28).

*Normal tissue outcomes:* Acute toxicity during radiation included dysphagia (5/9), fatigue (4/9), nausea and weight loss (1/9) and skin desquamation (9/9). Two patients were lost to long follow-up and one patient recently completed treatment. Longer-term toxicity included: pneumonitis (1/6), elevated liver function tests (1/6) and sternal osteonecrosis (1/6; in patient with prior sternal surgery).

*Conclusions:* Despite the small numbers of patients and relatively short follow-up, significant clinical toxicities were observed. Given the rarity of this situation and relatively high rate of complications in this small series, considerable care should be taken in minimizing dose to normal structures. Longer follow up with larger numbers of patients will be needed to establish safe dosimetric parameters for bilateral breasts/chest wall and nodal irradiation with tomotherapy.



## Introduction

Simultaneous (synchronous) bilateral breast cancer is uncommon and occurs in fewer than 2% of patients [1–3]. Radiotherapy for simultaneous bilateral breast cancer can be challenging [4]. Targeting both breasts/bilateral chest-wall alone (without regional lymph nodes) is often reasonably well achieved with conventional bilateral tangents [5]. However, if lumpectomy cavity(ies) are medially placed, and/or if the unilateral/bilateral internal mammary nodes are being explicitly targeted, conventional tangents may not be adequate. The use of multiple electron/photon fields has also been suggested [5], but this raises issues of multiple matching fields and associated dosimetric heterogeneities [6]. Further, with any of these approaches, there are concerns regarding normal tissue exposure [6].

Intensity modulated radiotherapy (IMRT), for example with helical tomotherapy, has been suggested as a means to deliver a more-conformal and uniform dose to both breasts/bilateral chest-wall/nodal targets [4]. We herein report our initial experience of using tomotherapy to treat simultaneous bilateral breasts/chest-wall with regional nodes.

## Methods

As part of an institutional review board-approved study, we queried our electronic record system to identify patients who received bilateral irradiation of the breasts/chest-wall with tomotherapy. Their medical records (from our hospital and, as needed, outside facilities) were reviewed for demographics, comorbidities, clinical course, and acute and late toxicities. All patients were seen at least once weekly during radiation by both a nurse and radiation oncologist, and both assessed and documented acute normal tissue reactions. Patients were seen post-therapy typically every 3–4 months by one of several providers (e.g. medical, surgical, radiation

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oncologists) and post-radiation normal tissue reactions were recorded. Records from other provider's visits (e.g. primary care visits) were also reviewed.

The radiation records were reviewed to extract key anatomic/dosimetric information for both the targets (e.g. site[s] irradiated, radiation doses received) and normal tissues (e.g. dose/volume parameters to the lung, heart, etc). The dose/volume/outcome data for each patient is presented.

## Results

From August 2011 to January 2016, nine women were treated with tomotherapy for bilateral breasts/chest wall irradiation; median age 52 years (range; 37–74 years), mean follow up was 10.3 months (range 0.3–34). The patient numbers are too small for any formal statistical analyses.

In seven patients (cases 3–9) this was their first course of radiation; four had recurrent disease (cases 1, 2, 7, and 9), of which two (cases 1 and 2) had previously received unilateral irradiation (and thus the tomotherapy represented re-irradiation). Patients' clinical information and treatment sites are summarized in Tables 1 and 2.

None of the patients had a significant history of cardiovascular or pulmonary disease prior to irradiation. One patient (case 5) had radiographic evidence of emphysema, but was not symptomatic nor was receiving medical therapy for it. Four of the 9 patients were former smokers (up to 0.5 pack/day < for 10 years). As shown, these patients had relatively advanced disease, essentially all with gross nodal or local disease. All treatments were delivered with daily megavoltage CT image guidance. All patients had complex treatment volumes and the provider deemed the tomotherapy plan to be superior to the alternative conventional 3D plan (e.g. with bilateral tangents, +/− electrons). The typical total doses were 50 Gy at 2 Gy daily fractions, or 1.25 Gy BID for the re-treatment cases (with concomitant chemotherapy). Target volumes, radiation doses and bolus during tomotherapy are listed in Tables 2 and 3.

