AbstractID: 3326 Title: Concept and evaluation of Averaged 4-D CT imaging in determining the internal target volume for extracranial stereotactic radiotherapy of lung nodules.

Purpose: To evaluate the accuracy and robustness of averaging 4-D images to determine the internal target volume (ITV) for small lung tumors during breathing.

Method and Materials: A Philips Brilliance 16-slice CT simulator (CT-sim) obtained axial cinematographic (cine') images (512x512 pixels, 480mm FOV) of a phantom that moved with known distance and velocity in both the longitudinal and axial planes. The CT-sim recorded 25 cine' images in each of 16 slices, 1.5mm thick to create a 24mm slab of data at different times during a motion cycle. The images at each slice position were averaged to produce composite slices. Composite slices were assembled longitudinally to produce a composite slab. Concatenated composite slabs are called an Averaged 4-D (4-D_{Avg}) image set.

Patients were scanned using the protocol above. Gross tumor volume (GTV) appearing in the 4-D_{Avg} image set was contoured to produce an mGTV (ITV minus the margin for sub-clinical disease) before superposition on beam's-eye-view DRRs and transferred to an on-line electronic portal imager (EPI) for comparison of the mGTV position to that of the GTV as observed during treatment.

Results: Phantom measurements showed key factors which govern the ability of the 4-D_{Avg} image set to accurately represent the location of objects during motion: slice thickness, cine' duration relative to the period of motion and the sampling frequency of the cine' relative to the duration of motion at its extremes. We determined the position of objects undergoing a 0.2Hz movement over 20mm to within approximately 1.0mm. Similar results were obtained for a patient in the stereotactic body frame using an EPI.

Conclusions: For tumors with motions having a frequency about 0.2Hz over a 20mm range, one can obtain positional accuracy within approximately 1mm using the 4-D_{Avg} technique outlined above.

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