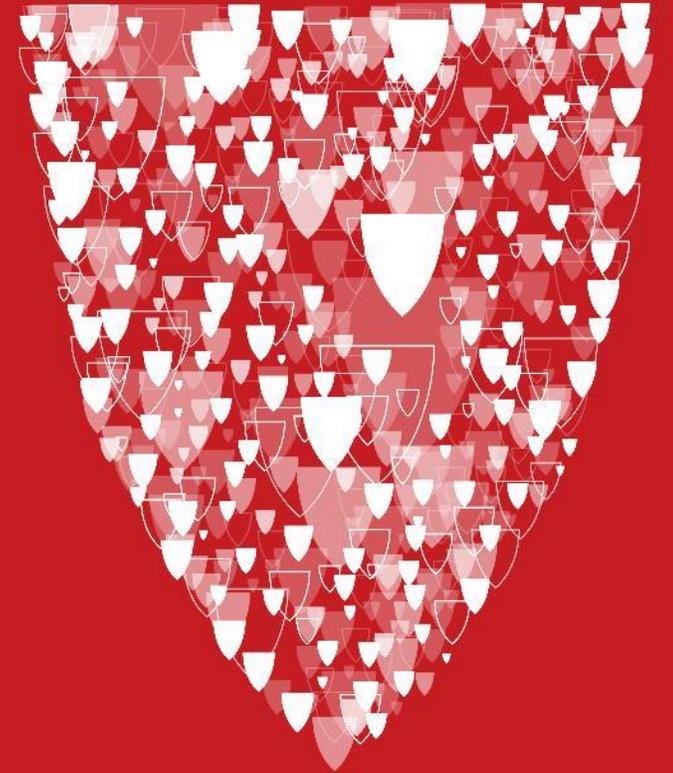


ADVANCING SBRT PLANNING: INNOVATIONS IN MR/CT IMAGING AND CONTOURING TECHNIQUES

Daniel E Spratt, MD
Associate Chief Scientific Officer
Director, Clinical Research Center
UH Cleveland Medical Center

Vincent K Smith Chair, Department of Radiation Oncology
UH Seidman Cancer Center

Chair and Professor, Department of Radiation Oncology
Case Western Reserve University



Disclosures

Personal fees from Astellas, AstraZeneca, Bayer, Boston Scientific, GSK, Janssen, Novartis, Pfizer

NIH Funding:

- R01: G-MAJOR Randomized Trial
- U01: STAMPEDE2 North America Randomized Trial: METANOVA

Study PI or Study Chair:

- ASCLEPIUS; niraparib, abiraterone (Janssen); no personal financial support
- OPTYX; relugolix (Myovant/Sumitomo); no personal financial support
- NRG GU006; apalutamide (Janssen), PAM50; no personal financial support
- NRG GU009; apalutamide (Janssen), Decipher; no personal financial support
- NRG GU010; darolutamide (Bayer), Decipher; no personal financial support
- STARLiT; 177Lu-PSMA-617

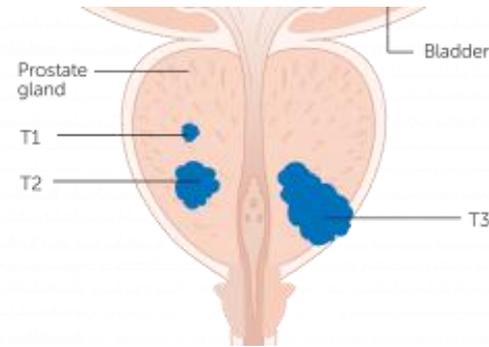
Leadership:

- Chair, NCCN Prostate Cancer Guidelines
- Standing Member, FDA Oncology Drug Advisory Committee

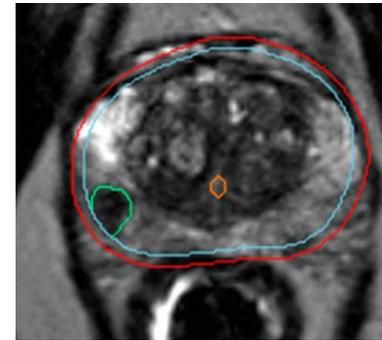
Role of MRI for Contouring



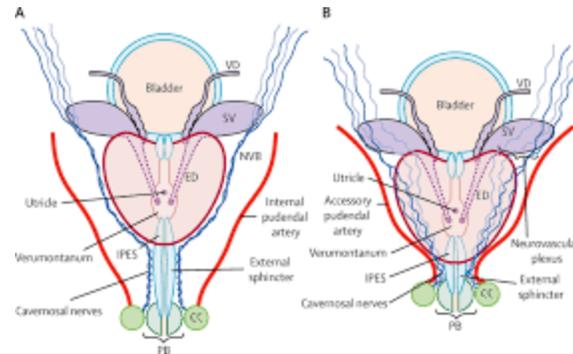
Tumor Extent



Tumor localization



Organs at Risk



How accurate are prostate contours on CT?

