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Teaching Case

Radiation therapy for right-sided breast cancer in a patient with pectus excavatum: A comparison of treatment techniques

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Introduction

Pectus excavatum (PE) is the most common idiopathic chest wall deformity, affecting 1 in 300 to 1000 births.[1] Because of irregularities in chest wall shape, PE patients receiving radiation for breast cancer have increased risk of radiation dose to normal structures. Our report evaluates the suitability of different radiation techniques for a PE patient with right-sided breast cancer. Limited studies have examined radiation techniques in PE patients with breast cancer.[2-4] We were able to achieve most optimal coverage and dose distribution using volumetric modulated arc therapy (VMAT).

PE consists of a posterior depression of the lower sternum, which causes reduced anteroposterior chest wall depth, produces anatomical limitations on the heart, and is associated with sternal rotation.[1,5] Because of these irregularities, PE patients receiving radiation for breast cancer are at higher risk of dose to the contralateral breast, heart, and lungs.

Standard of care for breast-conserving therapy involves lumpectomy and radiation therapy.[6] Traditionally, radiation is administered with 3-dimensional conformal external beam radiation therapy (3D-CRT). Intensity modulated radiation therapy (IMRT) is used when 3D-CRT poses toxicity risks, as in patients with bilateral tumors or carcinomas near the heart.[2,7,8] Recently, VMAT, compared favorably to 3D-CRT and IMRT.[9,10] In this report, we evaluate prone and supine 3D-CRT, IMRT, and VMAT to optimize radiation treatment for a PE patient with right-sided breast cancer.

Case presentation

A 41-year-old female was found to have a palpable mass in her inferior medial right breast. Ultrasonography revealed a 1.5-cm hypoechoic nodule. Biopsy revealed invasive ductal adenocarcinoma. After lumpectomy with tumor-free margins and sentinel lymph node dissection, she was staged as pT1, pN0, and cM0 (American Joint Committee on Cancer stage IA). Histopathology revealed 100% estrogen receptor positivity, 15% progesterone positivity, and HER2 negativity.

She had never been diagnosed with PE, but was found to have a Haller index of 5.41 (normal, 2.5), which estimated her PE to be “severe.” She subsequently underwent right breast irradiation prescribed to 50 Gy, with 10-Gy boost to lumpectomy cavity, in 2-Gy fractions. Treatment was complicated by grade 2 skin erythema. She also began 5 years of daily tamoxifen. The patient consented to publication of this case report, which qualified for institutional review board exemption.

Conflicts of interest: None.

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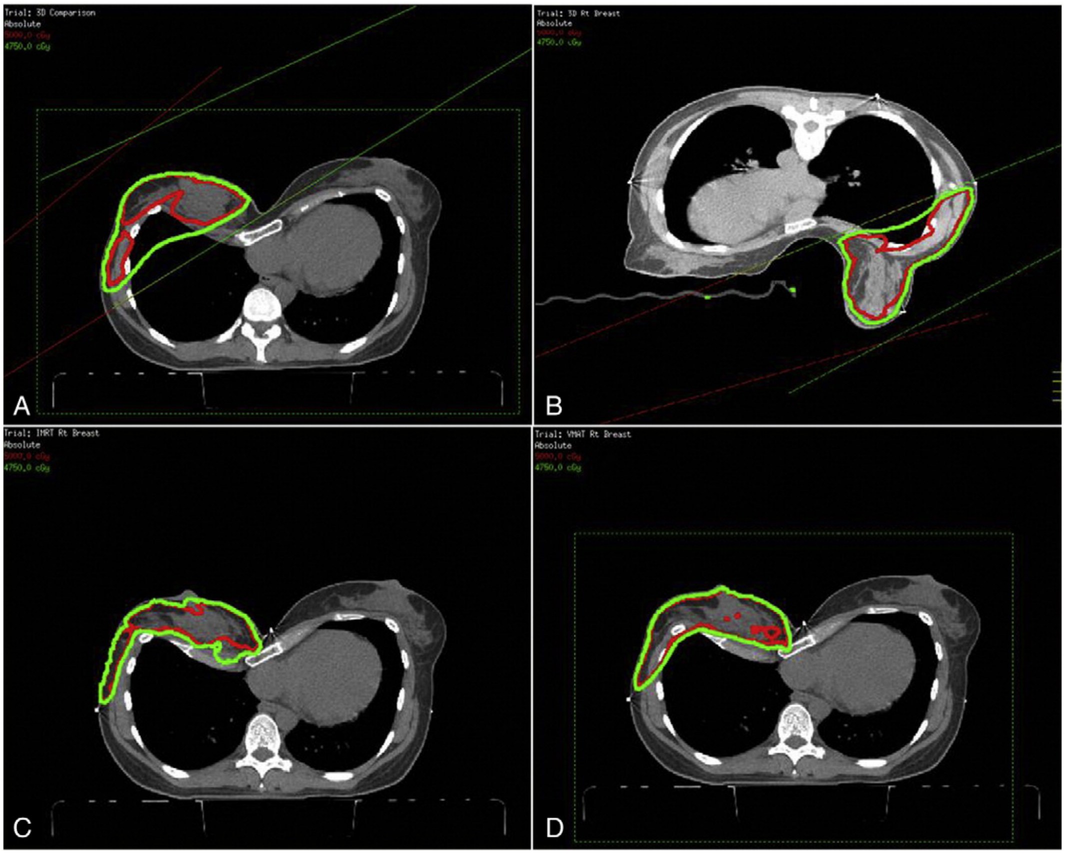

