PD-0278

Effect of lateral scatter on dose distribution for target volume near skin in Ir-192 HDR Brachytherapy

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Purpose/Objective: To study Effect of lateral scatter on dose distribution in Ir-192 HDR Brachytherapy.

Materials and Methods: Brachytherapy phantom was designed and fabricated using commercially available tissue-equivalent material consisting of 90% Polystyrene & 2% TiO2 (electroconductivity 1.045 gm/cm3). Phantom has provision to place plastic catheters at every 5mm and also provision to place TLD and Gafchromic film at every 10 mm distance along vertical direction. CT scan of phantom was performed, images were transferred to Brachyvision Planning System, Version 10.2 (VMS, Palo Alto) which is also having option of analytical dose calculation algorithm termed as Acuros. Acuros is Grid-Based Boltzmann Solver (GBBS) code which directly solves the linear Boltzmann equation. We reconstructed single catheter at 5 mm from edge of phantom with three source dwell positions, 10mm apart. Dose was prescribed to single point at 10 mm from the central source along its transverse axis. Dose calculation was done using TG-43 algorithm and Acuros algorithm. Dose was measured at 10, 20and 30 mm depth using TLDs and Gafchromic EBT3 films. Same procedure was repeated by placing catheter at 10mm, 15mm, 20mm and 30mm from the edge of phantom.

Results: At prescription point close to phantom edge i.e. 5mm away from edge, we observed scatter's contribution to dose at prescription point decreases and it is within 1% at 20mm from the edge of phantom.

At greater depths, catheter close to phantom edge (5mm from edge), we observed TG-43 overestimates dose by 7% at 20mm and 10 % at 30mm depth from transverse axis of source. For catheter placement at 20mm from phantom edge, TG 43 overestimates dose by 3% at 20mm and 4 % at 30mm depth from transverse axis of source. These results were confirmed by measurements of TLD and Gafchromic films.

Conclusions: No consideration of lateral scatter contribution by TG-43 algorithm can lead to dose variation up to 5% to target which is near the skin. Overestimation of dose must be considered while deciding dose to critical structures which are at greater depths.

PD-0279

Dosimetric accuracy of three dose calculation algorithm for SBRT with conventional and free flattening filter beams

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Purpose/Objective: To verify dosimetric accuracy in SBRT conditions for three dose calculation algorithms: Collapsed Cone (Philips Pinnacle v.9.2), AAA and Acuros (Varian Eclipse v.10).

Stereotactic Body Radiotherapy is used to deliver high dose per fraction usually in small volumes in lung. Heterogeneous volumes in lung are a very demanding calculation task, and specific quality assurance has to be made to treatment planning systems to verify dose calculations in heterogeneous and small volume conditions.

Materials and Methods: Pinnacle and Eclipse (AAA and Acuros) were commissioned for 6 MV, 10 MV and 15 MV conventional beams and 6 MV FFF and 10 MV FFF beams using iba Blue Phantom2 and ionization chambers and diodes. Verification of calculation accuracy was assessed in homogenous phantom following usual acceptability criteria for conventional and IMRT/VMAT treatment plans. Dosimetric accuracy for SBRT is made using in house made heterogeneous slab phantom (solidwater-bone-solid water-lung-solid water) and SBRT-like (5 cm diameter cylinder inside lung)phantom with 4x4 cm, 10x10 cm field sizes and VMAT beam. Comparison with ionization chamber and film dosimetry measurements are performed in selected points of the phantoms.

Results: Dose comparison in slab phantom shows mean differences-0.4%, 6.4% and 2.1% for Pinnacle, AAA and Acuros for both 4x4 cm and 10x10 cm field sizes. Maximum differences are -5.2%, 24% and 7.8% for Pinnacle,AAA and Acuros in points below lung and bone slabs. AAA shows a very different dose behaviour than the other algorithms inside lung. AAA behavior is worsens when smaller field size and higher energy is used.

In SBRT-like phantom Pinnacle and Acuros shows better agreement than AAA for both square fields and VMAT field. AAA shows differences of 5% inside PTV volume. In lung region there are a big difference between AAA and the other two algorithms. No difference is observed in using conventional or free flattening filter beams in any calculation algorithm.

Conclusions: Pinnacle Collapsed Cone and Eclipse Acuros shows better agreement than AAA in all conditions. In our institution Acuros and Collapsed Cone are the algorithms of choice for SBRT treatments. AAA is deprecated due to the high observed differences.
Carlo Plan (SMCP) [2]. The inverse treatment planning process starts with the definition of the SSD, the gantry angle and the collimator rotation for each electron field. Then the DAO is initiated and a potential aperture by energy change is determined. A cost function (cf) which determines the squared dose differences in all voxels of the PTV and the OARs between the actual value and a given upper or lower limit is to be minimized. The actual dose distribution has to be determined efficiently in each iteration step. For this purpose, the inverse electron beam has been divided into a grid of beamlets for which the dose distribution has been pre-calculated using eMC [3]. Hence, the update of the dose distribution is realized by adding or subtracting the corresponding beamlet dose distributions. After DAO the final apertures have been set up as ML-C shaped fields. To correct for the MLC impact on the dose distribution which has not been accounted for during the DAO, post processing steps are carried out by a weight optimization or adjusting the MLC apertures. The DAO implementation has been tested using a water phantom containing an artificial PTV and a distal OAR.

