Dosimetric studies affecting the quality of delivered treatment plan with and without rotational setup corrections for treating prostate cancer

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INTRODUCTION

Varian Halcyon linear accelerator enables fast intensity-modulated radiation /volumetric modulated arc (IMRT/VMAT) delivery due to it's unique features such as high dose rate FFF beam and 0.5cm MLC effective resolution along with automated daily IGRT workflow and portal dosimetry. However, due to structural limitations, couch rotations/table kicks are not possible for radiation treatment in Halcyon.

AIM

The aim of this study was to explore if the limitation of the couch rotation on the Varian Halcyon (3D couch translations only) affects the quality of delivered treatment plans for prostate cases by resampling the simulation CT images (CT Sim) in to the geometry of the daily cone-beam CT (CBCT) images; performing automated 6D (Auto6D) and 3D corrections (Auto3D); then recalculating dose distribution on the rotated images and comparing dose statistics.

METHOD

Hypo fractionated prostate VMAT plans, planned in Varian Eclipse and delivered on Halcyon, were evaluated in this study.

- For each case, original CTSim was resampled in Velocity into the geometry of a representative sample of five daily CBCT images (selected throughout the treatment course)
- Prostate, GTV, PTV, Bladder and Rectum were contoured on each of these reformatted CBCT images.
- The CT Sim images were matched in Eclipse Image registration software with each reformatted CBCT scan with Auto3D match with rotations turned off and Auto 6D match with rotations turned on. For each image set, the dose distribution was then recalculated on the registered CT images derived from Auto3D match and Auto6D match. Dose statistics were compared.

RESULTS

Seven prostate/seminal vesicle hypofractionated VMAT plans, planned in Varian Eclipse and delivered on Halcyon, were evaluated in this study. Treatment was planned for Prostate/Seminal Vesicles and /or lymph node and the prescription dose was 45 Gy in 25 fractions (fxs) with a simultaneous integrated boost (SIB) dose of 55 or 57.5 Gy in 25 fxs to the involved nodes. Planning CT scan was done with full bladder and empty rectum, and the same filling status was instructed for daily treatment as well.

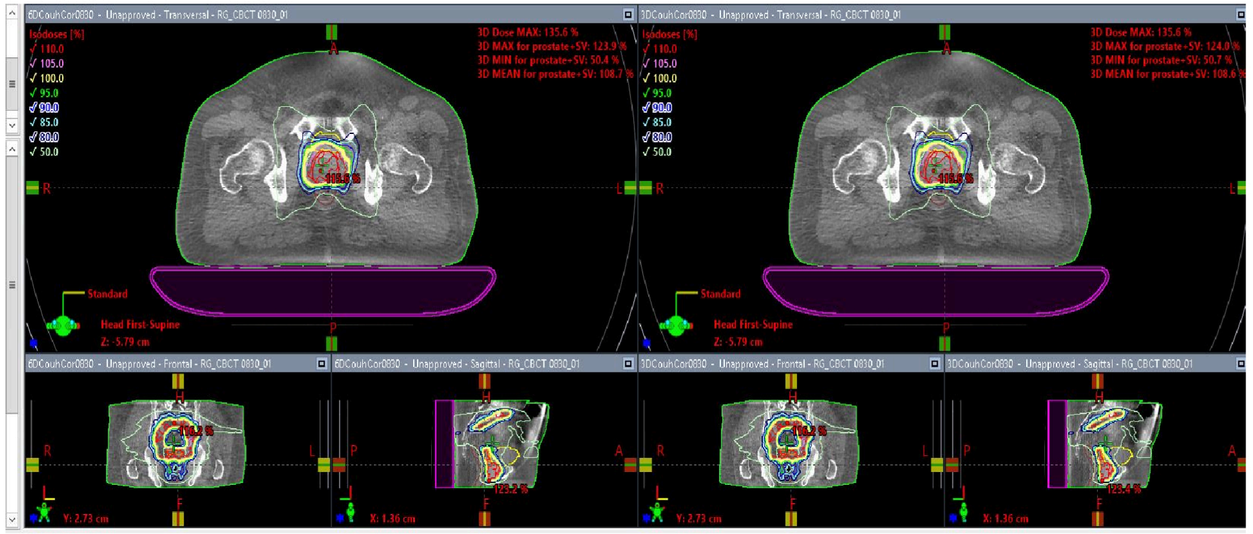

Figure1: Plan evaluation window in Eclipse showing comparison between Auto3D corrected plan and Auto6D corrected plan for a case patient.

Compared with Auto3D corrected plans, Auto6D corrected plans (Figure 1) resulted in improved planning target volume (PTV) coverage D95% (45.69 ± 0.51 Gy vs 42.33 ±6.90 Gy). No significant reduction was observed in Bladder D25, D35, D50, V50 and Rectum V25, D35 and D50. However, Auto6D plans reduced rectum D25 significantly, 28.34 ± 0.76Gy as compared to Auto3D plans 31.76± 4.5 Gy. More data needs to be evaluated to confirm these results.

CONCLUSIONS

To deliver the hypo fractionated radiotherapy in prostate cancer, Auto6D plans increased PTV D95% dose and decreased rectum dose significantly as compared to Auto3D plans. Improved daily online image-guidance and better management of bladder and rectum could make a more precise treatment delivery. More patient data is being evaluated to further confirm these results.

REFERENCES

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