Patient-Specific PTVs Improve Bowel OAR Sparing and Safely Reduce PTV Volume for Whole Bladder Irradiation

J Schulte, Q Zeedrich, S Vay, Z Zhang, KR Amarell, S Moningi, P Xia

Department of Radiation Oncology, Taussig Cancer Institute, Cleveland Clinic, Cleveland, OH.

Purpose/Objectives

Whole bladder radiotherapy planning historically uses conventional isotropic PTV expansions of 15-20 mm to accommodate bladder volume variability. This creates large treatment volumes that often encompass significant amounts of bowel inside the PTV. Because bladder filling changes are inherently anisotropic, uniform PTV expansion increases dose to the bowel while still insufficiently encompassing the bladder volume, risking an underdose to the bladder.

This study aims to determine if a patient specific PTV can spare OARs while still maintaining minimal PTV coverage compared to a conventional PTV. To account for daily variations of the bladder volume on each patient, an algorithm was developed to produce multiple patient-specific PTVs with small, medium, and large sizes based on the CT simulation scan and the first five CBCTs of each patient. The goal of this study is to demonstrate dose reduction to OARs without sacrificing target coverage.

Materials/Methods

- Six patients were retrospectively chosen for this study, who received whole bladder irradiation 64 Gy in 32 fractions
- For each patient, four plans were developed using a patient specific small, medium, and large PTVs alongside a conventional PTV
- Each plan was normalized to maintain 95% of the PTV receiving the prescription dose (V_{RX} >95%), while limiting the maximum dose of the bowel inside the PTV to < 105% of the prescription dose
- Additional dosimetric parameters analyzed include volume of small bowel receiving 45 Gy (V_{45}) and 64 Gy (V_{64}), volume of large bowel receiving 65 Gy (V_{65}), and volume of rectum receiving 60 Gy (V_{60})

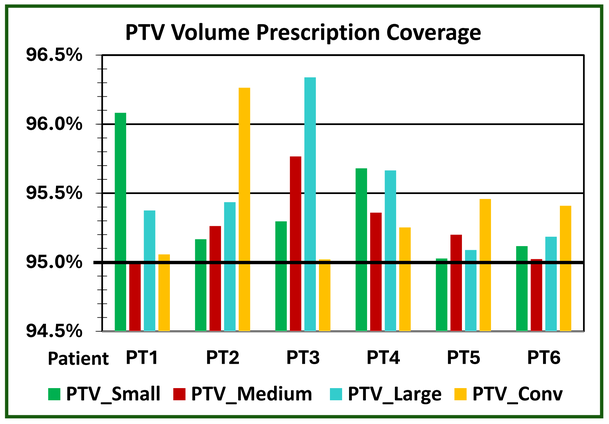
Results

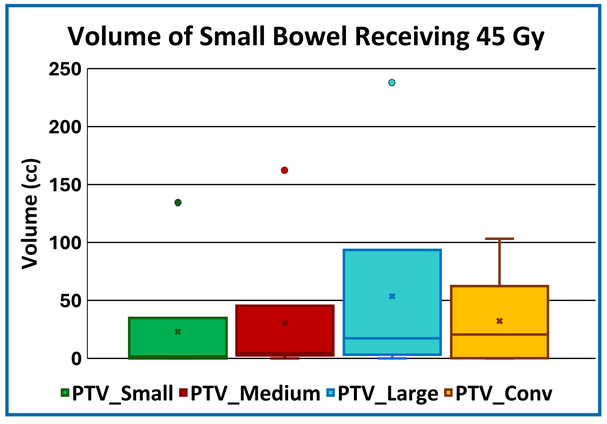
- Average V_{RX} of all PTVs was 95.4% ± 0.39%
- Maximum dose to 0.03 cc was limited to 108% of the prescription dose
- Small Bowel: median of V_{45} was 1.9 cc, 4.6 cc, 17.3 cc for small, medium, and large PTV respectively; 20.5 cc for the conventional PTV
- Small Bowel: median of V_{64} was 0.0 cc, 0.0 cc, 4.8 cc for small, medium, and large PTV respectively; 2.4 cc for the conventional PTV
- Large Bowel: median of V_{65} was 0.1 cc, 1.8 cc, 9.0 cc for small, medium, and large PTV respectively; 9.2 cc for the conventional PTV
- Rectum: average volume receiving 60 Gy was 2.0% ± 4% with 17 out of 24 plans having 0% of rectum receiving 60 Gy and was largely independent of PTV size

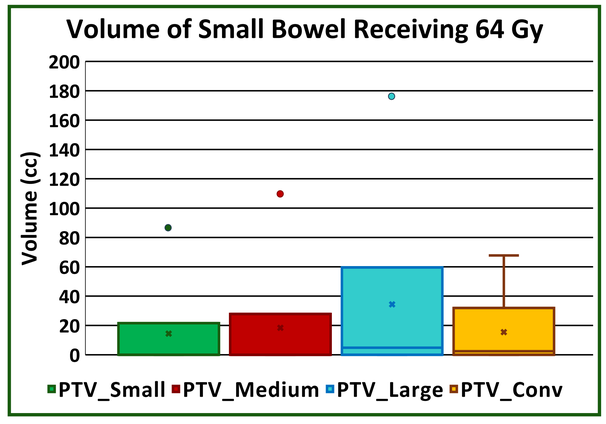
Conclusion

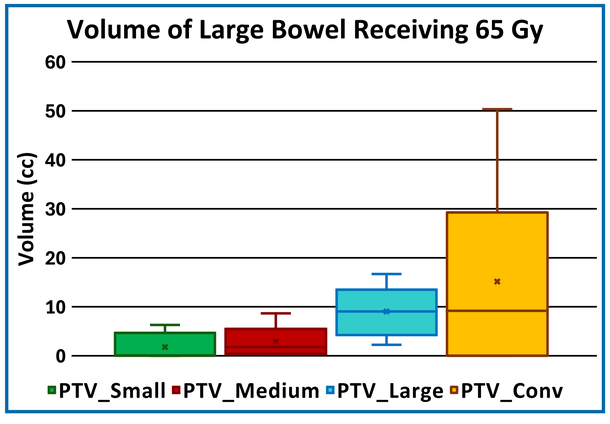
This study demonstrates that using a patient specific bladder volume can safely reduce PTV size while still maintaining adequate dose coverage to the bladder. The V_{45} and V_{64} of the small bowel and the V_{65} of the large bowel increased with PTV size but typically remained lower than the conventional PTV.

This indicates a meaningful reduction in both intermediate and high dose exposure to the bowel. The benefit is most evident for small and medium PTVs but is also present for large PTVs. Overall, this study indicates that a patient specific PTV can decrease dose to OARs and safely reduce PTV volume without sacrificing target coverage.









Pictured:
A comparison of isodose distributions for each Planned Treatment Volume

Isodose Lines:
6270 cGy
6400 cGy
5760 cGy
5120 cGy
4480 cGy
3840 cGy
3200 cGy