AbstractID: 1986 Title: Dose reconstruction in deforming anatomy: methods and clinical implications

A previously described mutual information-based image registration scheme (using thin-plate spline warping) provides a transformation that allows tracking of points between inhale and exhale treatment planning data sets (and/or intermediate state scans). In this study we investigate the accumulation of dose to deforming anatomy (such as lung) based on voxel tracking and using time weighting factors derived from a breathing probability distribution function (p.d.f.). Dose distributions are computed at the same resolution on each data set using full density corrections (e.g., DPM Monte Carlo). Two accumulation/interpolation approaches are assessed. The first maps exhale dose grid points onto the inhale scan, estimates the doses at the "tracked" locations by tri-linear interpolation and scores the accumulated dose (via the p.d.f.) on the original exhale data set. In the second approach, the "volume" associated with each exhale dose grid point (exhale dose voxel) is first sub-divided into octants. Differences between the interpolation schemes are voxel size and tissue density dependent, but in general appear primarily only in regions with steep dose gradients (e.g., penumbra). As these differences are small (less than $\pm$6%) they seldom result in clinically significant differences to volume-based evaluation metrics such as NTCP or EUD beyond those already computed for the deformed anatomy relative to the "exhale only" dataset. The overall effects of dose accumulation with deformation are variable among patients, being dependent on tumor location, field size, volume expansion, tissue heterogeneity and direction of tumor displacement with respect to the beam.
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