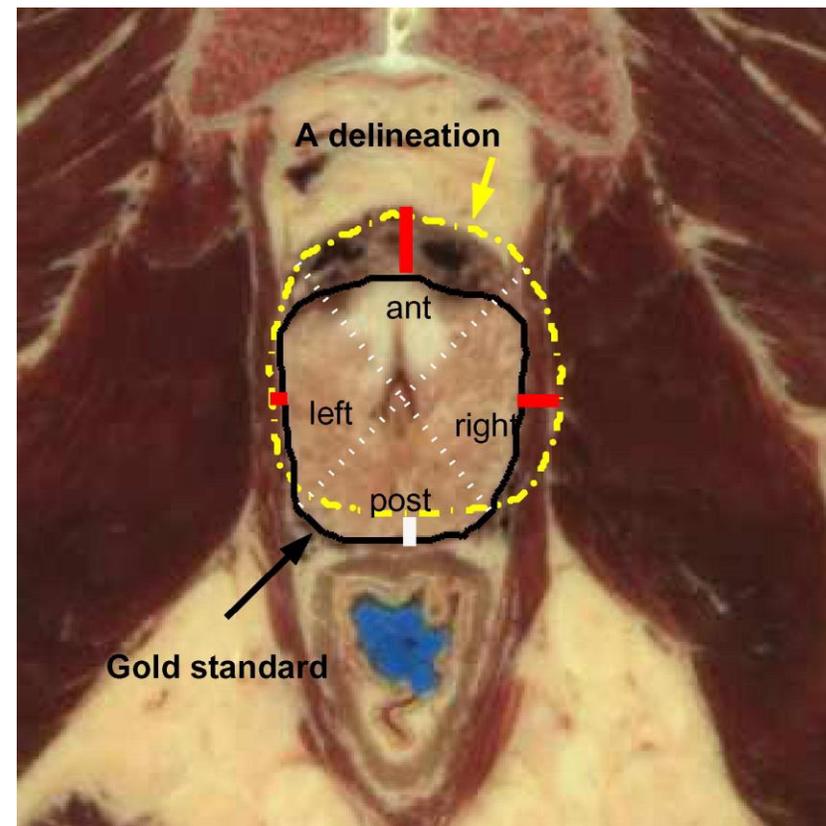


(a) Anatomical image of pelvic region

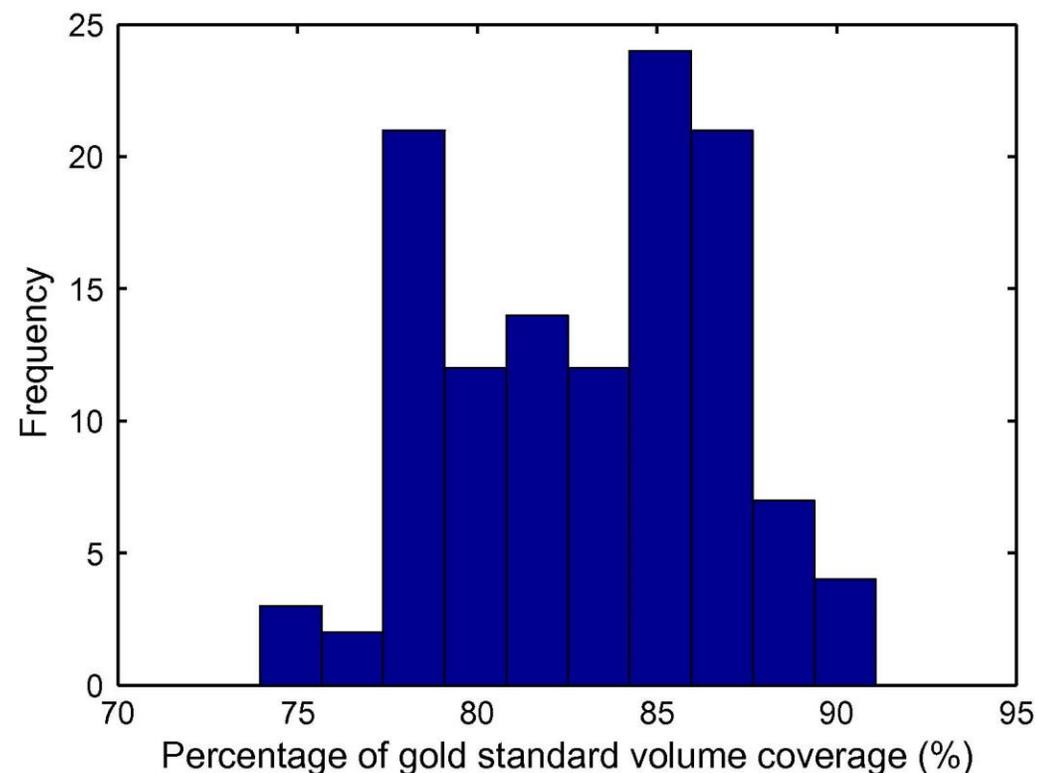
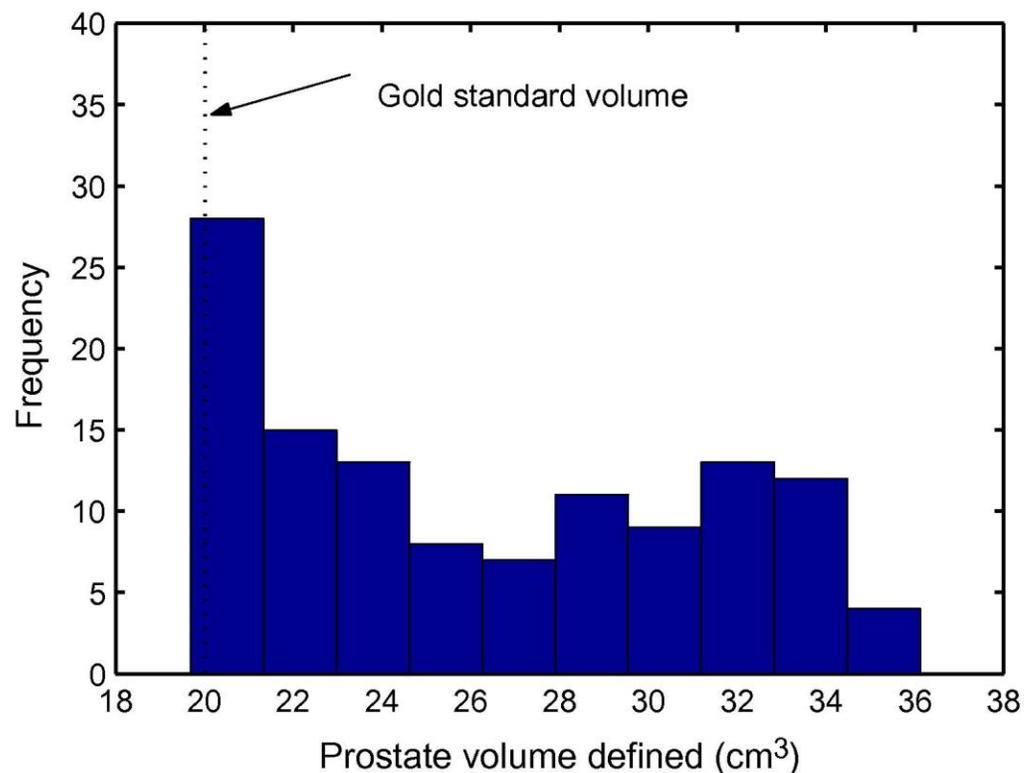


