Registration of Serial CT Images in the presence of soft-tissue deformation and displacement: Dose Planning for Locally-Advanced Carcinoma of the Cervix

Integration of three dimensional (3D) imaging into intracavitary brachytherapy treatment planning has been hindered by large, localized deformations and displacements of the pelvic soft tissue structures caused by applicator insertion and tumor regression. We have adapted a novel and fundamental image registration approach, the method of deformable anatomical templates (MDAT; IEEE Trans.Imag.Proc. 5: 1435, 1996), for registration of serial 3D CT pelvic studies obtained at fixed points during definitive radiation therapy for cervix cancer patients. For example, to register pre- and post-applicator insertion CT studies, MDAT identifies the high-dimensional (10^7 unknowns), voxel-to-voxel transformation that best preserves coincidence of the contoured anatomical structures (bladder, rectum, sigmoid, vagina, uterus, bony anatomy) and uncontoured gray-scale anatomy on the two studies. This warping process is guided by the laws of continuum mechanics: each anatomical structure is modeled as a deformable elastic solid or viscous fluid. Experience with our first few study patients is encouraging: MDAT is able to model dramatic changes in shape, position, orientation and size of the soft-tissue anatomy within the bony pelvis while retaining excellent alignment of the bony anatomy and peripheral gray-scale anatomy. By transforming CT studies obtained at different times in the patient's treatment course to a common reference frame, 3D dose distributions describing different

intracavitary and external beam treatment components can be meaningfully summed.

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