AbstractID: 10374 Title: Dose variation with breast density in cone beam breast CT- a Monte Carlo simulation study

Purpose: By using Monte Carlo (MC) dose calculation to investigate the variation of radiation dose with the breast density (tissue composition) in cone beam breast CT, both globally and on a voxel-by-voxel basis.

Method and Materials: To simulate cone beam breast CT imaging, we first used Rep78 to build an x-ray spectrum for an x-ray tube with tungsten target and a HVL of 4.08mm Al. A collimator was defined in BEAMnrc and used to form a half-cone beam for pendant geometry used in cone beam breast CT. For validation, we compared MC dose calculations with ionization chamber measurements at 4 different locations inside the 11 cm diameter, 12 cm high cylindrical phantom under the same imaging conditions. After normalizing for the iso-center dose, the deviations were within 3.7%. 3 cone beam CT images were first corrected and filtered to minimize the cupping artifacts and then filtered to reduce the noise level. The processed images were then segmented using threshold method to separate the dense tissue from the adipose tissue. The segmented image sets were binned into a 100×100×80 image sets with a pixel size of 1mm for MC calculation. DOSXYZnrc was used to track $1x10^9$ incident photons distributed over 300 projection images over 360°. The resulting radiation dose was tallied for each voxel and averaged over all voxels in the breast.

Results: Results from MC calculations indicated that radiation dose was significantly higher in dense tissue structures and lower in the adipose tissue. The regions of higher dose were found to match the 3D dense tissue structures. The average breast dose was found to linearly vary with the breast density computed from the breast CT data.

Conclusion: Our MC study has shown a close relationship between the radiation dose and the breast density both globally and on a voxel-by-voxel basis.