A Case Study: Proton Therapy for Male Breast Cancer with Previous Irradiation

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Abstract

This is a case report of a male patient with previous radiation for a thymic carcinoma (20 years ago) who presented with a left breast cancer. He underwent a partial mastectomy followed by proton radiation therapy with a dose of 5040 cGy to the whole breast in 28 fractions with simultaneous boost to 5800 cGy to the lumpectomy cavity. Proton beam therapy was used instead of conventional photon radiation therapy to spare the heart and lung and to avoid any previously irradiated areas. This study describes the technique and comparative dosimetry for this case.

Keywords: proton therapy; re-irradiation; breast cancer; male breast cancer; particle beam therapy

Introduction

Male breast cancer occurs in 1 in 100 000 men, with a frequency that is about 1% of female breast cancer. In 2014, there were approximately 2360 cases in the United States and 430 deaths. The treatment guidelines for male breast cancer are similar to those of female breast cancer. Male patients with breast cancer often receive postoperative radiation therapy as part of their treatment, and typically, conventional photon radiation can provide adequate treatment. For some patients who have had previous radiation treatment in or nearby the presenting lesion area, postoperative adjuvant radiation therapy with proton beam therapy is preferred when treating the breast to avoid critical organs and any previously treated areas. Charged particle beam therapy has been used in the treatment of breast cancer during the past decade for both early-stage and locally-advanced breast cancer [1–4].

Case Report

In this report, we describe the case of a male patient with breast cancer who previously underwent resection and received radiation therapy for thymic carcinoma. Twenty years ago, the patient received postoperative radiation therapy with a dose of 5000 cGy using a combination of anterior-posterior and oblique fields with 6-MV photons. He remained free of recurrence but developed radiation-induced heart disease, including coronary artery disease, cardiomyopathy, and congestive heart failure, which may be due to his previous radiation therapy. He has no family history of cancer. In January 2014, he felt a lump in
his central left breast, which was biopsied and confirmed to be invasive ductal carcinoma, grade 3 (estrogen receptor(+), progesterone receptor(+), and Her-2/neu 3+ by immunohistochemistry). He underwent a left breast partial mastectomy and sentinel lymph node biopsy in February 2014. The pathology report indicated a 4-cm tumor with widely clear margins, no lymphovascular space invasion, and 2 negative sentinel lymph nodes. The cancer stage was T2 N0 M0. The patient then received systemic chemotherapy consisting of 11 cycles of weekly paclitaxel/trastuzumab, which was discontinued due to severe fatigue.

The patient then underwent evaluation for adjuvant radiation therapy. Due to the large size of the breast, previous radiation therapy, and existing radiation-induced heart disease, it was felt that conventional photon radiation therapy could have significant undue toxicity. Therefore, proton therapy was considered to treat the entire left breast and lumpectomy cavity while attempting to spare the previously irradiated medial breast tissue, lungs, and heart. The patient was set up in a Vac-Q-Fix cushion (Qfix, Avondale, PA) with the left arm up (Figure 1).

A computed tomography simulation was done for treatment planning purposes with fusion of the patient’s preoperative imaging for localization of the tumor site. Three-dimensional imaging with 2.5-mm cut was done. The treatment plan was done on the Varian Eclipse Treatment Planning System (Varian Medical Systems, Palo Alto, CA). The physician contoured all clinical target volume of the whole breast and lumpectomy site as well as normal critical structures (lung, heart, ribs). The previous treatment area was re-created.

A single-field en face with left anterior oblique direction with pencil beam scanning (PBS) proton was used to treat the whole breast to 5040 cGy while simultaneously boosting the lumpectomy cavity to 5800 cGy in 28 fractions over a period of 5.5 weeks. The beam direction is shown with yellow arrows in Figure 2. Intensity-modulated proton therapy using single-field optimization technique was done. Plan robustness was also performed. The patient’s PBS proton plan was compared with a RapidArc treatment plan as shown in Figure 2.

The proton plan spares significant dose and volume to the normal critical structures (heart, left lung, soft tissue, and bone), compared to the photon plan, while providing similar coverage to the clinical target volumes (whole breast and lumpectomy cavity) as shown in Table 1.

For the heart, the mean and maximum doses were 2 and 122 cGy with proton, compared with 310 and 810 cGy for photon, respectively. For the left lung, the mean and maximum doses were 4 and 1867 cGy with proton, compared with 793 and 3679 cGy for photon, respectively. For the esophagus, the mean and maximum doses were both less than 1 cGy with proton, compared with 192 and 681 cGy for photon, respectively.

The patient’s total treatment went well and his setup was checked with orthogonal kilovoltage (kV) imaging every day during the treatment course. The metal wires at his sternum (from his previous thorax surgery) were used as “fiducial markers” for the daily alignment between the digitally reconstructed radiograph and kV image as shown in Figure 3. The metal wire from his previous cardiac surgery was located just distal to the target volume from the beam; therefore, its presence did not affect the dosimetry.
Figure 2. The proton pencil beam scanning (left panel) versus photon RapidArc treatment isodose plan (right panel). The light blue area indicates the patient's previous radiation treatment area 20 years ago with 5000 cGy. The lumpectomy site is contoured in red, and the left breast volume is contoured in orange. The yellow arrows indicate the direction of the proton beam.

Figure 3. The daily setup using kV imaging. The alignment of metal wire under the patient's sternum (from his previous thorax surgery) on DRR and kV imaging was used for daily setup with a single LAO field. The metal wires are downstream from the beam beyond the target, so they are not affecting the dose distribution. **Abbreviations:** DRR, digitally reconstructed radiograph; kV, kilovoltage; LAO, left anterior oblique field.
The main side effects were mild fatigue and skin reaction. The patient developed a mild skin reaction toward the end of the treatment; otherwise, there was no other adverse event in his treatment course. The skin reaction is shown in Figure 4 on the patient’s last day of treatment. He developed some moist desquamation at the breast-fold and the nipple area. He was treated with Aquaphor ointment (Beiersdorf Inc., Wilton, CT) and silver sulfadiazine 1% cream (Monarch Pharmaceuticals, Bristol, TN). At his last follow-up at 1 year and 2 months after treatment, the patient is doing well with no evidence of disease or any significant side effects (Figure 5).

Discussion

Treatments for patients with breast cancer have continued to improve the survival rate over the past decade. Radiation therapy has played an integral part in the treatment regimen of most patients with breast cancer.

As survival improves and affected patients live longer, treatment complications have emerged as the major cause of morbidity, affecting the quality of life and raising healthcare costs. Even though photon radiation to the breast region to locally control the tumors has in general been adequate, it does not come without side effects. These potential side effects include soft tissue fibrosis, rib fractures, arm lymphedema, brachial plexopathy, radiation pneumonitis, cardiac complications, and radiation carcinogenesis. All of these side effects are caused by unnecessary radiation to surrounding normal structures and improvement in radiation therapy for breast cancer by reducing these side effects to the surrounding organs is clinically relevant. This is particularly significant in high-risk patient populations, such as young patients, those with expected long survival, patients with underlying diseases (heart, lung, diabetes), and those with previous radiation. The patient described in

The patient at last follow-up with no evidence of disease or significant side effects.
this case report has many features of the high-risk patient group. He had previous radiation in a nearby area, which may have caused breast cancer and cardiomyopathy, presented with underlying comorbidities, and had a life expectancy of at least 10 years. Proton therapy with PBS can deliver a superior dose distribution compared to any photon therapy technique and is expected to reduce future potential side effects and complications from the radiation treatment.

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