

INTRODUCTION

Background: Accurate contouring and highly conformal dose distributions are critical challenges in prostate stereotactic body radiotherapy (SBRT), requiring significant clinical effort. Artificial intelligence (AI)-based automated approaches have the potential to improve efficiency.

Purpose: This study investigates a prostate SBRT treatment planning workflow integrating commercial solutions of AI contouring and knowledge-based planning (KBP). The purpose is to determine whether AI-generated contours are comparable to physician-delineated contours in achieving dosimetric goals.

METHODS

- In this retrospective study, 20 patients with intact prostate cancer were included. A commercial AI contouring software was applied to CT scans.
- Contouring accuracy for the prostate, rectum, and bladder was assessed against physician-delineated (clinical) contours using geometric metrics including Dice similarity coefficient (DSC), surface DSC (sDSC), and added path length (APL).
- Treatment plans were generated by a prostate SBRT KBP model without user interaction, utilizing VMAT and a 10 FFF beam. The prescribed dose was 36.25Gy in 5 fractions to the planning target volume with a 40Gy simultaneous integrated boost to the prostate. All plans were calculated using AcurosXB and normalized to cover 98% of the prostate.
- Given the high precision required for prostate SBRT, all plans used clinical prostate contours.
- Three plans were generated for each patient: 1) a reference plan using clinical contours, 2) a plan using AI OARs, and 3) a plan using post-processed AI OARs that removed any overlap with the clinical prostate contour. The latter two plans were recalculated on clinical contours with fixed monitor units to evaluate the dosimetric impact of AI contouring.
- Plan quality was evaluated using NRG-GU013 criteria. Pearson correlation was used to identify correlations between geometric and dosimetric performance.

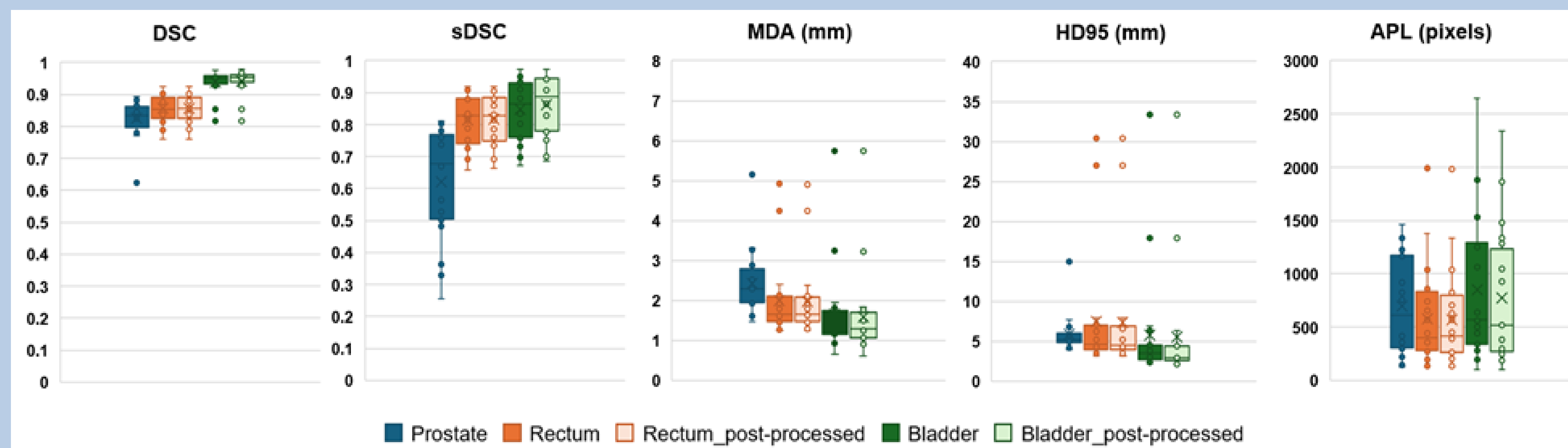


Fig. 1. Boxplots of the geometric metrics for the prostate, rectum and bladder.