(b) Corresponding CT image

CT performed on a frozen cadaver
120 prostate contours done



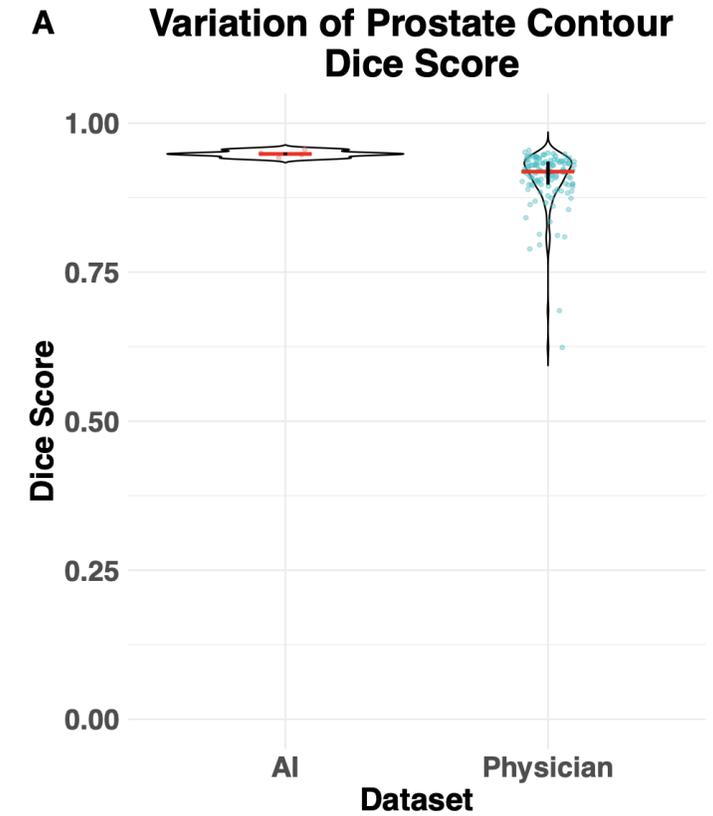
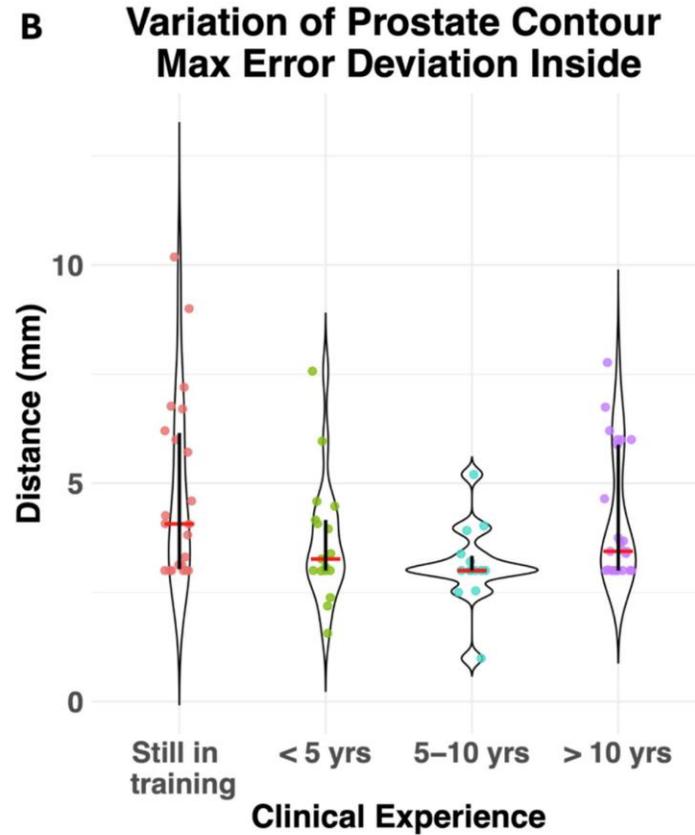
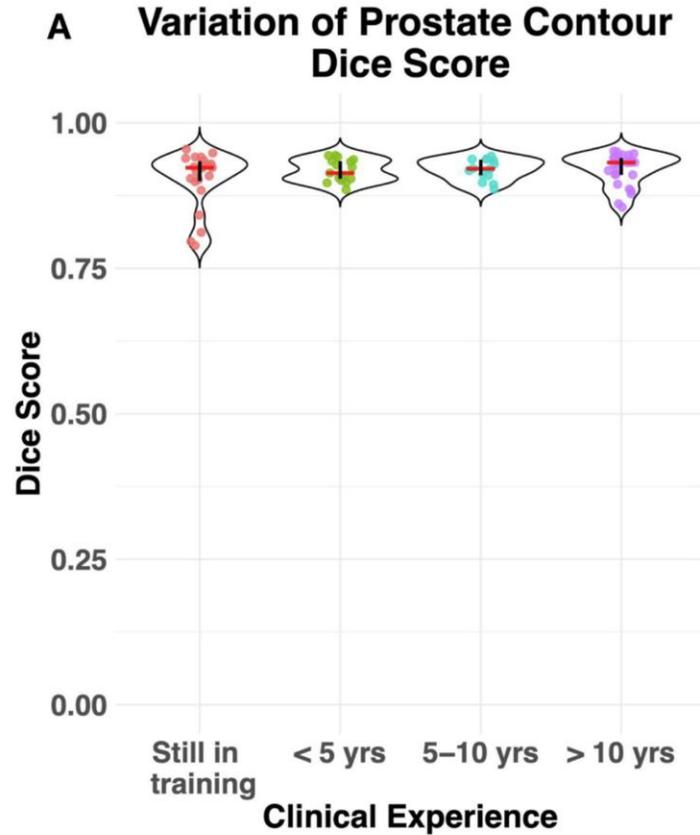
Prostate not clearly visible on CT



