

Purpose: On-board cone-beam imaging is being used to collect kilovoltage CT images for treatment position verification and analysis of tumor response. One challenge of cone-beam imaging is that full sinogram acquisition takes more than 1 minute. While breathing motion in the lungs, influence both cone-beam and fan-beam modalities, its profound effects in cone-beam CT are well known. However, there are many portions of the body where voluntary and involuntary processes can yield small motions. The purpose of this study is to investigate the influence of small motions on cone-beam reconstruction quality.

Materials and Methods: A commercial CT performance phantom (Catphan, Phantom Laboratory, Salem, NY) containing various image quality assessment tools was imaged using a kilovoltage on-board cone-beam CT system (Varian Medical Systems, Palo Alto). The imaging phantom was moved using an in-house developed “4D phantom” (with a 0.4 mm position accuracy), in sinusoidal patterns with amplitudes of 1.25mm and 2.5 mm in the three orthogonal directions and elliptical patterns with axes from 1 mm to 2.5 mm in steps of 0.5 mm. To quantify the effect on the image quality, the CT number accuracy, spatial integrity, image uniformity, high and low contrast resolution were compared.

Results: CT number accuracy and spatial linearity were unaffected by motion. While single-dimensional motion did not affect the low-contrast resolution, elliptical motion yielded degradation. The visibility of the 1% cylindrical low contrast resolution targets was 7 mm, 8 mm and 15 mm for static through 1 mm, 2.0 mm, and 2.5 mm ellipses. High contrast spatial resolution was improved slightly for in-plane motion, but degraded sharply with out-of-plane motion.

Conclusions:

This information will allow investigators to evaluate the ultimate utility of cone-beam imaging for imaging studies when patient immobilization is not perfect.