registration. **Method and Materials:** Before a treatment fraction is delivered, a CT image of the patient in the treatment position is obtained. The couch is adjusted to match the planning CT image via on-line image guidance. Verification dose is calculated using this daily image. A deformable registration between the planning image and the daily image is performed and the ROIs are automatically re-contoured on the daily image. The daily dose is mapped back to the planning frame and then accumulated with the previous fraction dose. The new patient position is chosen via a procedure that optimizes the plan evaluated using the daily ROIs. The whole procedure entails the sequential execution of the following tasks: daily CT, CT-guided patient setup, deformable registration and automatic re-contouring, deformation of dose back to reference CT, dose-based patient position optimization, and plan evaluation using cumulative and daily doses. **Results:** The new couch alignment procedure was validated on clinical prostate cancer data that includes a planning CT image and 17 fraction CT images (256×256×47) with resolution of $0.1875\times0.1875\times0.3cm^3$. The whole procedure was completed in a few minutes. The DVH results indicated improved sparing of the sensitive structures and better target coverage. **Conclusion:** The new dose-based patient alignment procedure is an advancement to the image guidance alignment alone. Notable improvement in delivery dose can be achieved for certain types of treatment sites such as prostate cancer where the inter-faction positions of target relative to sensitive structures are not well correlated with the positions of rigid structures and are difficult to predict.

SU-FF-J-26

Analysis of 10,327 Pre-Treatment Ultrasound Localizations for 387 Prostate Cancer Patients Treated with Conformal 3D External Beam Radiation Therapy

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Introduction: Daily 2D ultrasound-based target localization is routinely used for the patient setup in treatment of localized prostate cancer with external beam radiation therapy. A statistical analysis of a large data set can provide insight into target margin definition. **Methods and Materials:** Data from 387 patients treated between 2001 and the end of 2005 was retrospectively analyzed. Every patient in the study received daily pre-treatment localization resulting in a total of 10,327 localizations, each comprising an isocenter shift in 3 directions: anterior-posterior (AP), right-left (RL), and superior-inferior (SI). The mean shift for each direction for each patient was computed from daily treatment records, and a mean of the means was used in the analysis. The standard deviations (SD) for each direction were also computed for each patient and averaged. The data was statistically verified for normality. The mean shifts represent systematic uncertainties in the patient setup, and the SD represent the random variations. **Results and discussion:** The mean distances required for shifting the target to the required position were 6.1 mm posterior (4.4 mm SD), 2.1 mm superior (4.5 mm SD), and 0.5 mm right (3.6 mm SD). The 6.1 mm shift posterior is indicative of a non-negligible systematic uncertainty. There are several sources of this uncertainty, the major one being the difference in patient setup and procedures between the CT simulation and the treatment room. **Conclusion:** Our study has revealed systematic inter-treatment uncertainties. The results support the use of up to a 15 mm PTV margin to encompass the CTV for 95% of our sample, if the ultrasound localization system were not used.

SU-FF-J-27

Analytical Quality Assurance Criteria For CT-MRI Mutual Information Image Fusion

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Purpose: To use point-based error metrics as an analytical criterion for CT-MRI mutual information (MI) image fusion. **Method and Materials:** A commercially available MI algorithm was used to fuse CT and MRI image sets for 5 patients. Three corresponding anatomical landmarks were manually identified on CT and MRI to initialize the fusion algorithm. All landmarks, designated A(CT) and A(MRI), were identified by a single expert user. A program was developed to extract the CT and MRI point coordinates, scaling factors and homogenous transformation matrix M from the commercial system. The parameters were used to calculate the "ideal" MRI coordinates, A'(MRI) = M*A(CT), that analytically always produce zero documented error by the manufacturer's software. The difference between the ideal calculated A'(MRI) and the user indicated MRI data set A(MRI) was then analyzed in terms of standard point-based error metrics, Fiducial Localization Error (FLE) and Fiducial Registration Error (FRE). The program also performs the inverse transformation, A'(CT) = M-1*A(MRI), into CT space for a similar error analysis. **Results:** The FLE was determined, by statistical analysis in the form of the repeated digitization of the anatomical landmarks by the same expert user, to be 0.6mm (+/- 1 pixel). The range of FRE for the 5 patients was 2.2 mm to 2.5 mm. Visual inspection of the MRI points transformed into CT space clearly indicated that the fusion error was as much as 20% of the cone diameter for small treatment cones and therefore clinically significant. **Conclusion:** FREs as large as 2.5 mm are dosimetrically significant given that typical dose gradients in stereotactic radiosurgery are 10%/mm. In addition to being representative of the performance of the MI fusion, FRE should be considered when determining clinical target margins for stereotactic target delineation.

SU-FF-J-29

Assessment of Patient Setup Variations with a Commercial On-Board Imaging System: Is There a Benefit to the Patient?

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Purpose: Kilovoltage imaging with a commercial on-board imager (OBI) has been implemented in our treatment room for image-guided radiation therapy (IGRT). It holds great potential to improve treatment accuracy by reducing the setup errors. However, performing patient setup with OBI costs extra time and effort. Thus, it is important to demonstrate which patient will benefit from this new technique. We have assessed patient setup variations and its dosimetric effect. **Method and Materials:** We perform daily OBI setup on the prostate, head-and-neck (H&N), and central-nerve-system (CNS) IMRT patients. Our setup procedure: (1) Patients were aligned to their skin marks. (2) Orthogonal kV images were acquired with OBI. (3) Setup corrections were made by registering the kV images with DRR's based on bony landmark (H&N and CNS patients) or fiducial markers (prostate patients). Shifts larger than PTV margins were verified with MV portal imaging. Setup data from 2 CNS, 9 H&N, and 10 prostate patients were analyzed. For H&N and CNS patients, dose redistributions that incorporate each day's actual shifts were calculated by rigid-body translation. **Results:** (1) H&N and CNS patients: the random setup variations (standard deviation of the daily data) are 0.15cm, 0.32cm and 0.42cm in LR, AP, and SI direction. The systematic setup variations (the average) are 0.5cm. The largest shift is 1.2cm. (2) Prostate patients: average interfractional variations are 0.26 cm (LR), 0.24 (SI) and 0.39 cm (AP). (3) Dose redistribution in the postplans demonstrated that OBI setup corrections typically don't modify the CTV coverage but frequently affect sparing of the critical organs. **Conclusion:** Our random setup variations were found to be smaller than the PTV margin (5mm). With OBI setup corrections, we can further reduce the PTV margin safely. Our postplans have shown that OBI setup corrections can dramatically improve sparing of the normal structures.

SU-FF-J-30

Automatic Determination of Required Adjustment in Patient Setup for Radiation Therapy

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Purpose: To automatically determine the required adjustment for radiotherapy patient setup from two electronic portal images and rapidly calculated digitally reconstructed radiographs (DRR's) from the CT dataset acquired during CT-simulation. **Method and Materials:** An amorphous silicon EPID (OPTIVUE, Siemens) was used to obtain setup portal images on patients receiving radiotherapy treatment at various anatomical sites. Two orthogonal portal images or a pair of portals with minimum of 12 degree parallax were acquired. A CT dataset obtained during CT-simulation was used in an algorithm that calculated DRR's in approximately 80 ms. An iterative procedure compared the generated DRR with the acquired portal image using as the initial position the treatment plan isocenter and gantry angles. The minimum deviation between the generated DRR's and the acquired portal images was obtained using various similarity measures. The output from the registration algorithm gave the required patient setup adjustment with 6 degrees of freedom (3