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Involved field radiation for Hodgkin's lymphoma: The actual dose to breasts in close proximity

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ABSTRACT

To decrease the risk of late toxicities in Hodgkin's lymphoma (HL) patients treated with radiation therapy (RT) (HL), involved field radiation therapy (IFRT) has largely replaced the extended fields. To determine the out-of-field dose delivered from a typical IFRT to surrounding critical structures, we measured the dose at various points in an anthropomorphic phantom. The phantom is divided into 1-inch-thick slices with the ability to insert TLDs at 3-cm intervals grid spacing. Two treatment fields were designed, and a total of 45 TLDs were placed (equally spaced) at the margin of the each of the 2 radiation fields. After performing a computed tomography simulation, 2 treatment plans targeting the mediastinum, a typical treatment field in patients with early stage HL, were generated. A total dose of 3060 cGy was delivered to the gross tumor volume for each field consecutively. The highest measured dose detected at 1 cm from the field edge in the planning target volume was 496 cGy, equivalent to 16% of the isocentric dose. The dose dropped significantly with increasing distance from the field edge. It ranged from 1.1–3.9% of the isocentric dose at a distance of 3.2–4 cm to <1.6% at a distance of >6 cm. Although the computer treatment planning system (CTPS) frequently underestimated the dose delivered, the difference in dose between measured and generated by CTPS was <2.5% in 90 positions measured. The collateral dose of radiation to breasts from IFRT is minimal. The out-of-field dose, although mildly underestimated by CTPS, becomes insignificant at >3 cm from the field edge of the radiation field.

Introduction

The treatment of Hodgkin's lymphoma (HL) with radiation therapy has evolved considerably since its early applications in the 1950s. A series of changes in the extent of the fields, tumor dose, dose per fraction, type of radiation, and techniques used has taken place over the last half century. These changes have successfully achieved and maintained a high cure rate while decreasing the side effects seen in the early days of radiation.[1–4]

Despite this, the use of involved field radiation is still often questioned with respect to out-of-field radiation dose, especially to the critical organs in close proximity, namely breasts in female patients. Although multiple publications addressed the out-of-field dose,[5–9] there is a paucity of data in the literature addressing specifically the dose to the breasts in young female patients with HL treated with modern field radiation therapy. We undertook this study to determine the dose of radiation to the breasts located in close proximity of a mediastinal radiation field, using an anthropomorphic phantom. Our hypothesis is that the dose to regions in proximity to the involved field is minimal whether calculated using computer treatment planning system (CTPS) or measured.

Methods and Materials

Using an anthropomorphic phantom (Phantom Laboratories, Inc., Salem, NY), designed to simulate a female patient in the supine position (Fig. 1), with the intention to treat the mediastinum and thoracic inlet, we performed a simulation in which the phantom was placed in a supine treatment position. The room laser was used to establish the appropriate location of the isocenter on the phantom. We acquired a computed tomography (CT) scan from the level of the neck to below the diaphragm. Using the CT scans acquired, we contoured the area of the mediastinum, creating a gross tumor volume (GTV). Because the relation between breasts and mediastinal fields varies in real patients, and in an attempt to simulate this variation, we created 2 almost equal in size GTVs, one in between the breasts with the field spanning from the top to the bottom of the breasts, and the second with the bottom of the field starting at the top of the breasts (Fig. 2). The clinical target volume (CTV) was obtained by adding 1.5 cm bilaterally superiorly and inferiorly to the GTV. Planning target volume (PTV) in this case is equal to CTV because we are delivering treatment to a motionless phantom. The fields were PTV1 for the field in between the breasts and PTV2 for the field

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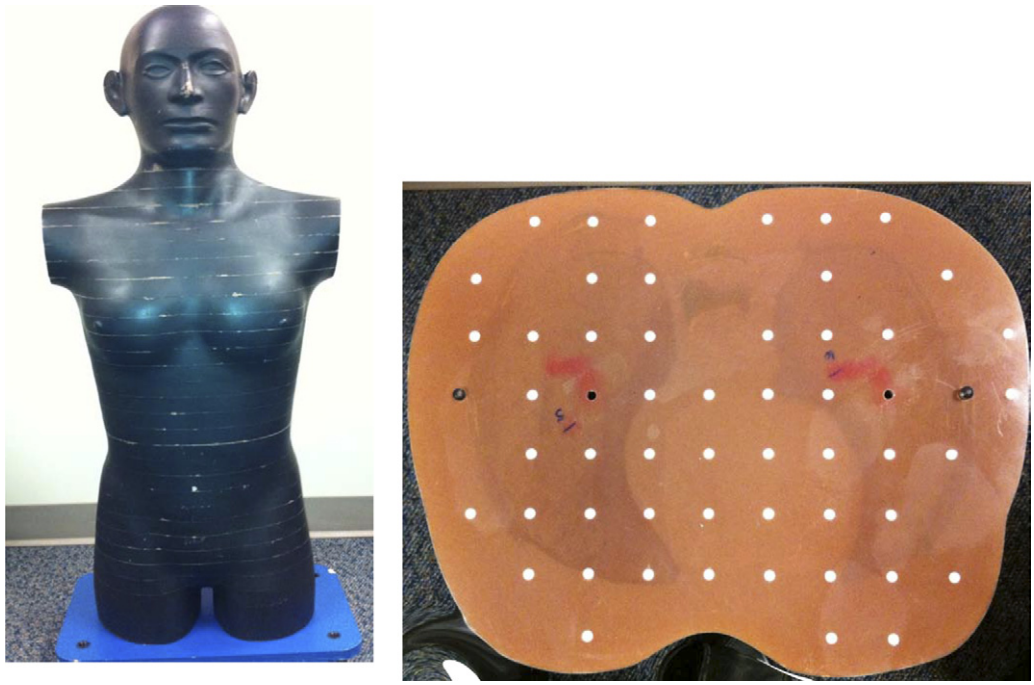

