Evaluation of a Third Party AI Auto-Contouring Tool for Online MRI Guided Adaptive Radiotherapy In Prostate SBRT

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Introduction

MRI guided Adaptive Radiation Therapy (MRgART) allows for daily plan adaptation to the patient's anatomy. This is achieved by imaging the patient before each fraction, editing the contours to the new anatomy, and adapting the plan to the new contours. However, since the patient is on the table, time is a concern because of potential patient discomfort and drifts in internal anatomy after the initial image is taken. To limit treatment time, online contour edits are often limited to specific structures or regions within a certain proximity of the target[1]. Thus, the delivered plan is often adapted to structures that do not always fully represent the true anatomy.

This project evaluates the utility of a third party AI auto-contouring tool to assist clinicians in the online workflow, allowing for more accurate contouring without increasing treatment times.

Methods

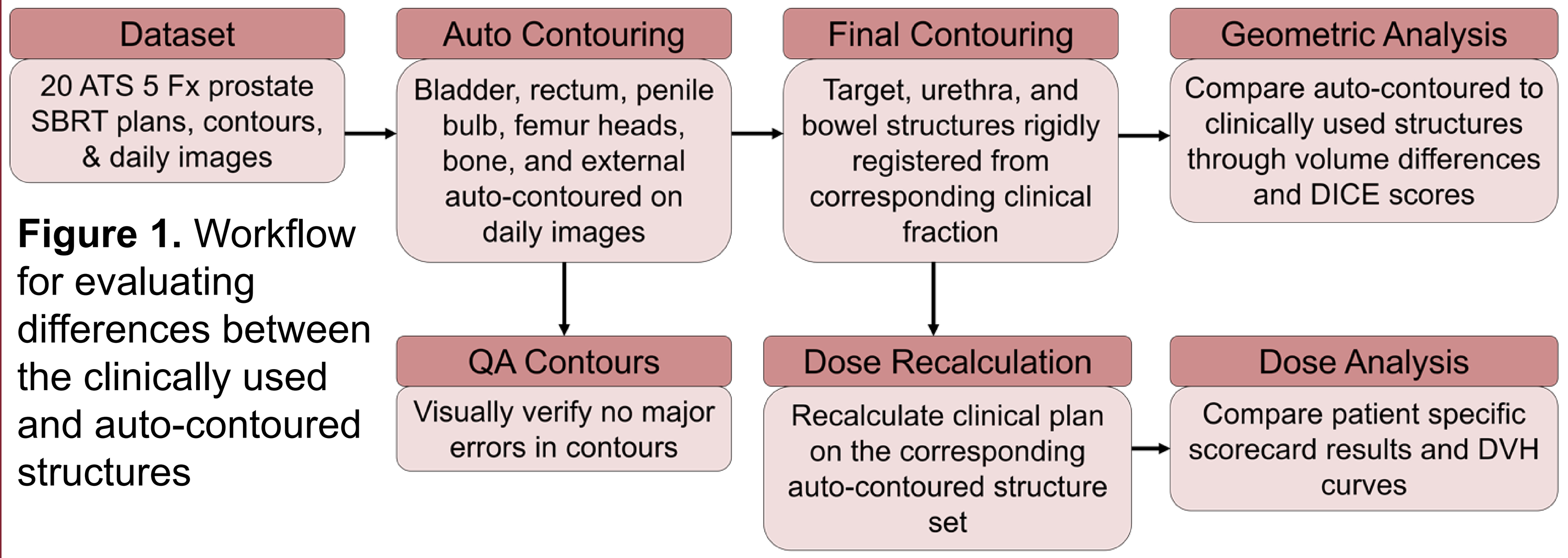


Figure 1. Workflow for evaluating differences between the clinically used and auto-contoured structures

Twenty anonymized MRgART prostate SBRT patients' daily images, structures, and treatment plans were gathered and anonymized for this study. All plans utilized the Adapt To Shape (ATS) workflow on the Elekta Unity MRI LINAC (Elekta AB, Stockholm, Sweeden). The daily images were processed by the auto-contouring tool, which contoured the Organs At Risk (OARs). The target, urethra, and bowel structures were rigidly transferred from the corresponding clinical contours. **To evaluate dosimetric impact, the clinical plan was recalculated on the auto-contoured structure set.** Various geometric and dosimetric tests were performed to compare the physical and clinical differences between the structure sets.