- **Contours typically 30% larger than true prostate**

- **0% of attempts covered full prostate**
- **Median ~84% prostate coverage**

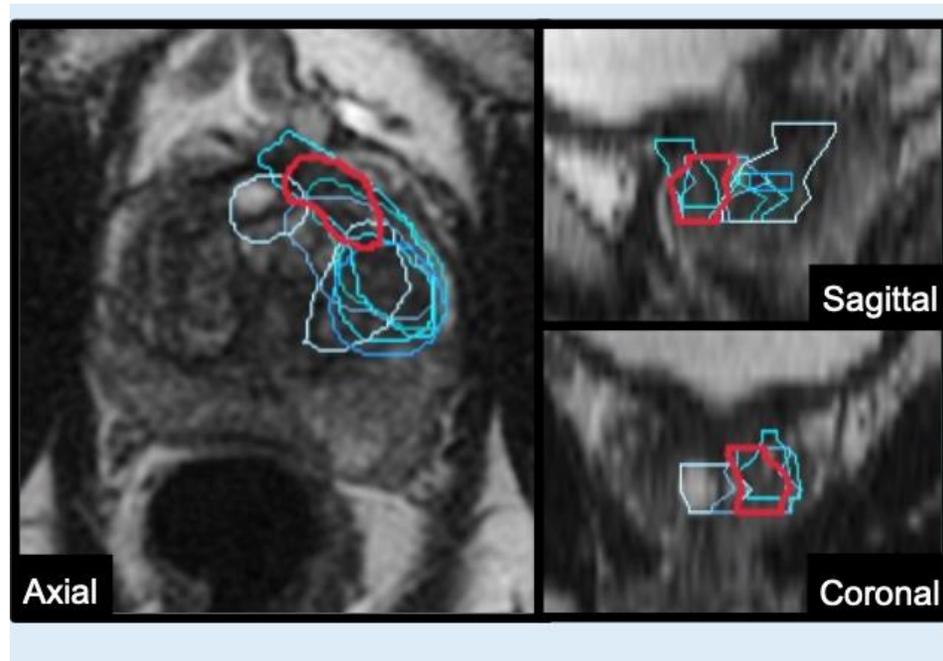
Contouring is more accurate on MRI



- Prostate and UREthra on MRI (PURE-MRI) study: 62 physicians, 114 prostate contours
- AI tool performed better than the physicians

Even on MRI most physicians are not great at finding the tumor

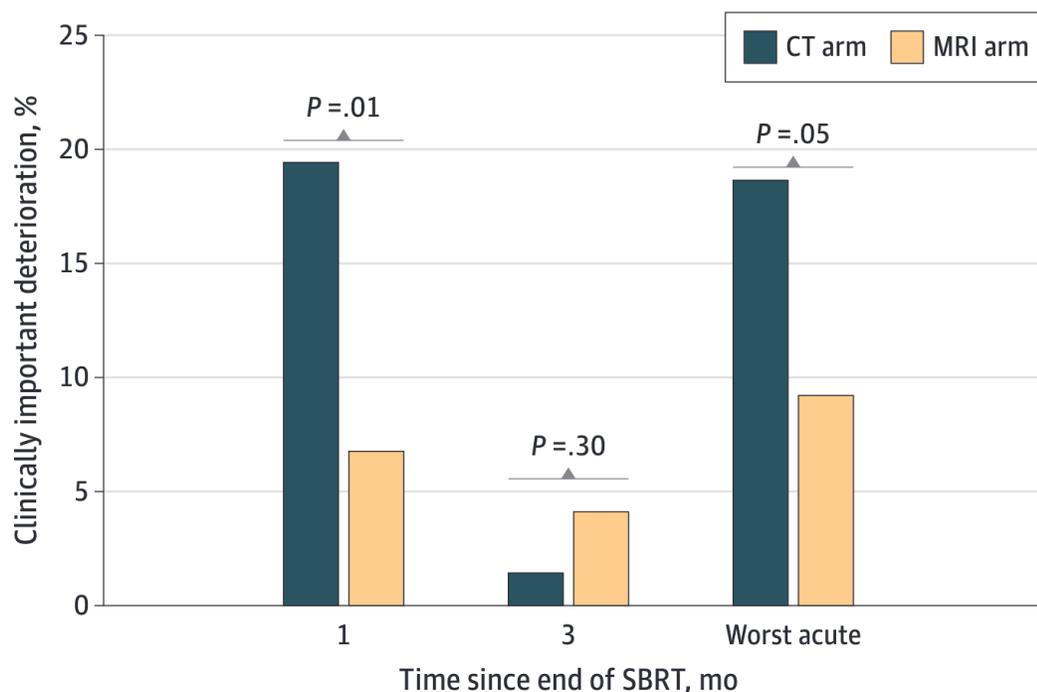
- Expert radiologists outlined the **tumor** in **red**
- Radiation oncologists' **attempts** to outline the tumor are shown in **shades of blue**



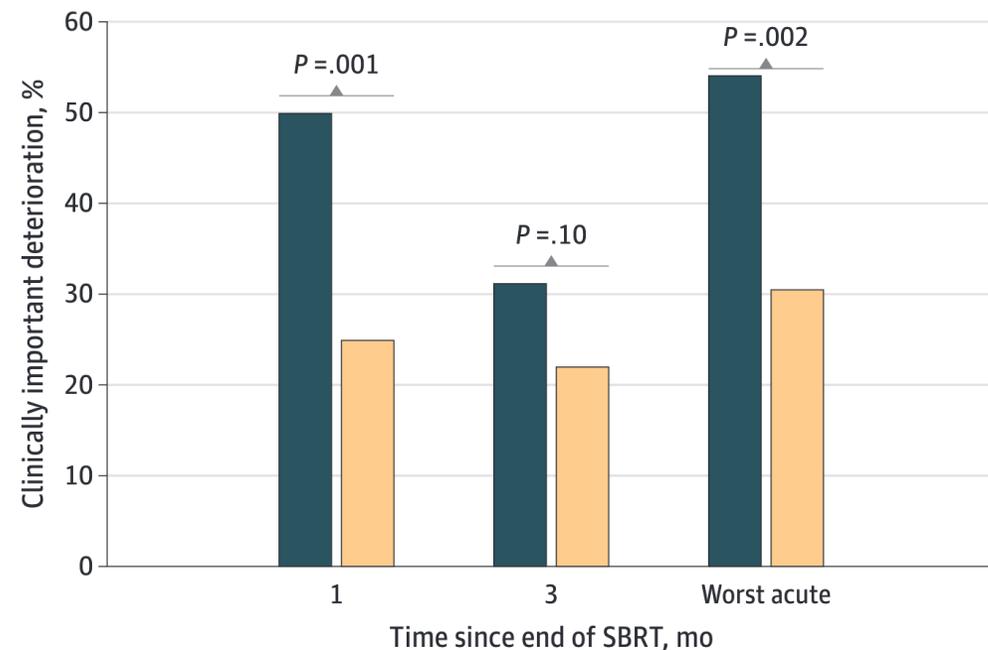
With only conventional MRI, many oncologists struggled to find the tumor

Does accuracy of prostate contour matter?

