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Compensator-Based IMRT Re-Planning Using Field-In-Field Technique and the Original Compensators

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Purpose: Compared with MLC-based IMRT for moving targets, compensator-based IMRT has advantages in shorter beam-on time, less monitor units with decreased carcinogenesis risk, better optimization-to-deliverable dose conversion, and often better dose conformity. Some of the disadvantages include additional time for the compensators to be built and delivered as well as extra cost. Treatment of moving abdominal cancers with this technique introduces the clinical problem of weight change, which can occur at any time during treatment. Accounting for a change in weight with a new plan and a second set of compensators would result in treatment delays and more costs. A method to re-plan the patient using the same set of compensators would be advantageous. **Method and Materials:** With abdominal cancers, most often the tissue change is reflective of weight loss. Since the reduction is usually small, a new 4D CT acquired in the treatment position with markers on the original iso-center tattoos can be registered to the first planning scan. The contours from the original scan can be copied to the new scan and edited as needed to reflect their new anatomical position. The original compensator set can be used together with a few field-in-field beams defined by MLCs. The weights of the beams with compensators are reduced so that the field-in-field MLC beams can be optimized to mirror the original plan and dose distribution. **Results**: With this technique, the new plan usually restores the original plan on the new planning CT images. The target coverage and dose uniformity are improved compared to the plan without the field-in-field modification. **Conclusions:** To save time and cost, the original compensators can be used in the new compensator-based IMRT plan when the patient's weight changes. Field-in-field modification to the plan is necessary to restore the original plan on the new planning CT.

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To Reduce Hot Dose Spots in Craniospinal Irradiation: A Two-Field IMRT Approach with Matching Beam Divergence

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Purpose: In conventional craniospinal irradiation (CSI), hot/cold dose spots are commonly seen with two adjacent fields that cover the spinal cord due to different beam divergences. The purpose of this study was to develop new techniques to reduce or eliminate the hot/cold spots, and achieve a more uniform dose coverage of the spinal cord. **Materials and Methods:** Two approaches to reduce the effect of beam divergence were investigated. Tilted beams were used with the table in the 90^{o} position and patient in prone position. In the first method, we used four beams in two pairs to reduce the divergence. Wedges were used to improve the dose uniformity. In the second method, two IMRT fields with beam-divergence match were employed to compensate the dose inhomogeneity due to different SSD. Based on a phantom torso, plans were created for each new method and compared with the conventional CSI technique. **Results:** Both new techniques improved the dose homogeneity of spinal cord. When normalizing the mean dose to 180 cGy, the minimum dose is approximately 168 cGy for all three plans; however, the maximal cord doses are different: 237, 204 and 201 cGy for the conventional, 4-field and IMRT plans, respectively. The maximal body dose is 269, 214 and 216 cGy, and the volumes receiving a dose >200 cGy are 128, 78 and 42 cm^3, respectively. **Conclusion:** Two new techniques with matching beam-divergence have been developed for CSI to effectively reduce hot/cold spots and improve the dose uniformity in the spinal cord. The two-field IMRT technique showed the best improvement in dose homogeneity, and is feasible to be implemented clinically. The 4-field technique can be used in IMRT-incapable facilities. The observed improvements in dose coverage and homogeneity with the beam-divergence matching techniques warrant further studies with more patient data.

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Delivery Angle Dependency On Treatment Plan Quality for Whole Breast Radiotherapy Using Helical Tomotherapy

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Purpose: To characterize the effect of delivery angle (DA) on target dose homogeneity and coverage as well as normal tissue sparing for whole breast treatments using helical tomotherapy. **Method and materials:** Tomotherapy treatment plans (TomoTherapy Inc, Madison WI) were generated for three sets of patients with varying breast sizes: small (<975cc), medium (<1600cc), and large (>1601cc). All patients presented with left-sided breast cancer. For each patient, three tomotherapy plans were created with different DAs. Pinnacle^3 (Philips Medical, Fitchburg WI) treatment planning system was used to segment the PTV, critical structures, and blocking structures. Blocking structures were created to allow radiation delivery from 180°, 210°, and 240° relative to conventional tangent beam geometry. Treatment plans were prescribed 50.0Gy to 95% of the PTV for 25 fractions. A directional block was used for the blocking structures. Plans were compared based on target homogeneity (HI) and conformity (CN) and dose to critical structures. **Results:** Percent differences between the average CN of each DA was less than 0.5%. The 180-degree DA produced the least homogenous dose distributions with an average HI of 0.0654 while the 240-degree DA produced the most homogenous with an average HI of 0.0531. Regarding contra lateral breast dose, the 180-degree DA limited the $D_{2\%}$ and V_{10Gy}. The 240-degree DA reduced the dose to the heart and ipsilateral lung. Treatment time decreased as the DA increased. **Conclusion:** By using a 210-degree DA, the sparing of the contra lateral breast increases dramatically while not substantially impacting the dosimetric quality of the PTV and dose sparing of the heart, and lung for all of the patients studied. This study indicates that the 210-degree DA may be an optimal DA when considering all treatment planning goals and may serve to be beneficial during the beam angle selection process of topotherapy.

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Integral Dose Variation in Three-Dimensional Conformal Radiotherapy, Intensity-Modulated Radiotherapy, and Helical Tomotherapy

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Purpose: To evaluate the integral doses (IDs) to organs at risk (OARs), normal tissue (NT) and the whole body in three-dimensional conformal radiotherapy (3DCRT), intensity-modulated radiotherapy (IMRT) and helical tomotherapy (HT) for whole pelvic radiotherapy (WPRT) in postoperative endometrial cancer patients. **Method and Materials:** We selected ten patients with endometrial cancer undergoing postoperative WPRT. Plans of 3DCRT using both 6-MV (6MV-3DCRT) and 18-MV (18MV-3DCRT), static IMRT using a conventional linac with 6-MV (6MV-IMRT) and 18-MV (18MV-IMRT), and HT using 6-MV were developed for each patient. The IDs to OARs, NT and the whole body were compared. **Results:** Compared with 3DCRT, both IMRT and HT significantly improved dose conformity and the IDs to OARs (8.8% - 29.9%, $p < 0.05$). Compared with 6MV-3DCRT, IMRT resulted in 13.2% and 11.0% lower IDs to NT and the whole body (p=0.00), whereas no significant difference was found in HT plans. Compared directly with IMRT, HT reduced the IDs to rectum and bladder ($p<0.05$), whereas the IDs to NT were 13.9% higher than with 6MV-IMRT (p=0.00), the IDs to pelvic bones also slightly increased with HT ($p<0.05$). The use of 18MV reduced the IDs to NT 5.8% and 2.7%, to the whole body 4.8% and 2.1% in the 3DCRT and IMRT plans (p=0.00). **Conclusions**: In postoperative WPRT of endometrial cancer, IMRT and HT result in better conformity and lower IDs to OARs compared with 3DCRT. The IDs to NT and the whole body were significantly lower with IMRT, whereas no significant difference was found with HT compared with 6MV-3DCRT. Compared directly with IMRT, HT further reduced the IDs to rectum and bladder, at the expense of a slightly higher ID to pelvic bones and NT. The use of 18 MV improved the IDs to NT and the whole body in both 3DCRT and IMRT.