Results

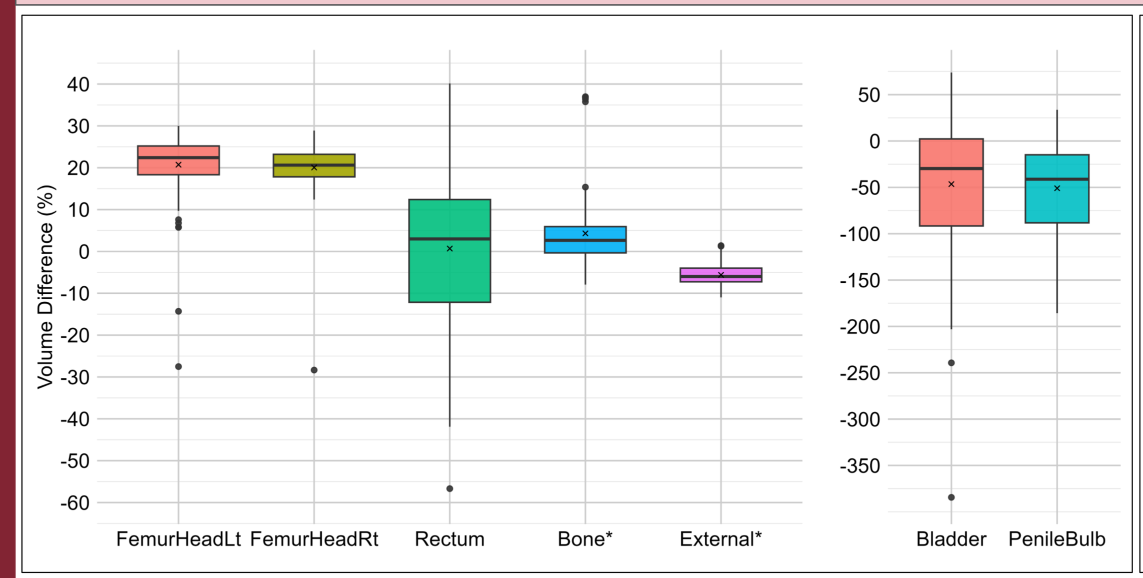


Figure 2. Normalized volume differences comparing the AI generated and clinically used structures. Positive values indicate the AI generated contours were larger.

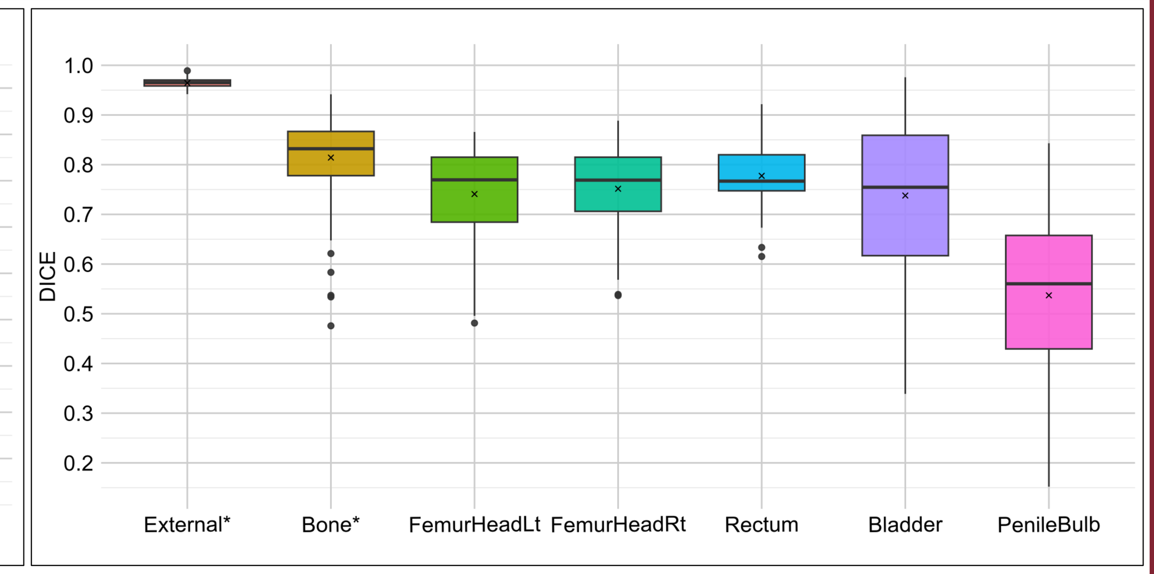


Figure 3. DICE scores comparing the AI generated and clinical structure sets. A "*" in Figure 2 & 3 indicates the structure was clipped 2 cm superior | inferior of the PTV.

