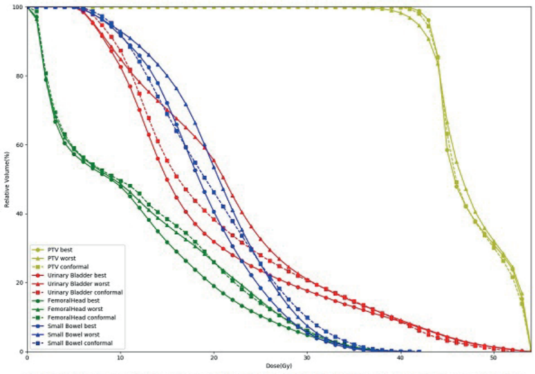

Figure 2. DVH comparison of the best (circle), worst (triangle) and conformal (square) plans as suggested by the scores. The urinary bladder, small bowel and femoral head are indicated by red, blue and green colors respectively.

Conclusion

VMAT plans using optimal jaw locations can be created automatically using ESAPI and RapidPlan. Conformal jaws are not the optimal choice.

EP-1876 Column generation based multicriteria direct aperture optimization for mixed beam radiotherapy

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Purpose or Objective

To develop a multicriteria direct aperture optimization (MCDAO) algorithm to navigate on the approximated Pareto surface for a mixed photon-electron beam radiotherapy (MBRT) plan with the desired trade-off of clinical objectives directly in the space of deliverable apertures.

Material and Methods

A previously in-house developed inverse treatment planning process for photon MLC collimation based step & shoot MBRT including a column generation direct aperture optimization (DAO) algorithm for simultaneous optimization of photon and electron apertures is extended for MCDAO. Based on dose-volume objectives, the MCDAO approximates the Pareto surface by generating database (DB) plans each representing different objective priorities. Thereby, the DB plans consist of deliverable apertures instead of fluence maps and thus avoids a leaf sequencing, which typically degrades the optimized dose distribution. The apertures assigned to the DB plans by the column generation algorithm are either individual to a DB plan, shared over all DB plans or locally shared over neighboring DB plans in the objective priority space. The framework implemented allows to combine these aperture settings. An academic situation with a target and an organ at risk (OAR) is defined to quantitatively investigate the navigation regularity, the smoothness and the objective function values of the approximated MBRT Pareto surface as a function of the fractions of individual, shared and locally shared apertures. Finally, the most promising fractions of aperture settings is applied to MCDAOs for MBRT, modulated electron radiotherapy (MERT) and photon IMRT for a clinical chest wall case.

Results

The higher the fraction of individual apertures, the lower the navigation regularity. Moreover, the navigation regularity is mostly insensitive to the ratio between shared and locally shared apertures. The higher the fraction of shared apertures, the higher the smoothness. However, only 30% shared apertures is already sufficient to have a comparable smoothness as using 100% shared apertures. Unexpected, the objective function values of the Pareto surface is not lowest for only individual and locally shared apertures. Instead, using a fraction of 30% shared apertures lead to lower objective function values. Overall, 30% shared and 70% locally shared apertures is found to be the most promising combined aperture setting based on the investigations with the academic case. For the chest wall case, the whole MBRT Pareto surface offers a higher quality in terms of objective function value compared to the MERT and photon IMRT Pareto surfaces.

Conclusion

An MCDAO algorithm for MBRT is implemented which allows to combine individual, shared and locally shared apertures. Further, the high dosimetric potential of MBRT compared to MERT and photon IMRT is underlined by comparing Pareto surface approximations for a chest wall case. This work was supported by Varian Medical Systems.

EP-1877 Plan robustness under respiratory effect: Comparison of margin-based and robust optimization

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Purpose or Objective

Respiration may introduce adverse dose errors in tumors and organ-at-risks (OARs) during stereotactic body radiotherapy (SBRT) of peripheral lung tumors. Robust optimization has the potential of reducing the dosimetric variations and consequently producing more consistent clinical outcome estimates. This study aims to estimate the uncertainty values for robust optimization, and compare the robustness of conventional margin-based and two robust optimization schemes in the presence of respiration.

Material and Methods

Four-dimensional computer tomography (4DCT) images of fourteen peripheral lung tumors were used. Each case was prescribed 54 Gy in 3 fractions using four approaches: (I) gross target volume created from maximum intensity projection (GTVMIP) and isotropic 5 mm planning target volume (PTVMIP) margin were used; (II) uncertainties of 2 mm, 3.4 mm and 3.3 mm in X, Y and Z direction respectively, which was estimated from daily 4D cone-beam CT, were input for MIP robust optimization (3Drobust); (III) Van Herk margin receipt was used to generate PTVVH from GTV at mid-ventilation phase; (IV) the above uncertainty values were used and ten-phase CT image sets were all incorporated in the 4D robust optimization (4Drobust). All plans were created in Raystation v5.0 (RaySearch Laboratories, Stockholm, Sweden) with the same beam geometry and optimization parameters for each case. Subsequently, these plans were recalculated in ten respiratory phases and the robustness under the respiratory effect was investigated. Minimum, mean and maximum dose of GTV (GTVmin, GTVmean and GTVmax), volume to 30 Gy of chest wall and the volume to 5 Gy and 20 Gy of lung (LungV5 and LungV20). Paired student t-test was performed between (I) and (II); (III) and (IV); and (II) and (IV) at significance level $p<0.05$.

Results

The ranges of uncertainties within respiration of 14 cases were shown in *Table 1*. The uncertainties of doses to chest wall under respiratory cycle were found to be less for 3Drobust and 4Drobust than PTVMIP and PTVVH respectively ($p<0.001$ in both pairs). Moreover, 4Drobust produced less variation for LungV5 and LungV20 than PTVVH ($p=0.002$ and 0.001 respectively). The results