modalities. Gross tumor volume (GTV) and spinal cord were contoured on MRI. Image registration of MRI and kVCT favoring GTV was repeated for 2 times for each patient. GTV and cord were then mapped to kVCT, giving GTVmap1, GTVmap2, cordmap1, and cordmap2. GTVmap1 is then expanded isotropically by 1mm 2mm 3mm and 4mm until the expanded volume encompasses GTVmap2. Similarity of the contours is defined by Dice index, ratio of overlapping volume of the contours from two registrations to the original volume. kVCT/MVCT registrations were then performed. Contours were mapped to MVCT. Dice index was then calculated.Results: For repetitive MRI/kVCT registrations, manual registration was always required to improve the accuracy, resulting in average Dice index of 0.81±0.08 for cord and 0.91±0.04 for GTV between different trials. Most patients require 2mm expansion in order to compensate for the difference between the two repetitive MRI/KVCT registrations, indicating the reproducibility of the registration has a 2mm uncertainty for GTV. Compared to the kVCT/MRI registration, kVCT/MCVT registration can be performed reproducibly with automated registration, resulting in close to 100% Dice index and 0 uncertainties Conclusions: An intrinsic 2mm error was observed for MRI/KVCT registration but not between the kVCT and MVCT. The results indicate the necessity of taking the 2 mm uncertainties into consideration in contour transfer from MRI to CT.

SU-E-J-37

An Open Platform for 2D-3D Image Registration Experiments

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Purpose: To provide a flexible environment for experimenting with various combinations of input images, arc length and resolution, projection geometries, search methods, and cost functions for projection-to-volume ("2D-3D") image registration Methods: A MATLAB graphical user interface was developed to align a series of orthogonal pairs of radiographs acquired during arc therapy to projections through a region of interest of a reference CT image volume. The projection and volume geometries are based on a distributable image registration toolbox. Experiments can use single or orthogonal radiograph series, simulations from second input volumes, modified volumes of the reference CT such as additive noise, and variable regions of interest. Two forward projection algorithms (Siddon and separable footprint) are incorporated, both mutual information and SSD metrics can be used, and search engines include conjugate gradient (for SSD), simplex, as well as direct mapping of the cost function in a user-defined local search region. Results: A number of initial experiments have been performed with this interface. The tradeoffs of local contrast and detail versus angular range, image noise, and angular resolution for identifying local transformations have been explored. The impact of removing, maintaining, or reducing CT signals outside the region of interest for alignment to radiographs has been tested. Modifications including temporal regularization to monitor movement during arc rotation are easily implemented within this open framework. Conclusions: This environment is continuously expanding, and should support collaborative investigations across institutions on common problems and solutions for projection-based image registration.

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SU-E-J-38

Tracking Changes in Head-And-Neck Rotation and Flexion Using Megavoltage Cone-Beam CT and Deformable Image Registration

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Purpose: Megavoltage cone-beam CT (MVCBCT) images used for patient positioning can also detect complex changes in neck flexion and head rotation. Deformable image registration (DIR) algorithms could automate detection of positional variability and facilitate adaptive therapy strategies. This study investigates the ability of DIR to track changes in neck flexion, jaw position, and head tilt in MVCBCT images of head-and-neck radiotherapy patients.Methods: Landmark points at the base of skull, along the cervical vertebral column and on the mandible were identified and annotated on planning kVCT and MVCBCT images of patients. Baseline MVCBCT images were first fused to the kVCT via rigid registration, and distances between corresponding landmark points were computed. The same MVCBCT images were then fused via DIR, and the vector displacement between landmark points and deformed points was calculated. The change in the distance using DIR versus rigid registration was used to quantify how well the deformation algorithm tracked the shift of landmark positions. The same tests were also performed by registering and deforming the baseline MVCBCT to another MVCBCT taken at a different time. Results: Data for 11 reference points and images from five patients were analyzed. Changes in landmark distance of greater than 1 mm were considered. Deforming the MVCBCT to the kVCT, one patient showed an average decrease in landmark distance of 3 mm after DIR. However, the landmark distance increased by an average of 2 mm for another patient. When deforming the baseline MVCBCT to another MVCBCT, all five patients showed an improvement in landmark matching. The average decrease in landmark distance varied from 0.4 mm to 3.4 mm Conclusions: Deforming MVCBCT to kVCT images of the head-and-neck region did not consistently improve landmark matching. However, DIR consistently improved landmark matching when applied to two MVCBCT images acquired at different times.

SU-E-J-39

Daily Prostate Rotation Should Be Compensated in Translational Correction and Not to Be Ignored

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Purpose: To quantify magnitude of the prostate rotation during daily treatment and evaluate strategies to effectively compensate the rotation if a six-degree table is not available. Methods: Six patients, with forty-four kilo-voltage cone beam CT (KV-CBCT), were selected for this study. On these KV-CBCTs, the prostate was contoured by a physician. These patients had three transponders implanted for non-imaging daily prostate localization using the Calypso system. To determine the prostate movement, we registered each KV-CBCT with the planning CT in four different ways: (a) manually align to the bones with translation only (Bone_T); (b) automatically align to the markers with both translation and rotation (Marker_TR); (c) manually align to the markers with translation only (Marker_T); (d) manually align to the prostate contour with translation only (Contour_T). The prostate rotations from the second method were recorded. Using the contour registration as a benchmark, two center of mass distances (CMD) between the Contour_T and Marker_TR/Marker_T registrations were calculated. Only translations were used for the CMD calculation. Results: Detected from the Marker_TR method, the mean and standard deviation of the prostate rotations about the transverse, anterior-posterior, and longitudinal axes were 3.21±6.26°, -1.39±2.91°, and -0.94±2.75°, respectively. The mean CMD between the Contour_T and the Marker_TR/Marker_T shifted prostate were 6.6 and 4.0 mm, respectively. When the rotation is greater than 10°, the differences in CMD were greater than 5 mm in 7 out of 8 (87.5%) of such fractions. When the rotation is greater than 6°, the differences were greater than 4 mm in 13 out of 19 (68.4%) cases. Conclusions: Without a six-degree table, prostate rotations were often not corrected. Compensating for the rotations with translational shifts is effective, and superior to ignoring rotations. Simply ignoring large rotations may lead to increased planning margins or inaccurate prostate localization.

SU-E-J-40

A Study of Voxel-By-Voxel Accumulated Dose for Prostate Cancer Using Deformable Registration

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Purpose: This study explores the methodology of determining accumulated delivered dose using deformable registration. The aim of the study was to examine the inter-fraction variation of dose delivered to the patient and to compare the voxel-by-voxel accumulated dose with the planned dose. Methods: Five prostate patients treated with a rectal balloon using the same 12-fraction Hi-Art Tomotherapy technique were studied. The dose was calculated on the pre-treatment MVCT images of each fraction. All 12 dose grids were then accumulated on the 12th fraction MVCT using adaptive tools in the Pinnacle treatment planning system (v9.100). The rectal wall and prostate were outlined on each fraction's pre-treatment MVCT for each patient to study the inter-fraction dose variation. Results: The absolute