Stony Brook School of Health Professions

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Application of a prostate bed and lymph node RapidPlan model to treatment planning of anal cancer patients: a dosimetric comparison and feasibility study

Background

The planning process for anal cancers is time consuming and labor intensive. RapidPlan (RP) is a knowledge-based planning system that aims to improve quality and efficiency. A RP model for anal cancers did not previously exist at our institution. This study investigates validation and application of a configured prostate bed and lymph node model in the supine position with volumetric modulated arc therapy (VMAT) to planning anal cancer in the supine or prone setup treated with simultaneous integrated boost (SIB).

Purpose

The purpose of this work is to investigate how a RapidPlan model designed for the prostate bed and lymph nodes, trained in the supine position with a single dose planning target volume (PTV), can be applied to plan treatments for other pelvic region sites. We specifically focused on anal and rectal cancer cases, considering both supine and prone setups and treatment with SIB. The outcomes of this investigation may inform the development of site-specific models or the adaptation of existing models to enhance treatment planning accuracy and efficiency in clinical practice.

Materials and Methods

A preconfigured RP model for the prostate bed and lymph nodes originally trained using 50 plans with VMAT on a single dose level was tested on 53 anal and 67 rectal patients using single iteration planning (SIP) and multiple iteration planning using the model (MIP) followed by comparison with the clinical plans (CP), to help build site-specific models. Validation of site-specific models was performed by comparing plans generated using them in a single iteration referred to as model-based plans (MBP) with CP. Statistical analysis was conducted using Wilcoxon signrank test in MATLAB.

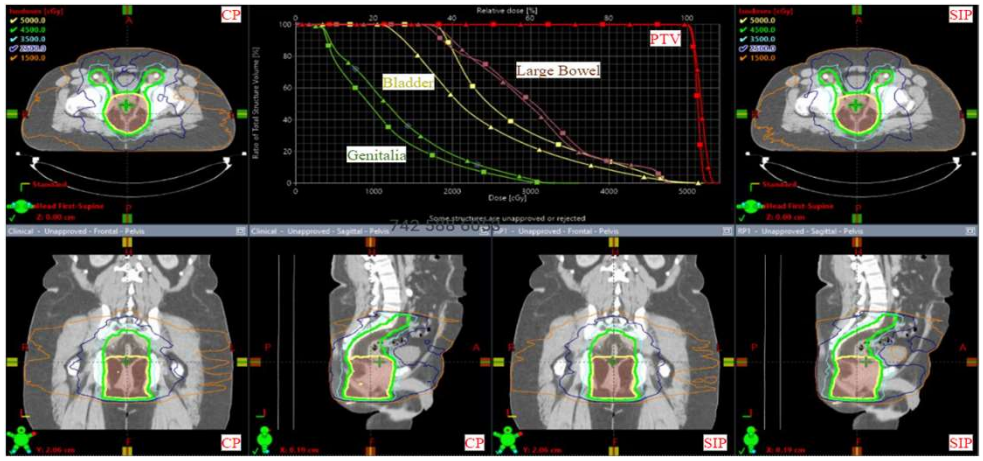

Figure 1. Comparison of isodose distribution for an anal patient's CP on the left and the prostate bed and lymph node model on the right with a single iteration (SIP). The DVH shows a comparison of the two plans, where the CP is in squares and the prostate bed and lymph node model is in triangles. The prostate bed and lymph node model better spared the bladder, while the CP better spared the genitalia.

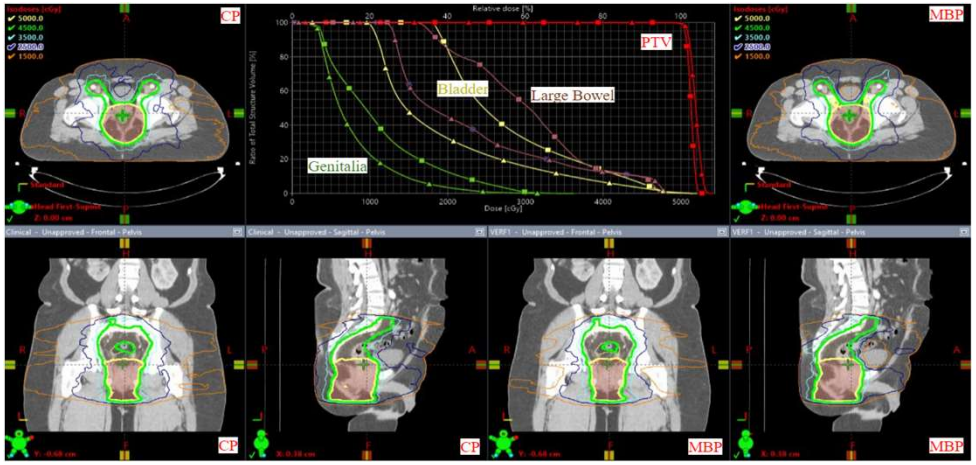

Figure 2. Comparison of isodose distribution for an anal patient's CP on the left and the single iteration, site-specific model-based plan (MBP) on the right. The DVH shows a comparison of the two plans, where the CP is in squares and the MBP is in triangles. The MBP has improved bladder, large bowel and genitalia sparing.

Results

SIP plans met the dose constraints but had a higher genitalia V20Gy by 12.9%, ($p<0.05$) compared to the CP while also exposing a greater volume of bowel (as much as 15cc higher) to intermediate doses ($p<0.05$). The MIP achieved comparable sparing of large and small bowel, as well as the femoral heads as the CP while on average decreasing the mean bladder dose by 3.5Gy, $p<0.05$. MBP plans demonstrated equivalent sparing of both bowels as well as the femoral heads as CP, with reduced genitalia V20Gy(%) by 9.3% and bladder mean by 4.9Gy ($p<0.05$). Moreover, this was accomplished in a single iteration as opposed to MIP which required 3 +/- 1 iteration.

Conclusion

The majority of plans designed with the prostate bed and lymph node model in a single iteration met acceptable plan criteria for anal cases. With MIP, the model was able to improve over the CP, however prolonging the treatment planning time compared to SIP. This study advances the field by generating and analyzing an RP model that improves planning efficiency. Site-specific models improve plan quality and efficiency, meeting clinical goals with tailored dose estimations.

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