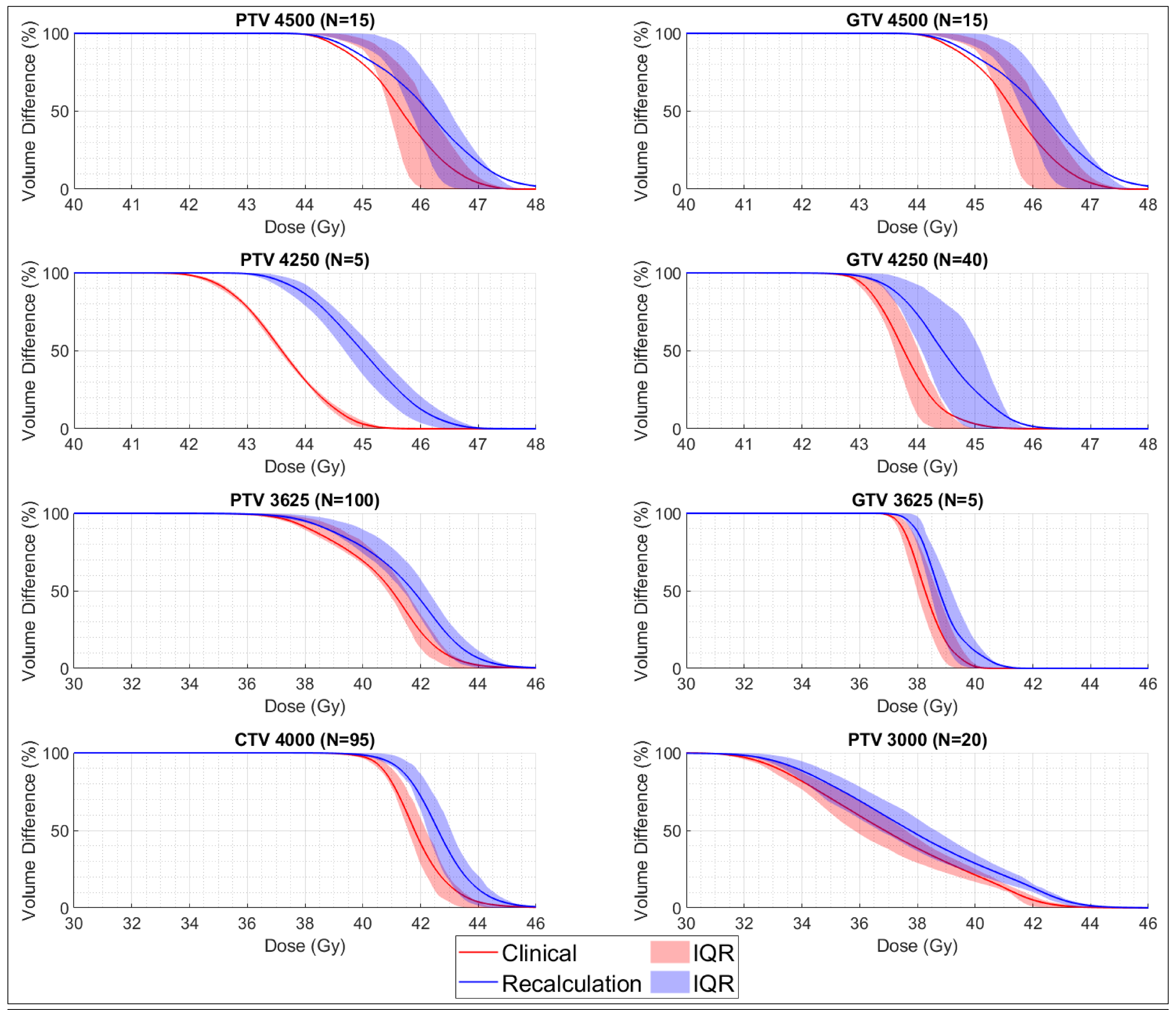


Figure 4. Statistical DVH curves showing the mean and IQR for target structures in the clinical plan (red) and the clinical plan recalculated on autogenerated structures (blue). The number of fractions containing each structure is listed adjacent to the structure's name.

