Purpose: Volume-of-interest (VOI) cone-beam CT (CBCT) is a technique to image a pre-selected VOI with enhanced image quality while maintaining an acceptable average breast dose. This technique requires a high exposure VOI scan with a low exposure full-field scan. In this study, Monte Carlo (MC) simulation was used to estimate the doses of the full-field scan, VOI scan and various combinations of the two for breast imaging.

Methods: For MC simulation, BEAMnrc and DOSXYZnrc were used to simulate CBCT breast imaging and estimate the average doses. For validation, air kermas at the VOI and iso-center were measured and simulated for comparison. For simulation study, a 13-cm-diam, 9-cm-high Lucite cylinder was scanned by an x-ray source located at 88 cm away. The VOI was defined to be a 2.5-cm-diam, 2.5-cm-high cylindrical volume located at various radial positions in the middle plane of the phantom. Two scanning techniques were simulated: (1) the breast centered scan, (2) the VOI centered scan. The former requires a moving collimator to be used during the VOI scan while the latter requires only a stationary collimator to be used. 400 million incident photons were used to simulate 300 projections over 360 degrees to achieve 3D dose maps.

Results: It was found that the average VOI doses decreased by 37% in the VOI scans as compared to those in the full-field scans. The additional dose incurred by a VOI scan (VOI centered) was 6% of the dose from a full-field scan for the same x-ray techniques used.

Conclusions: Our results indicated that it is feasible to employ a high exposure VOI scan in conjunction with a low exposure full-field scan to enhance the image quality within the VOI while maintaining the overall average dose to be equal to or even lower than that of a regular full-field scan.

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