Contour Propagation With Riemannian Elasticity Regularization: Abstract

Purpose/Objective(s): Adaptive techniques allow for correction of spatial changes during the time course of the fractionated radiotherapy. Spatial changes include tumor shrinkage and weight loss, causing tissue deformation and residual positional errors even after translational and rotational image guided corrections. This study compares manual delineations in replanning CT scans of head-and-neck patients to automatic contour propagation using deformable registration with Riemannian regularization. The potential benefit of locally assigned regularization parameters according to tissue type is investigated.

Materials/Methods: Planning PET-CT scans plus 2 - 4 subsequent replanning CTs for five head-and-neck cancer patients were obtained. The Gross Tumor Volume (GTV) was manually delineated on the planning CT by an experienced clinician and manually propagated by pasting the set of contours from the planning CT onto the rescans and correcting to reflect actual anatomical changes. For deformable registration, a free-form, multi-level, B-spline deformation model with Riemannian elasticity, penalizing non-rigid local deformations, and volumetric changes, was used. Regularization parameters was defined on a voxel basis, according to segmentations of bone, soft tissues and GTVs, ensuring smooth, diffeomorphic registration, while sustaining bone rigidity and allowing for large volume changes of the GTV. For comparison both rigid registration and deform registration with globally defined Riemannian regularization parameters was performed. For each replanning scan, the volume of the manually delineated and automatically propagated GTV was determined and Dice's coefficient was calculated between segmentations from the propagated contours and manual delineations. Results: The replanning segmentations showed substantial volume changes. The Dice coefficients indicate substantial improvement from rigid to deform registration with local regularization parameters. Using local regularization parameters gave a marginal improvement over global parameters. Conclusions: Deform contour propagation based entirely on the original delineation and tissue deformation in the time course between scans form a better starting point than rigid propagation. There was no significant difference of locally and globally defined regularization. The method used in the present study suggests that deformed contours need to be reviewed and corrected by an oncologist.

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