We observe a rightward shift in the target's DVH for the recalculation on the auto-contoured structures

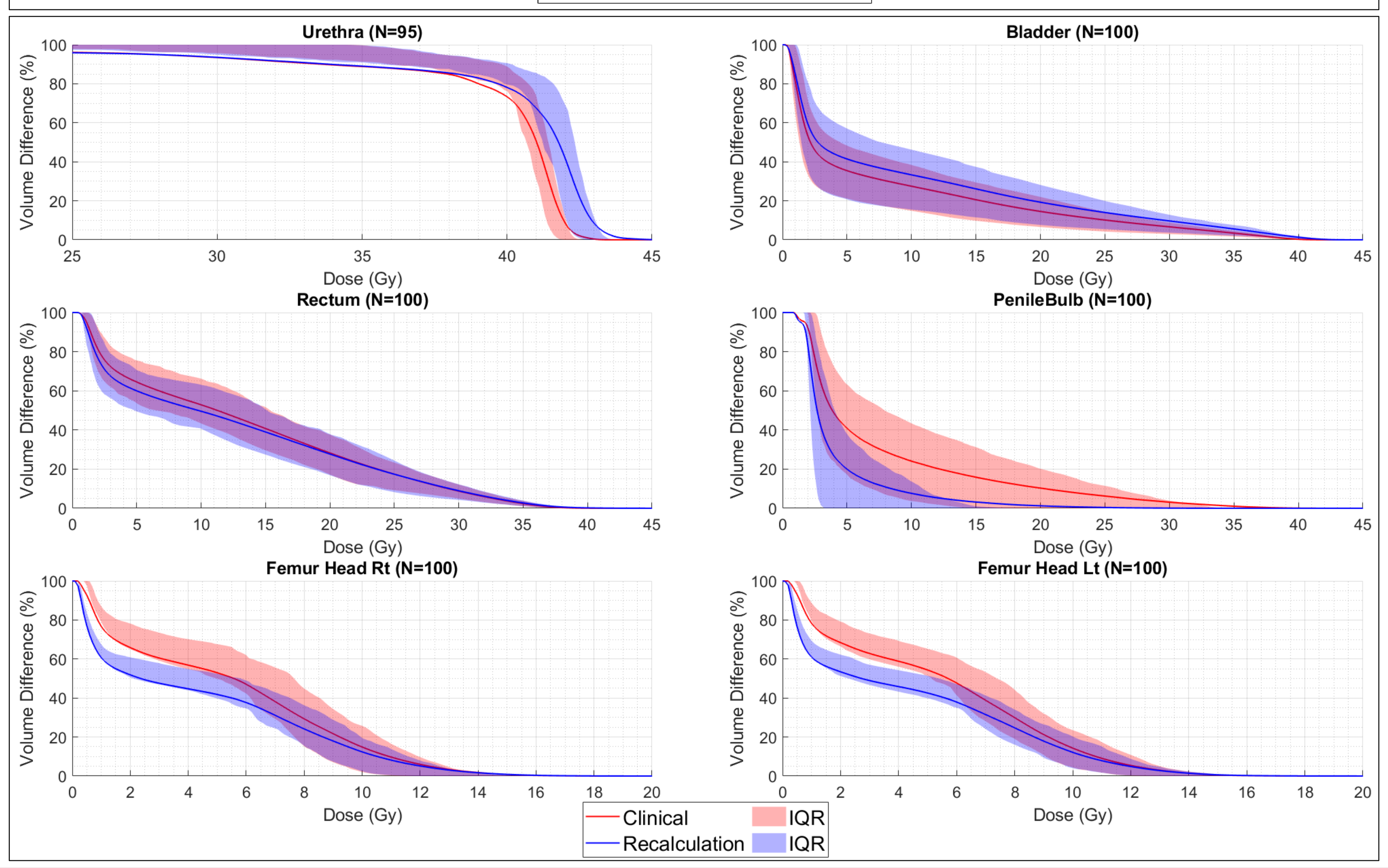
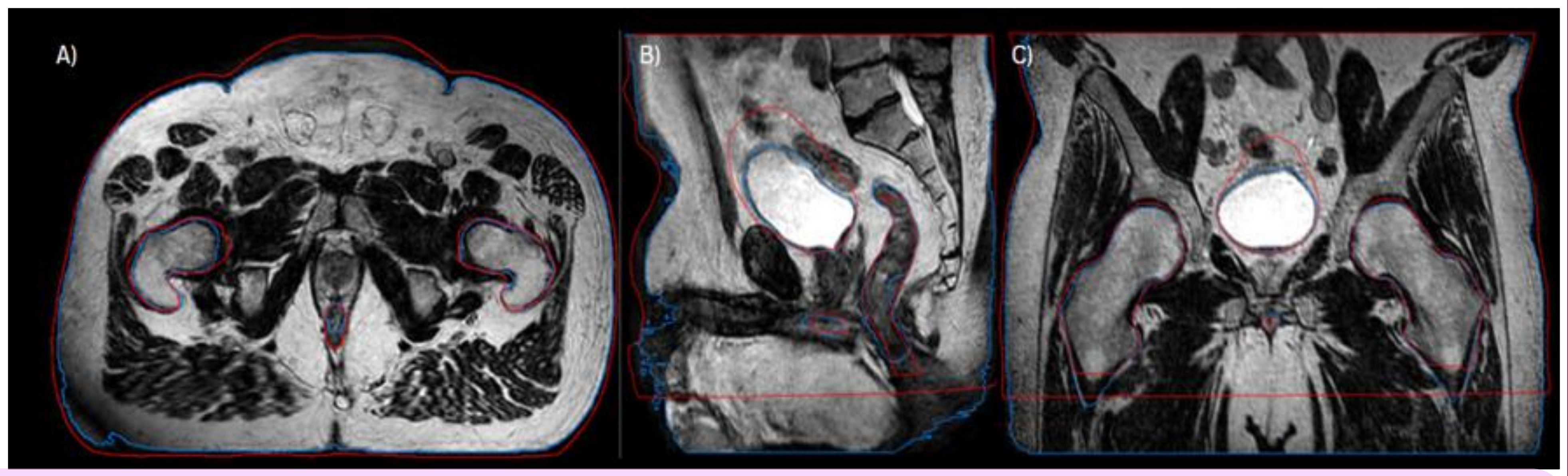