B Change in clinically relevant IPSS

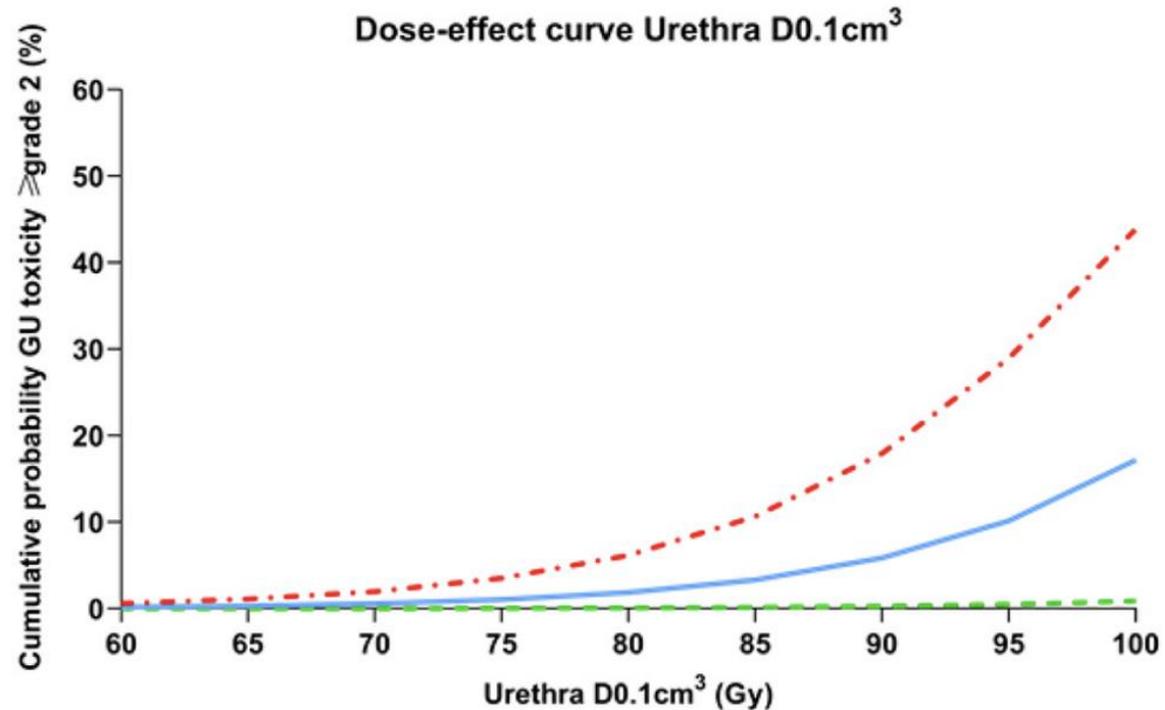


D Change in clinically relevant bowel domain score



- **MIRAGE trial compared 2 mm PTV margin (with MR-linac) to 4 mm PTV margin**
- **More side effects with only 2 mm difference in margin**
- **Errors on CT contours can be >> 2 mm**

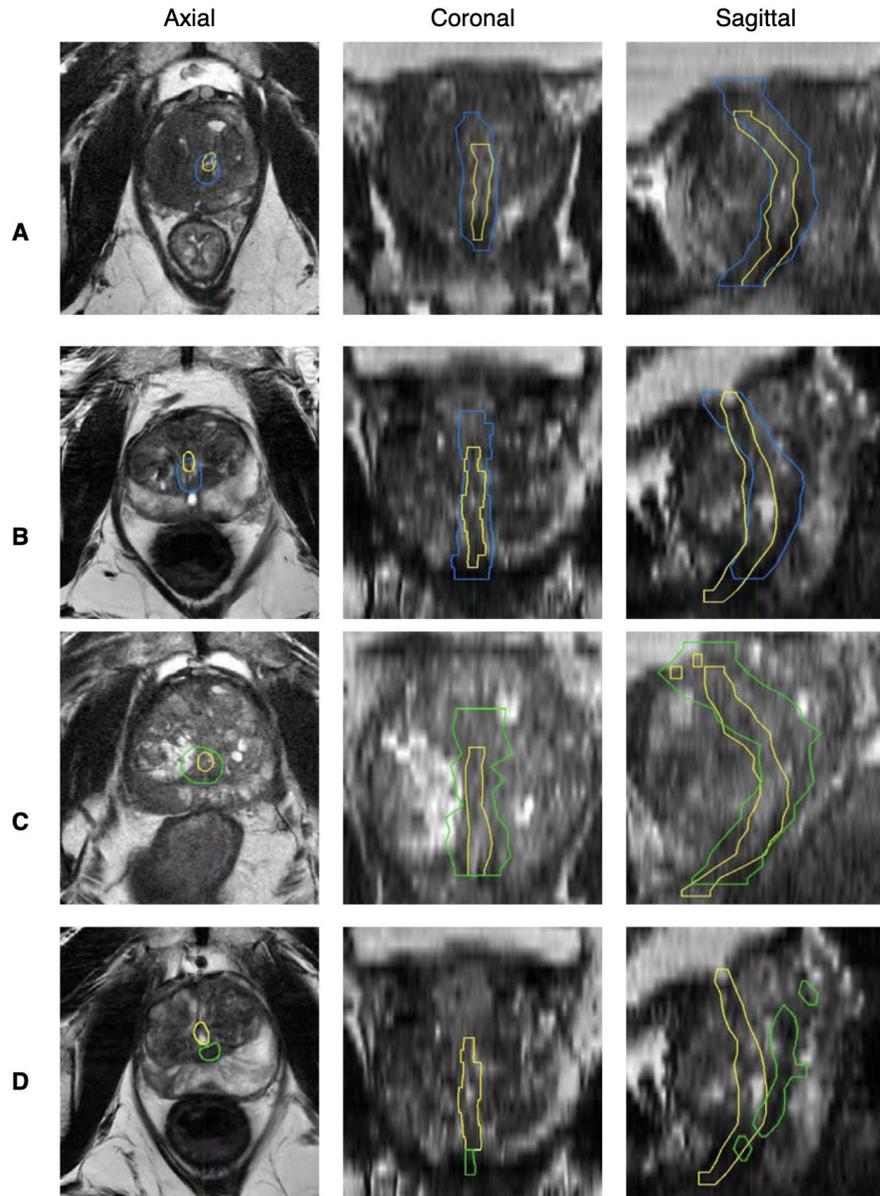
Urethra: organ at risk not visible on CT



