AbstractID: 14117 Title: Comparison of ellipsoidal and cylindrical breast phantoms for accuracy of Monte Carlo dose estimation in cone beam breast CT

Purpose: Monte-Carlo (MC) simulation was used to estimate doses for breast models derived from segmented CBCT images of mastectomy breast specimens. The results were compared to those estimated for half-ellipsoidal and cylindrical breast phantoms to investigate the accuracy in using them to represent real breasts in dose measurement or estimation.

Method and Materials: A previously validated EGSnrc MC package was used to form a half cone beam to simulate cone beam CT at 80kVp. CBCT images of 10 mastectomy breast specimens, covering a 130.5 mm diameter, 97.9 mm height, were segmented and binned into 100x100x75 image sets for MC simulation. Half-ellipsoidal and cylindrical breast phantoms, both with a diameter of 13cm and a height of 10cm and a breast density of 0%, 20%, 40%, 60%, 80% and 100%, were constructed and used in MC simulation. DOSXYZnrc was used to track $2x10^8$ incident photons to simulate 300 projection images over 360°. The resulting radiation dose was tallied for each voxel to study the dose distribution and average dose.

Results: Our study indicates that average doses estimated for the segmented breast models were similar to those for the ellipsoidal phantoms but significantly different from those for the cylindrical phantoms. Dose distributions for the ellipsoidal and cylindrical phantoms were found to be similar along a radius in the coronal direction close to the chest. However, those along the rotating axis were found to be different. Doses for the cylindrical phantoms were found to be smaller by as much as 56% in the slice closest to the nipple.

Conclusion: It was found that the ellipsoidal phantoms provided a better representation for patient breasts than the cylindrical phantoms in MC dose estimation. This indicates that an ellipsoidal phantom of same dimension and average density should be used in MC dose estimation or actual dose measurement.