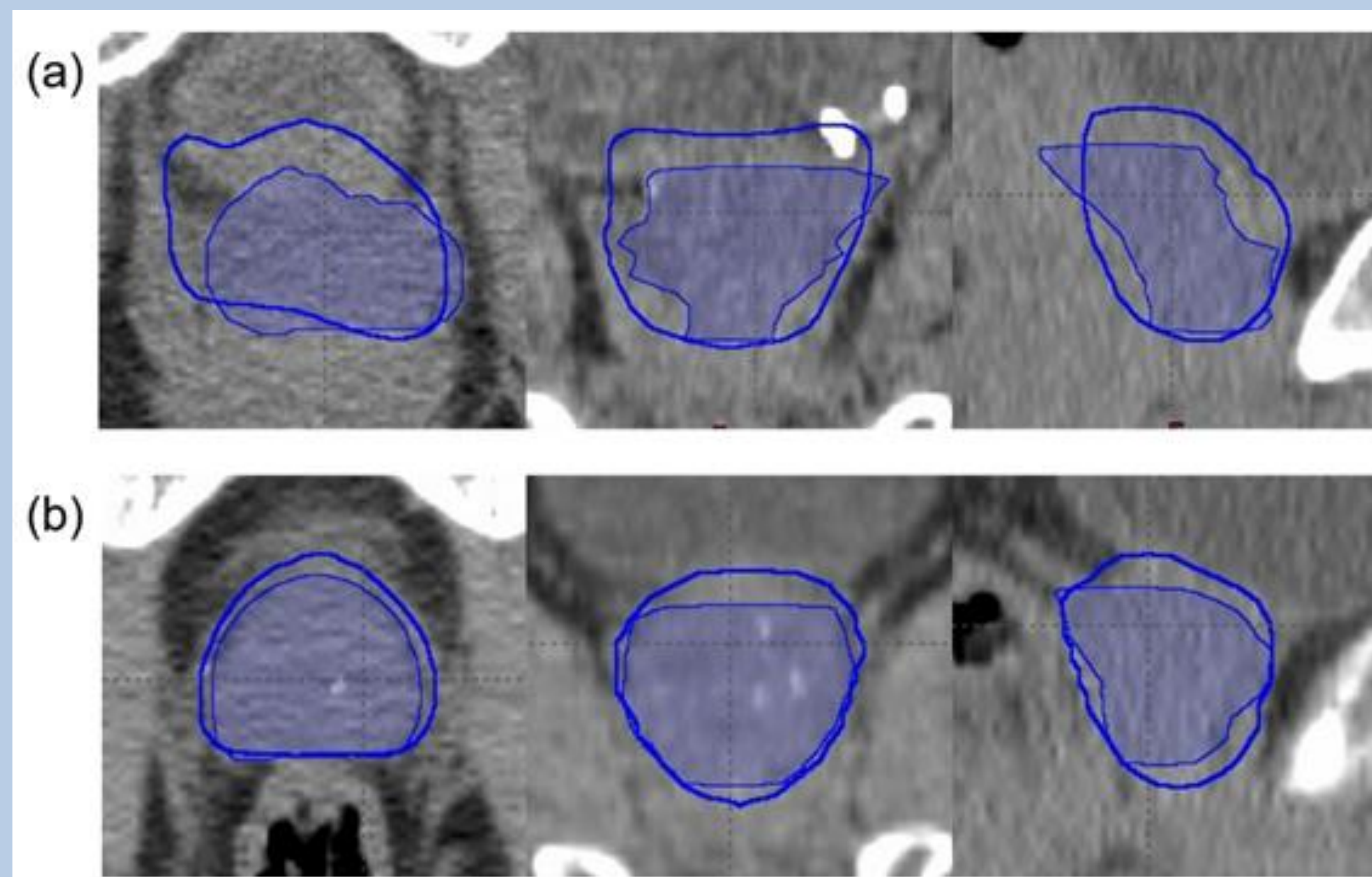


Fig. 2. Example cases of AI-generated prostate contours compared to the clinical prostate contours (filled) in three views: (a) case with the worst sDSC (0.26), and (b) case with the best sDSC (0.81).

