Purpose: To evaluate the feasibility of a dedicated breast computed tomography (bCT) platform to deliver therapeutic dose distributions, specifically for partial breast irradiation (PBI), whole breast irradiation (WBI), and dose painting, through orthovoltage rotational external beam radiation therapy (EBRT).

Methods: Rotational EBRT using the geometry of a prototype bCT platform was evaluated by means of MCNPX Monte Carlo simulator. A 178 keV monoenergetic photon source was used to approximate 320 kVp photons filtered by 4 mm of copper, as validated by depth-dose characteristics in polyethylene. The source was rotated around a 14 cm voxelized polyethylene disk (0.1 cm tall) or cylinder (9 cm tall) to simulate primary and primary + scattered photon interactions, respectively. Simulations were also performed using bCT patient images. Beam collimation was varied in the x-y plane of rotation (1-14 cm) and in the z-direction (0.1-10 cm).

Results: As x-y collimation narrowed, 2D dose profiles shifted from a cupped profile with high edge dose (14 cm beam) to an increasingly peaked central dose. A 1 cm beam had a center-to-cylinder edge dose ratio of 14.8. Similar distributions were observed experimentally. Dose painting for multiple foci, a line distribution, and a ring distribution was demonstrated using multiple rotations with varying collimation. A homogeneous dose distribution (<5% fluctuation) with skin sparing was demonstrated by weighted summation of four dose profiles. Using 2 cm z-collimation, scatter tails decreased exponentially towards the cylinder top/bottom to 3% of maximum dose. Simulations using patient bCT images demonstrated the potential for treatment planning and image-guided therapy.

Conclusions: A bCT platform can feasibly deliver orthovoltage rotational EBRT for the treatment of breast cancer. A variety of dose distributions can be generated allowing for PBI to a single focus, dose painting, and WBI with skin sparing. Dedicated bCT is a potential platform for image-guided radiation therapy.

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