Figure 1 Plans using (A) supine 3-dimensional conformal radiation therapy (3D-CRT), (B) prone 3D-CRT, (C) intensity modulated radiation therapy, and (D) volumetric modulated arc therapy. Green depicts 47.5 Gy isodose line; red depicts 50 Gy isodose line.

The lumpectomy gross tumor volume (GTV) was contoured on the planning computed tomography scan as encompassing lumpectomy scar, residual seroma, and architectural distortion. The ipsilateral whole breast tissue was defined as the clinical target volume according to Radiation Therapy Oncology Group Consensus Guidelines of anatomical borders for breast cancer.[3] The heart, lungs, and contralateral breast were contoured and defined as organs at risk (OARs). The planning tumor volume (PTV) was created by 7mm uniform expansion on the clinical target volume. An additional *Breast PTV Eval* structure was defined for dose-volume histogram analysis. It limited PTV anteriorly by 5 mm under the skin, and posteriorly to the surface of the ribs.

Pinnacle[3] 9.10 treatment planning system (Philips Medical Systems, Fitchburg, WI) was used with a Varian TrueBeam linear accelerator using 6-MV photons. Prescription was 50 Gy to PTV in 25 fractions. Lumpectomy boost was 10 Gy in 5 fractions using 12 MeV electrons. 3D-CRT (both prone and supine positions), IMRT, and VMAT plans were created (Fig 1).

The 3D-CRT plan consisted of 2 tangential fields covering the PTV. The beam's-eye view was used to shape multileaf collimators to block OARs. Field-in-field technique was used to maximize homogeneity. IMRT planning consisted of 7 fields manually placed to reduce lung dose, with 50 iterations per optimization attempt. VMAT planning consisted of 2 arcs (gantry angle, 208-20°

Table 1 Dose constraints and target coverage for 3D-CRT supine, 3D-CRT prone, IMRT, and VMAT plans.

	Ipsilateral lung		Heart		Contralateral breast		PTV	
	>20 Gy	Mean dose (cGy)	>20 Gy	Mean dose (cGy)	>186 cGy	Max dose (cGy)	V47.5 (%)	V50 (%)
3D-CRT supine	37.0%	1804.5 ± 1937.1	0%	103.2 ± 64.3	49.5%	4736.9	88	66.3
3D-CRT prone	12.9%	668.9 ± 1386.8	0%	66.7 ± 9.0	23.7%	4786.4	77.6	56.3
IMRT	25.8%	1538.7 ± 939.2	2.3%	513.4 ± 589.3	7.4%	1033.5	86.1	65.2
VMAT	14.8%	1330.4 ± 960.6	0.7%	380.0 ± 277.2	69.8%	943.9	94.2	82.8

3D-CRT, 3-dimensional conformal radiation therapy; IMRT, intensity modulated radiation therapy; PTV, planning tumor volume; VMAT, volumetric modulated arc therapy.