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Title: A novel Dynamic Thorax phantom for 3D-CRT and IMRT of lung lesions

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We present a Dynamic Thorax phantom for use in motion studies pertaining to lung lesions.

A prototype of a dynamic thorax phantom (CIRS, Inc., Norfolk, VA) has been designed and manufactured. Major components include a tissue equivalent thorax phantom, a precision motion actuator, and controller with 16 pre-set motion profiles. The phantom is a 15 cm section that represents an average human thorax anatomy and is manufactured from lung, bone, and water equivalent materials. The spherical tissue equivalent tumor inserts of various diameters (10-30 mm) are placed at an off central axis location inside the lung tissue equivalent rod. The rod moves inside the lung to mimic tumor sinusoidal motion in SI, AP and LR directions. That is achieved through synchronized linear and rotational motion on the lung rod. A computer programmed motion controller is used to drive the motion actuator.

MOSFET and other dosimeters can be placed in the tumors center of mass for point dosimetry. The phantom is also customized to accommodate BAREX™ containers for volumetric gel dosimetry (BANG® Polymer Gel, MGS Research Inc., Guilford, CT). The gel serves as a target.

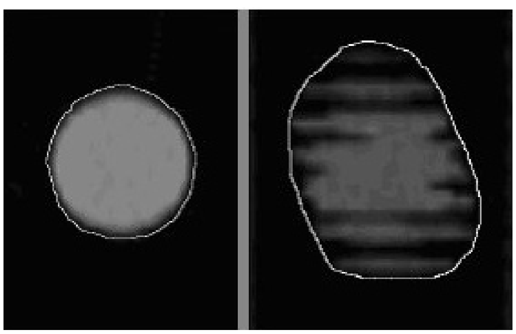

Fig 1. Coronal section of a 2 cm target depicting volume aliasing of the image on the left during pretreatment CT imaging in the presence of motion.

Preliminary imaging studies on a 2 cm target with moderate motion amplitudes of ± 5 mm SI, ± 2.5 mm AP, and ± 1 mm LR shows that as slice width increases, the clarity of the target boundary decreases while the notched-like appearance of its periphery rapidly disappears; a feature more prominent in slow (4 sec/rotation) scan techniques than in fast (1 sec/rotation) scan techniques. Geometric misses may be present, and target volumes are more reproducible at slow scan speeds. Significant changes in target CT number, as well as traces of streak and shading artifacts are evident on axial representations of the target. The physical volume of the target is overestimated by as little as 40% and as much as 21.6%. Complete imaging and dosimetry data will be presented. The novel dynamic thorax phantom provides a unique platform for a thorough understanding of motion effects on pretreatment data acquisition, as well as on dose and dose distribution during treatment delivery.