Figure 5. Statistical DVH curves showing the mean and IQR for OAR structures in the clinical plan (red) and the clinical plan recalculated on autogenerated structures (blue). The number of fractions containing each structure is listed adjacent to the structure's name.

We observe a rightward shift of the DVH for the urethra and a bladder structures and a leftward shift of the DVH in the penile bulb and femur heads for the recalculation on the auto-contoured structures.

Discussion

Figure 6. A representative case displaying the visual differences between the auto-contoured structures (blue) and clinically used structures (red) in the axial (a), sagittal (b), and coronal (c) planes. The auto-generated contours appear to be more conformal than the clinical contours in the external and bladder.



52 fractions in the recalculated plan contained at least one scorecard goal falling out of tolerance, most frequently occurring in overdosing the target hotspot (20 times), overdosing the bladder (17 times), overdosing the rectum (13 times), and overdosing the urethra (12 times). There were some plans that had multiple scorecard goals fall out of tolerance. Most points failing scorecard criteria were within 10% of the set scorecard tolerance level.

The target and urethra structures were not auto-contoured, however there is a systematic rightward shift in their DVH. A potential explanation is the definition of the external boundary. The MRgART ATS workflow utilizes Bulk Density Override (BDO) to define electron densities, allowing for dose calculation on the daily MRI, and anything within the external boundary is assigned a density. In Figure 2, we see the external boundary for the auto-contours was consistently smaller than the clinically used external boundary, with a mean difference of 5.6%. This can be observed visually in Figure 6. The reduction in the external boundary, along with BDO effects, results in reduced beam attenuation in the recalculated dose and therefore a hotter than expected dose to the target and urethra.

Although clinically viable planned doses can be generated in the current MRgART online workflow, the limited time available for contouring leaves room for contour improvement. These results demonstrate that contouring has a measurable impact on the planned dose in the MRgART online workflow.

References

1: de Leon, J., Twentyman, T., Carr, M., Jameson, M. and Batumalai, V. (2023), Optimising the MR-Linac as a standard treatment modality. J Med Radiat Sci, 70: 491-497. https://doi.org/10.1002/jmrs.712

The auto-contouring tool utilized in this study was TheraPanacea ART-Plan's Annotate (TheraPanacea, Paris, France) v2.3.2.

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The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Louisiana State University (protocol code IRBAM-25-0232, 25 May 2026).