age, T-stage, diabetes mellitus, baseline GU toxicity grade ≥ 1

- Analysis of FLAME trial found urethra dose was strongly associated with side effects

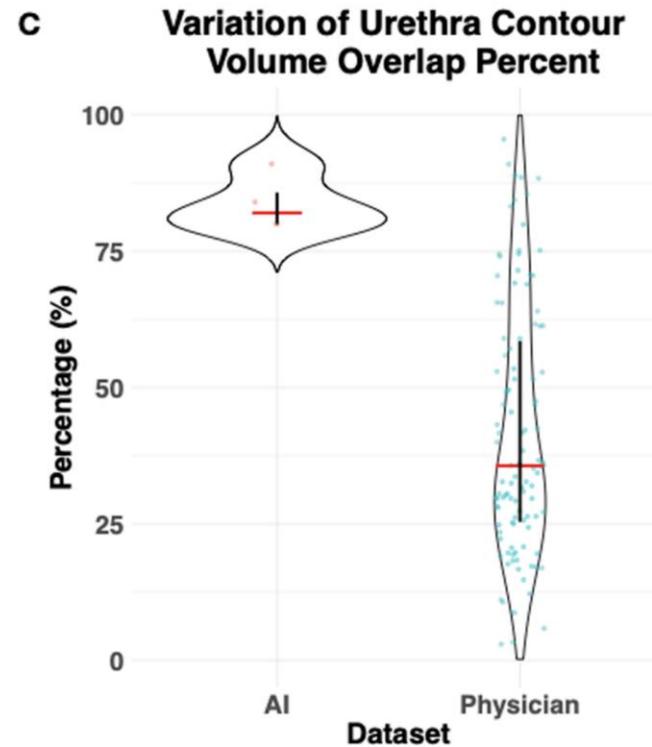
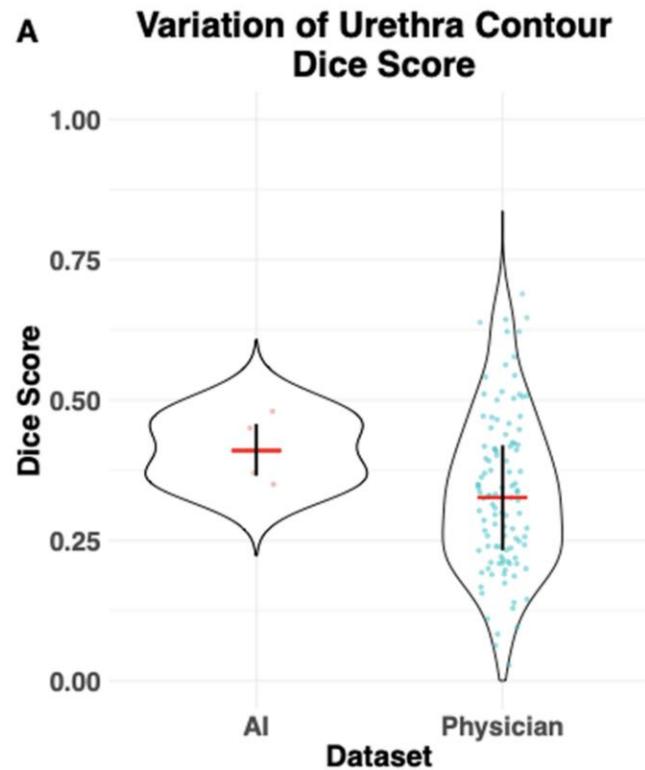
Urethra contouring is more challenging



- **PURE-MRI study: 62 physicians, 110 urethra contours**
 - **Yellow: expert panel**
 - **Green: physician participant**
 - **Blue: AI**

Nguyen et al. *Green Journal* 2025
Song et al. *Green Journal* 2026

Urethra contouring is more challenging



- **AI tool improved urethra contours**
 - **Physicians:** median 36% of urethra included
 - **AI:** median 81% of urethra included

Vessel Sparing RT

Vessel-sparing radiation and functional anatomy-based preservation for erectile function after prostate radiotherapy