## Dosimetric quantities to organs at risk

The planning objective for lungs was V20 < 35%, mean lungs 18–20 Gy, lungs V5 < 65%. For the heart we applied ALARA policy (as low as reasonably achievable), keeping in mind to aim for V40 < 50%, V25 < 10%. Dosimetric information for organs at risk (OAR) is presented in Table 4. The average lung V20 was 29% (range 25–35), average lung V5 was 66% (range 51–75). Average heart mean dose was 20 Gy (range 13–28).

**Table 1**
Disease site and stage.

| | Right breast | Left breast |
|---|---|---|
| Case 1 | Right scar recurrence extending to the left breast | cT4N+ |
| Case 2 | cT4N3 | Recurrence: cTxN0 |
| Case 3 | cT3N1 | cT1N1 |
| Case 4 | cT2N1<br>ypT1aN1 | cT2N1<br>ypT0N0 |
| Case 5 | cT1N0 (2 foci) | cT1N1 |
| Case 6 | Anterior chest wall (sternal lesion) cT4N0 | |
| Case 7 | Recurrent scar nodules | cTxN2-3 |
| Case 8 | DCIS | cT2N1 |
| Case 9 | cTxN3<br>ypT0N0(ITC) | Recurrent scar nodules |

## Boost to tumor bed/scar technique

Eight of the nine patients were planned and received additional dose to the breast tumor-bed/chest-wall with 6–15 MeV electrons following tomotherapy. A 0.5–1 cm bolus was applied (Table 3).

## Acute tolerance

Acute toxicity during radiation is presented in Table 5. One patient's electron boost was delayed for two weeks due to marked moist skin desquamation noted just after completing 50 Gy to the chest wall via tomotherapy; her skin healed well after the treatment break (Case 3). One additional patient (Case 4) was planned to receive 50 Gy to both breasts, right internal mammary lymph nodes (IMN), right supraclavicular nodes via tomotherapy and a 10 Gy electron boost to bilateral tumor beds. During radiation, she developed increased fatigue, shortness of breath and pleuritic chest pain, with new small right pleural effusion. Due to concerns of possible radiation-associated lung toxicity, her tomotherapy was stopped at 42 Gy and she received an additional 20 Gy (in 10 fractions) to the tumor beds. Two months later her pleural effusion progressed and cytology from this was consistent with malignancy. She received additional systemic treatment and died 8 months later from progressive disease.

## Longer-term outcomes

Three patients progressed during and within the 6 months post-tomotherapy. Case 1 had local disease progression at 6 months post-tomotherapy and died of distant disease 12 months post-tomotherapy.

In case 2 the patient was diagnosed with liver and lung metastases 4 months post-tomotherapy, and died of metastatic disease two months later.

Case 3 has two years of follow up without any symptoms of radiation induced toxicity. She was recently diagnosed with mild bronchitis and was prescribed antibiotics by her primary care physician. She is alive and without evidence of disease.

Case 4 was described in the previous section.

Case 5 developed severe radiation pneumonitis with fatigue, shortness of breath requiring oxygen 2 months post-tomotherapy, with corresponding lung imaging of bilateral mid-lung and bibasilar interstitial opacities, suggestive of pneumonitis. She also developed asymptomatic elevations in liver function tests (LFT) with negative workout for other hepatic ailments.

In retrospect, the plan was optimized to minimize lung and heart doses, and the liver was not defined as an avoidance structure during tomotherapy planning. Mean liver dose was 23 Gy, the highest compared to the other cases (Table 4).

Case 6 initially presented with a non-healing breast cancer ulcer and a 4 cm breast mass in the medial chest wall adjacent to the sternum. She received neoadjuvant chemotherapy with partial response, and had a subsequent wide local excision with removal of a portion of sternum. She tolerated tomotherapy acutely well, but presented a few days post-tomotherapy with abscess adjacent to her scar on the anterior chest wall. This necessitated a prolonged course of (12 months) multidisciplinary wound management. Imaging was suggestive of changes associated with osteonecrosis. The sternum was considered part of the clinical treatment volume (CTV) and received a total dose of 50 Gy. There were no hot spots/areas within the sternum that received over 106% of the planned dose. She is currently 2 years after completion of radiotherapy without evidence of lung or cardiac disease, and without evidence of systemic disease.