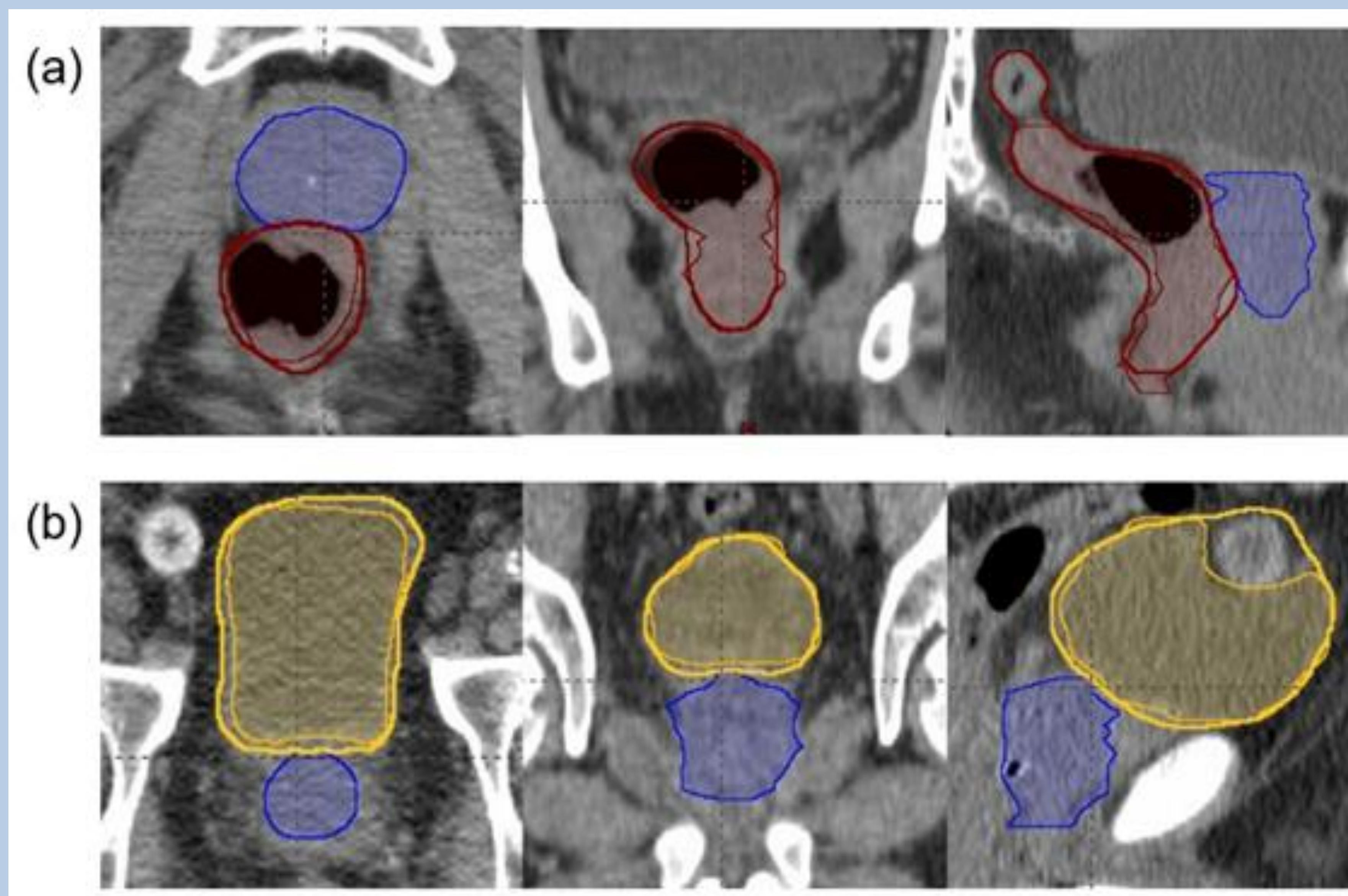


Fig. 3. Example cases of AI-generated OARs in three views: (a) rectum (in red) compared to the clinical contour (filled), and (b) bladder (in yellow), compared to the clinical contour (filled). The clinical prostate contours (in blue) are also displayed.

RESULTS

- The average DSC values were 0.83, 0.86, and 0.94 for prostate, rectum and bladder, respectively, and the average sDSC values were 0.62, 0.81, and 0.85. AI prostate contours were not clinically unacceptable. Rectum and bladder AI contours overlapped the clinical prostate contour in 15 and 20 cases, respectively.
- All reference plans using clinical contours met NRG criteria. Using AI OARs or post-processed AI OARs, only one case exceeded rectum V36Gy limits due to over-contouring, but it became clinically acceptable after recalculating on clinical contours. Plans using post-processed AI OARs yielded dosimetric results more comparable to reference plans for rectum and bladder sparing.
- Significant correlations were observed between the rectum geometric metrics (sDSC and APL)* and dosimetric endpoints, suggesting geometric metrics may predict key dosimetric outcomes.

*The sDSC measures the surface overlap between two contours, while the APL calculates the surface length of the clinical contour that is not captured by the AI contour.

CONCLUSIONS

- This study investigates a prostate SBRT treatment planning workflow by leveraging AI contouring and KBP. While a fully automated workflow is not yet feasible, results are encouraging when physician-delineated target volumes are combined with post-processed AI contours.

REFERENCES