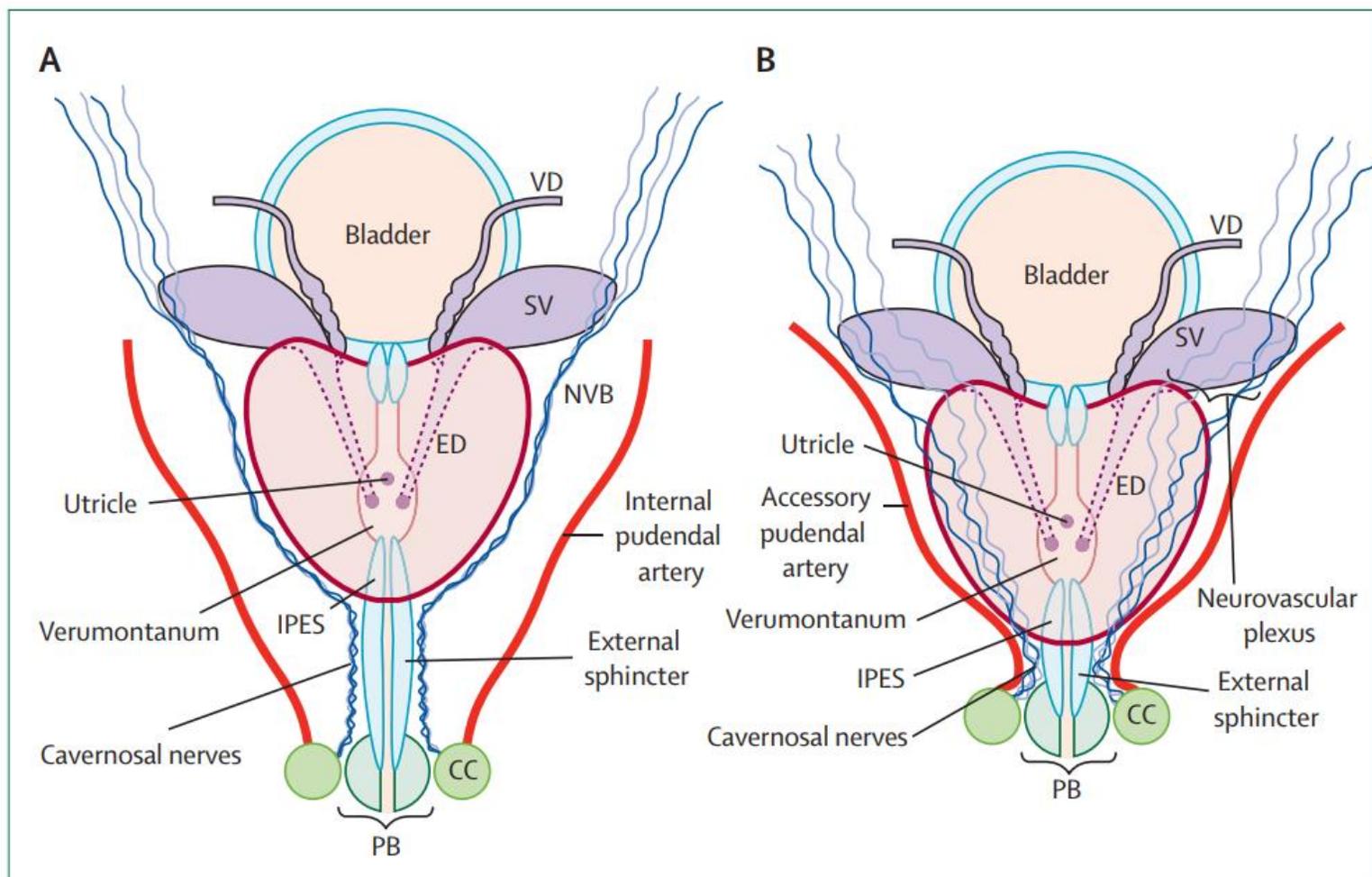


Figure 5: Favourable and unfavourable variations in anatomy for preservation of erectile function after radiotherapy

Vessel-sparing Radiotherapy for Localized Prostate Cancer to Preserve Erectile Function: A Single-arm Phase 2 Trial

	Nerve-Sparing Prostatectomy	Conventional External Beam Radiotherapy	Vessel-Sparing Radiotherapy	
	Expected	Expected	Observed	
	% Potent (95%CI)	% Potent (95%CI)	% Potent (95%CI)	P-value*
Total Cohort	24% (22-27%)	42% (38-45%)	78% (71-85%)	<0.001
Top quartile baseline erectile function	35% (32-38%)	55% (51-59%)	87% (77-97%)	<0.001
Bottom quartile baseline erectile function	13% (8-18%)	26% (21-31%)	69% (55-83%)	<0.001
Age <65	31% (28-34%)	44% (40-48%)	81% (72-90%)	<0.001
Age ≥65	15% (13-17%)	38% (33-43%)	73% (61-85%)	<0.001
No ADT	26% (23-29%)	51% (48-54%)	84% (76-92%)	<0.001
ADT	21% (18-24%)	22% (19-25%)	66% (52-80%)	<0.001

Abbreviations: ADT, Androgen Deprivation Therapy; CI, Confidence Interval

Vessel Sparing RT

Multi-center randomized trial of:

