

Development of Backup Treatment Plans for Patients Planned for MR-Linac Treatments

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Introduction

The purpose of this study is to create a backup plan for treatment on a conventional linac and compare it to the plan created with the MRL system. The treatment planning system (TPS) used in making the backup plans for the CT Linac is Pinnacle 9.10 (Phillips) while the TPS used for the MRL is Monaco 5.4 (Elekta). A total of twenty volumetric modulated arc therapy (VMAT) prostate cases have been planned on Pinnacle. The results of these plans are compared on the basis of gross tumor volume (GTV), treatment type, planning target volume (PTV), target dose volume histogram (DVH) metrics and organs at risk (OAR) DVH metrics.

Materials and Methods

For this research, a total of ten previously treated prostate cancer cases were randomly selected. All the patients were simulated in the supine position with a computed tomography scanner. All ten cases were prescribed 200 cGy per fraction in 39 fractions for a total prescribed dose of 78 Gy to the PTV. The TPS used for planning are Pinnacle and Monaco. The backup plans were done in Pinnacle with VMAT technique and 6 MV photon energy. The goal of both sets of plans [D1] was to achieve at least a 98% target volume coverage of the PTV. Furthermore, the other goal was to limit the dose to the critical structures.

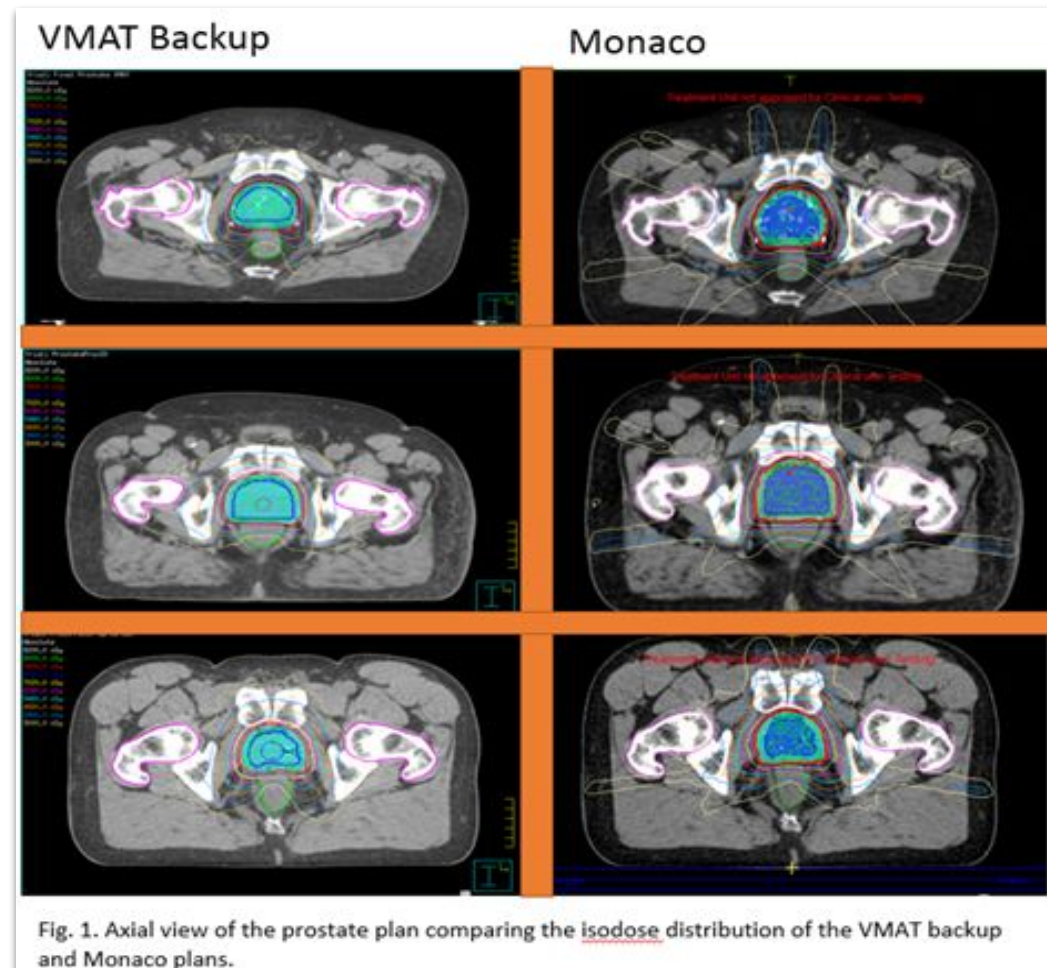


Fig. 1. Axial view of the prostate plan comparing the isodose distribution of the VMAT backup and Monaco plans.