Results: The DAO converged after about 2000 iterative steps which corresponds to 25 minutes. In about 15% of the steps, the changes selected by the SA have been accepted. The resulting treatment plan for the water phantom consists of three fields employing 20 MeV, 12 MeV and 9 MeV. Applying these MLC shaped fields and carrying out the post processing weight optimization, this result in a conformal dose distribution with a V95 of 92% and a V105 of 11% for the PTV.

Conclusions: This presented DAO has successfully implemented within SMCP and allows inverse treatment planning of MRT for phantom situations. This work was supported by Varian Medical Systems.

References:

PD-0283
Flatting filter free (FFF) HybridArc for stereotactic treatments in the brain
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Purpose/Objective: HybridArc is a new treatment technique available in version 4.5 of the treatment planning system iPlan (BrainLAB AG, Feldkirchen, Germany). Modulated arc fields are combined with IMRT fields along these arcs. The aim of this work was to investigate the suitability of HybridArc using the linear accelerator in the flattening filter free (FFF) mode for stereotactic treatments in the cranial region and to compare this method with HybridArc using the conventional flattening filter (FF) mode.

Materials and Methods: HybridArc was commissioned in iPlan for the 6 MV FF mode and the 6 MV FFF mode of a Truebeam equipped with a high definition multileaf collimator (Varian Medical Systems, Inc., Palo Alto, USA). For 10 patients with single metastases with a median target volume of 0.775 cc (ranging from 0.275 cc to 4.588 cc) FFF-HybridArc plans were calculated and compared with FF-HybridArc plans. Each plan consists of three HybridArc fields with two embedded IMRT fields per arc. The dose distributions were analyzed and compared according to homogeneity (homogeneity index: H-index = (D95% - D1%)/ D10% * 100%) and conformity (conformity index: CI = prescription isodose volume / target volume) to the normal tissue structure was defined as the 5 mm wall around the target volume. The dose to this normal tissue structure as well as the total number of monitor units (MUs) per plan were investigated.

Results: The mean ± standard deviation of the H-index over all 10 patients decreased from 4.0±0.4% for the FF-HybridArc method to 2.2±0.3% for the FFF-HybridArc method. The mean conformity index over all 10 patients was comparable for both methods: 1.35±0.12 and 1.33±0.14 for the FF-HybridArc and FFF-HybridArc method, respectively. The number of MUs per plan decreased by 9% comparing FFF-HybridArc plans with FF-HybridArc plans. The maximum and the mean dose in the normal tissue structure were decreased by up to 3% when using FFF-HybridArc instead of FF-HybridArc.

Conclusions: FFF-HybridArc is a suitable method for stereotactic treatments of small targets in the cranial region (e.g. for brain metastases). In comparison to the conventional FF-HybridArc method the maximum homogeneity in the target volume is improved while the conformity remains the same. The total number of MUs is decreased and the normal tissue sparing is slightly improved. Additionally, the higher dose rates available using FFF modes in comparison to FF modes leads to shorter beam on times.

PD-0284
4D dose accumulation for dose painting by numbers for lung cancer
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Purpose/Objective: In conventional radiotherapy of locally advanced lung cancer (LALC) doses levels are homogeneously delivered to the entire PTV, whereat dose escalation is restricted by normal tissue toxicity. Several studies have shown the geometrical correlation between high FDG uptake in a PET scan and tumour recurrence. This is the rationale for FDG-based local dose escalation, e.g. by dose prescription on the voxel values of a PET scan - dose painting by numbers (DPBN). The aim of this study is to investigate the robustness of the DPBN plans against tumour motion.

Materials and Methods: For 3 patients with LALC respiratory-correlated 4D-PET/CT studies were acquired (Philips GeminiTF64). The GTV delineation of the primary tumour was performed manually on CT and a 10mm margin was used for generation of the PTV. DPBN plans were generated with a baseline dose of 60Gy at 2Gy fractions to the entire PTV and a DPBN boost to the GTV. A linear relationship between the prescription dose to voxels within the GTV and the underlying SUV in ungated PET reconstruction was used. Planning was performed with Pinnacle TPS, research version 9.100 (Philips, USA) using a plugin extension for DPBN that was created by the authors. In the IMRT planning optimization, doses within GTV were increased up to a maximum dose of 100Gy in 30 fractions, applying the standard normal tissue constraints from the clinical routine. A DPBN plan was created and the dose distributions were transformed to and summed in asingle CT phase using a model-based nonrigid image registration. The 3D and summed 4D DPBN plans were compared based on DVHs of the target volumes and volumes corresponding to 50-90% of SUVmax.

Results: Summed 4D plans showed significant differences in the doses to the target volumes with maximal differences up to 7% in the Dnearn-min and Dnear-max as compared to the 3D DPBN plans. The high-dose region stay confined to the GTV in summed 4D plans. In mean, in all summed 4D plans, the dose delivered to 99% of the 50% and 90% of SUVmax volumes exceeded 72Gy and 83Gy respectively, compared to 70Gy and 75Gy in 3D plans. The dose to the lung and other organs at risk didn't differ significantly within 3D and summed 4D plans.

Conclusions: Our first results show good target coverage and no hot spots outside of PTV for DPBN plans. Further evaluation of 4D accumulation of DPBN plans for other patients with locally advanced lung cancer is in progress.

AWARD LECTURE: HONORARY PHYSICIST AWARDS

SP-0284
Collaboration supports success
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