Purpose/Objective(s): The accurate volumetric estimation of structures during organ motion forms the prerequisite basis of using cone-beam computed tomography (CBCT) images for future re-planning purposes. This study aimed to solve the problem of reconstructed volume loss of moving phantoms on CBCT by phase selected 4-dimensional image acquisition.

Materials/Methods: Phantom images were separately acquired by fan-beam CT (Siemens Somatom) and CBCT using X-ray Volumetric Image System on Elekta Synergy. Three acrylic ball phantoms with diameters of 5.1 cm, 9.9 cm, and 12.2 cm, respectively, were used for static and moving experiments. CBCT and FBCT images were imported to Pinnacle treatment planning system to compare the reconstructed volumes. The imaging adjustment program of CBCT was done for modified CBCT (mCBCT) by MATLAB v7.0 to modify CT numbers by transforming the functions to relative electron density for the more accurate calculation. The phantoms on FBCT and CBCT images were contoured with the CT number of 800. To simulate respiratory movement, the phantoms were moved longitudinally on an oscillator with amplitudes of 7.5, 10, 12.5, 15, 17.5 and 20 mm, and frequencies of 8, 10, 12, 14, 16 and 20 oscillations per minute, respectively. The imaging projections of mCBCT for moving phantoms selected from the same phases were used for 4-dimensional volume reconstruction (mSortCBCT).

Results: For static phantoms with imaging adjustment program, the losses in reconstructed volume of 3 phantoms (small, medium, large) between FBCT and mCBCT were 6.20%, 2.47%, and 2.19%, respectively. For moving phantoms, the significant reconstructed volume losses of 3 phantoms seen on mCBCT were 47.45-66.04%, 23.86-33.26%, and 15.53-22.65%, respectively. The volume losses significantly increased with the larger amplitude. In contrast, the volume losses did not differ between different frequencies. More volume losses in the small than large phantoms were again shown. The losses in reconstructed volume of moving phantoms between FBCT and mSortCBCT were significantly reduced, with 4.43% using the amplitude of 7.5 mm and frequency of 20 per minute.

Conclusions: As compared to the static targets, significant volume loss was seen on mCBCT for the moving phantom. The increased amplitude, but not frequency, correlated with more volume losses. mSortCBCT using 4-dimensional phase selected projections for reconstruction reduced the volume losses for the moving phantoms.

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