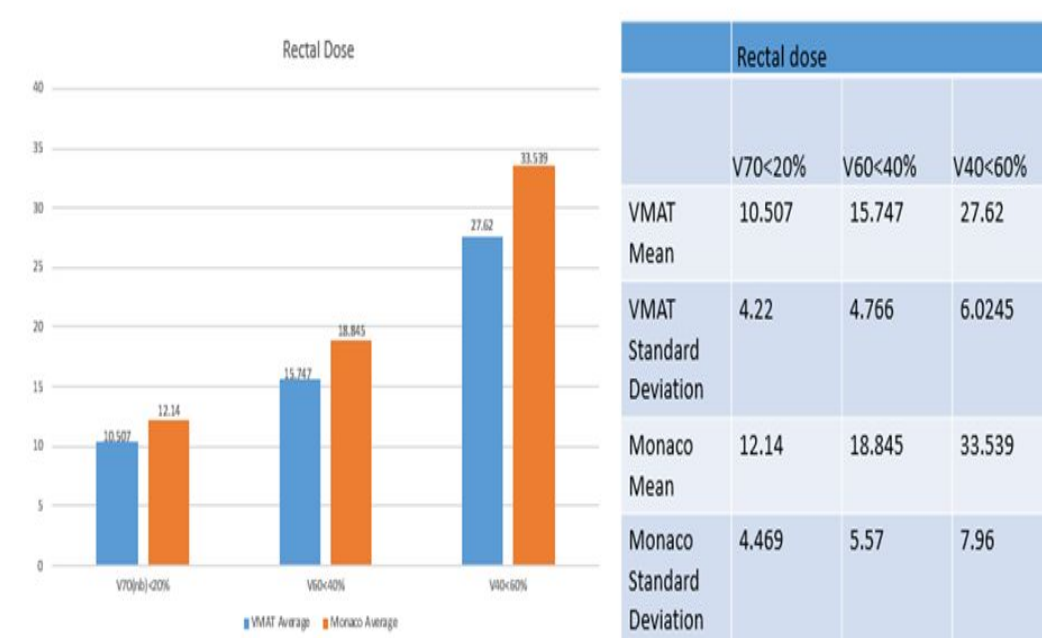


Fig. 2. Radiation dose to the Rectum for both the VMAT backup and Monaco plan

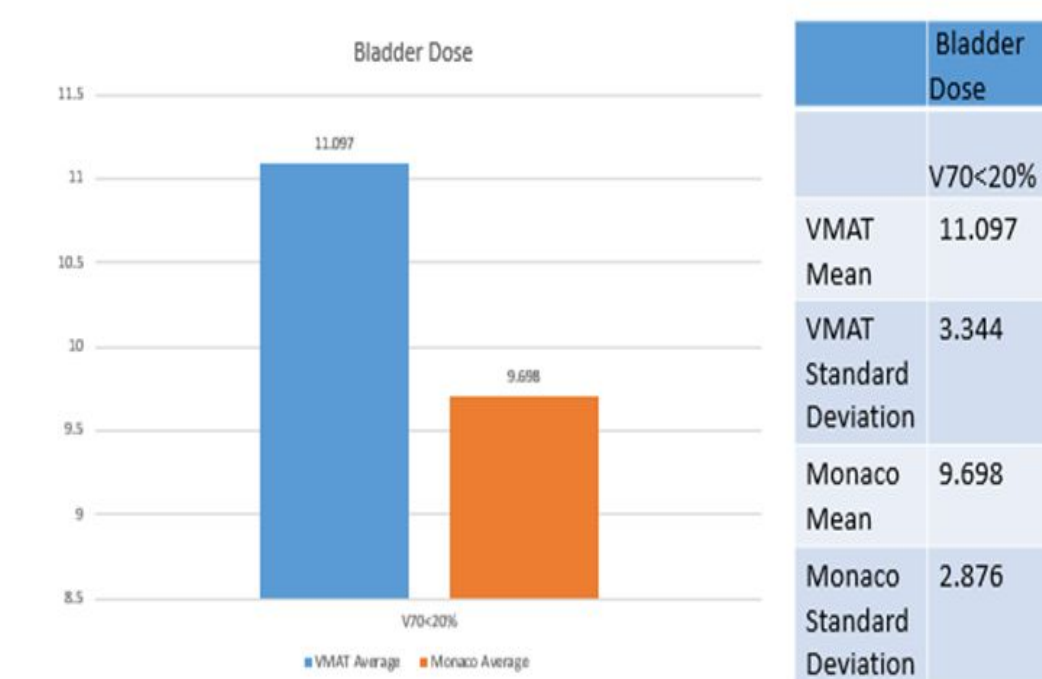


Fig. 3. Radiation dose to the Bladder for both the VMAT backup and Monaco plan

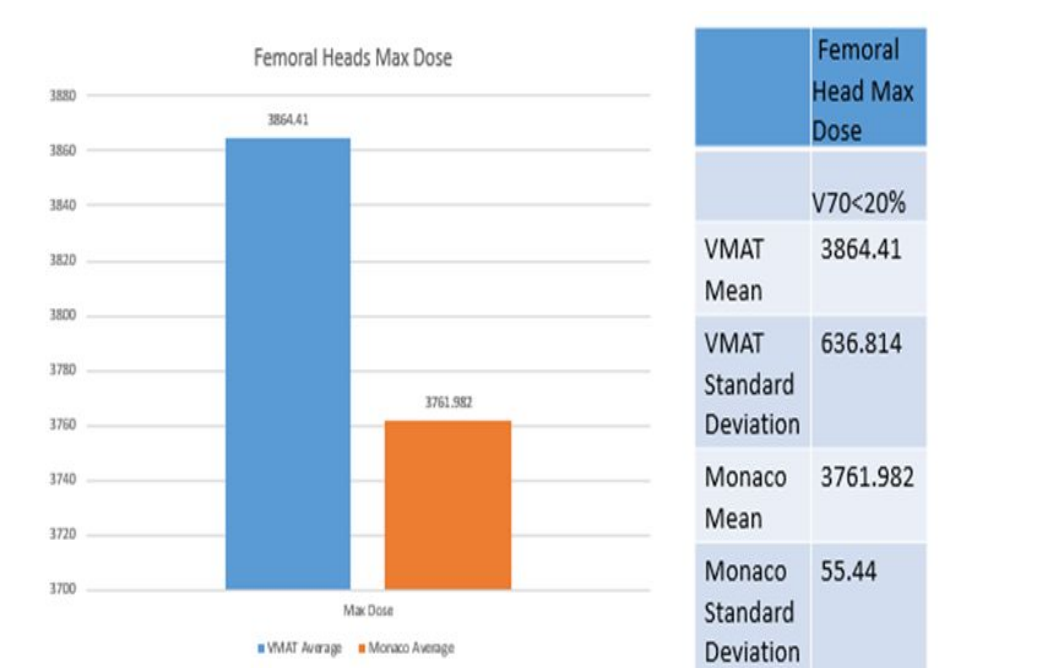


Fig. 4. Maximum radiation dose to the Femoral Heads for both the VMAT backup and Monaco plan

Results

Figure 1 displays the isodose distributions of 3 different cases planned using VMAT backup and Monaco. There is more conformality with the VMAT backup plans than the Monaco plans. This is seen with there being more streaking low dose in the periphery in the Monaco plans compared to the VMAT backup.

Figure 2 compares the V70<20%, V60<40%, and V40<60% of the rectum for both the VMAT backup and Monaco plans. The rectum received a lower dose with the VMAT backup plan because the V70<20%, V60<40%, and V40<60% are all lower with the VMAT plan. It can be noted that the V70<20% and V60<40% are only slightly lower for the VMAT plan but its V40<60% is significantly lower.

Figure 3 compares the V70<20% of the bladder for both the VMAT backup and Monaco plans. The bladder received a slightly lower dose with the Monaco plan.

Figure 4 compares the maximum dose of the femoral head for both the VMAT backup and Monaco plans. The femoral head received a lower maximum dose with the Monaco plan.

Conclusion

This study found that backup plans for MRL using VMAT is feasible for the treatment of prostate cancer. VMAT plans show an improvement in terms of conformality with minor differences between OAR DVHs. However, the limitation of MRL and the number of cases limit the results of this research. It would be more accurate if additional data could be obtained. Further research to better improve workflow and technique are needed while the MRL is still in the pioneering phase. As there are additional patients treated using the MRL, more disease sites and composite plans should be evaluated to continue to document how the MR treatment setup can improve patient outcome and quality of life.

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