Fig. 1. Left: Anthropomorphic phantom; Right: Phantom slice showing TLD placement postions.

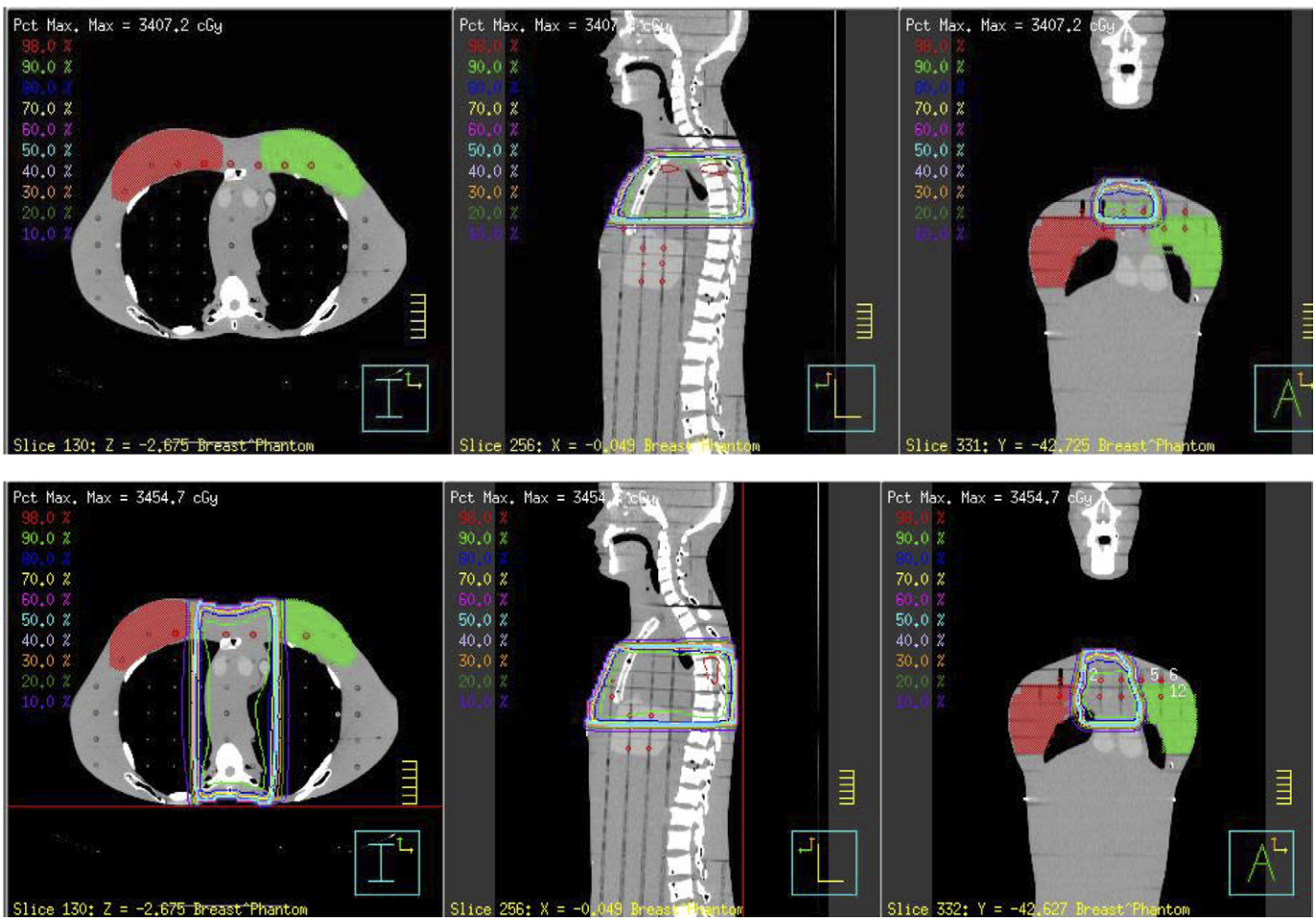

Fig. 2. Representation of the field/isodose lines of PTV1 Top and PTV2 bottom in relation to the right (red) and left (green) breasts.