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Automated fallback planning for switching beam energy on volumetric modulated arc therapy (VMAT) in RayStation

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Introduction

Fallback (FB) planning is an automated planning function in RayStation treatment planning system (RaySearch Laboratories AB, Stockholm, Sweden), which mimics the dose distribution and dose volume histogram (DVH) of a baseline plan to quickly create a new plan using another modality (photon vs. proton), treatment technique (3D vs. VMAT), treatment machine (Varian vs. Elekta), and beam energy (6 vs. 10 MV). The auto-plan can be post-processed in standard optimization to achieve optimal results.

The objective of this study is to evaluate the feasibility and effectiveness of the FB feature for energy switch.

Materials and Methods

Treatment plans of ten prostate cancer patients treated with a simultaneous integrated boost (SIB) to a total dose of 7000 cGy were obtained. Fallback plans using 10 MV were created in RayStation 8A SP1 for all patients treated by 6 MV VMAT on an Elekta Infinity linear accelerator with Agility MLC. All patients were treated SIB in 28 fractions, 7000 cGy to the planning target volume (PTV) expanded from prostate (PTV_7000) and 5040 cGy to PTV expanded from prostate + seminal vesicles (PTV_5040).

FB protocols were created for single and dual arc prostate VMAT plans. The protocol workflow uses the nominal plans isocenter by default and mimics the DVH and optimization parameters of the nominal plan to the FB plan. Beam angles of prostate VMAT plans are then set, and a protocol plan is saved under Fallback Protocol Management. FB plans were compared to the original plans for target coverage goals to the PTV_7000 and normal organ dose constraints of the bladder, rectum and penile bulb based on DVHs. The time it took for each 10 MV FB plan to be generated and post-processed in standard optimization was recorded.

Results

On average, a FB plan could be generated and post-processed in half an hour; less than half of the time needed for a fresh VMAT plan with MCO. Plan quality was evaluated based on dose distribution to the target volume. Nine of ten plans required post processing in standard optimization after automated FB plan generation to reduce hotspots, increase target coverage and make the dose distribution more conformal around the target volume (Figure 1).

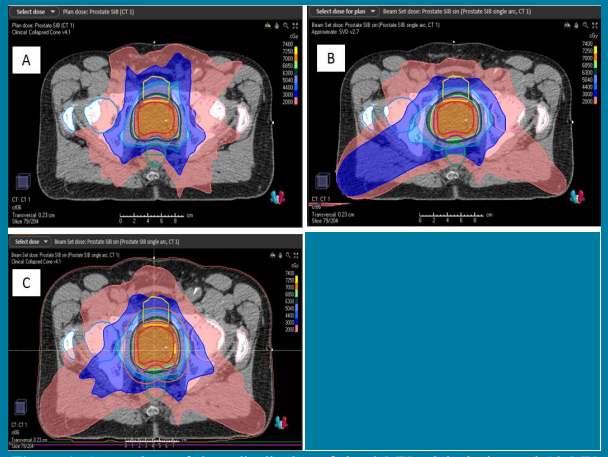

Figure 1. Comparison of dose distribution of the 6 MV original plan and 10 MV fallback plan. (A.) Dose distribution of the original plan to 70 Gy (B.) Dose distribution of the fallback plan to 70 Gy (C.) Dose distribution of the post-processed fallback plan to 70 Gy.

- Compared to the 6 MV clinical plans, the 10 MV FB plans met the clinical goal of V68.6 > 95% for PTV_7000 (97.6% vs 96.1%)
- The V70 of PTV_7000 was lower in the 10-MV FB plans (95.3% vs 92.9%)
- Organ doses were slightly higher in the FB plans, but all remained well below their clinical goals, for example:
  - The bladder V66 and V55 were 6.7% and 13.6%, respectively, both well below the 15% and 25% threshold
  - The rectum V66 and V53 were 2.9% and 10.5%, also below the 10% and 20% threshold
  - The mean dose to penile bulb was 10.2 Gy, well below the goal of 45 Gy

Conclusion

10 MV VMAT plans can be generated using automated FB planning with manual post processing from 6 MV VMAT in RayStation.

Despite slightly lower target coverage and subtle organ dose increase, all FB plans were clinically acceptable, making it a convenient option for our clinic to treat VMAT using 10 MV when 6 MV is not available.

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