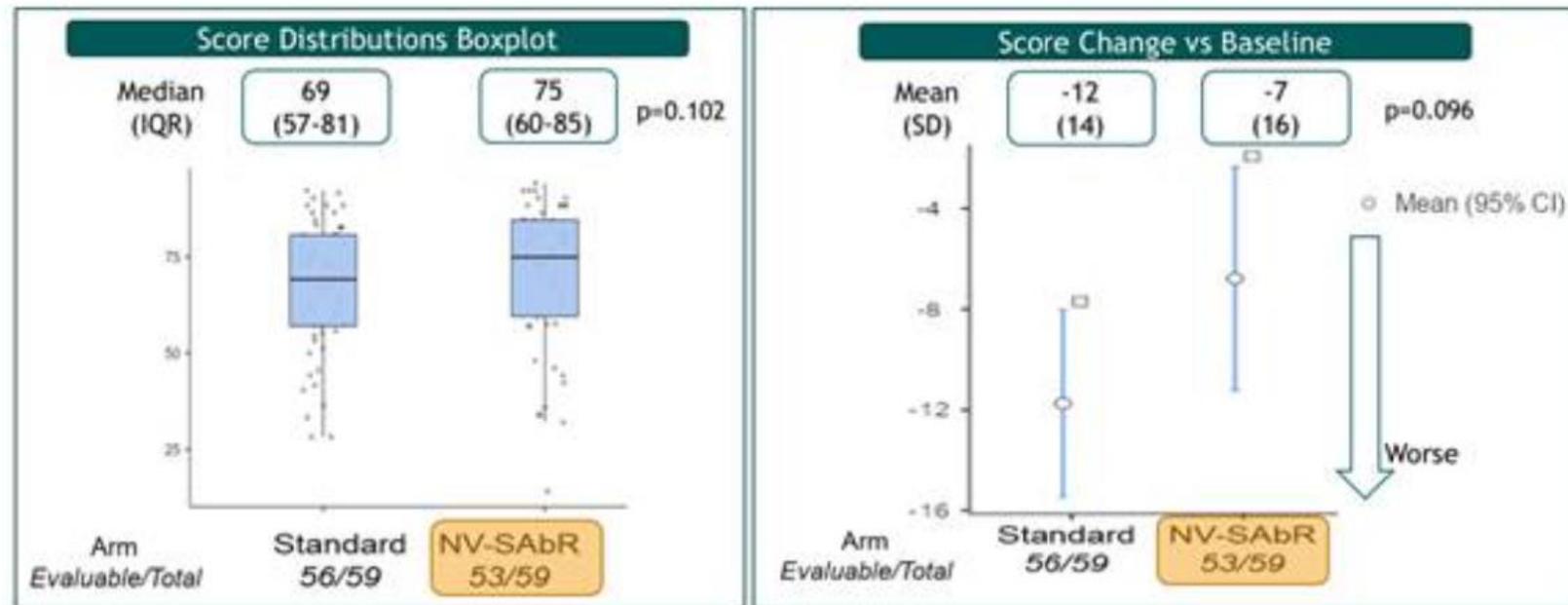
SBRT +/- Vessel-Sparing RT

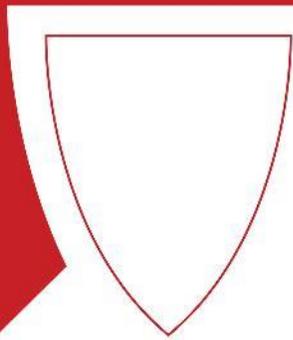
All patients get:

- IGRT
- 5 fractions of SBRT
- Rectal Spacer



3mo Patient-Reported Quality of Life: Sexual Domain (EPIC Full)





Practical Take Home Points

Timing of MRI

Try to avoid neoadjuvant ADT → changes prostate size and tumor clarity

- If you do this, will need another MRI

If using non-contrast enhanced rectal spacing → obtain MRI post-spacer

If using contrast enhanced rectal spacer → I am comfortable not obtaining another MRI

- Will need to move registration around potentially for different areas

MRI Registration

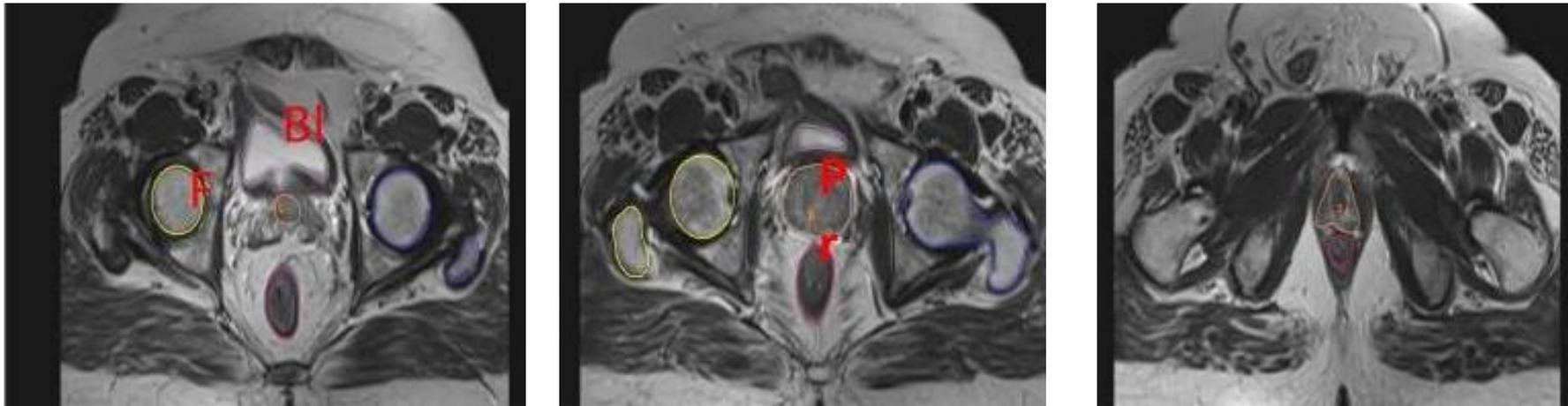
MR/CT registration

- Do not rely solely on dosi/physics → must learn to modify throughout case for different focus areas
- Multiple options:
 - Contour the prostate on MRI first → put it where you want on CT
 - Align fiducials (if post fiducials)
 - Align posterior edge of prostate
- I use both axial and sagittal registrations for MR
 - Helps in DIL, urethra, and apex delineation

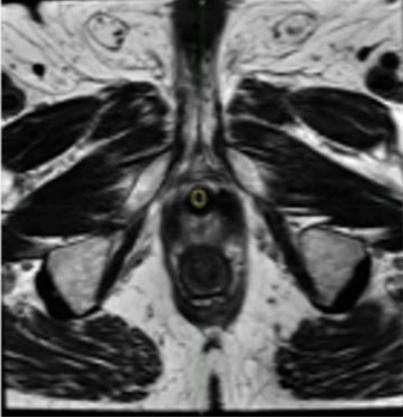
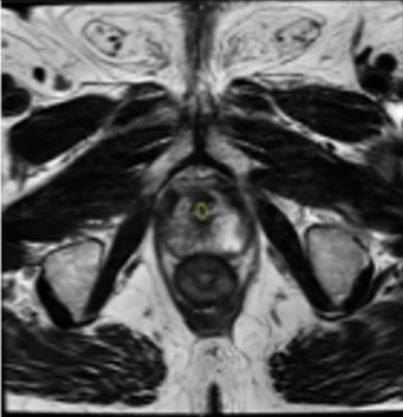
Urethra Contouring

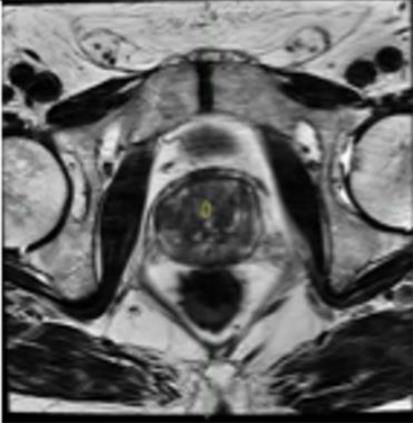
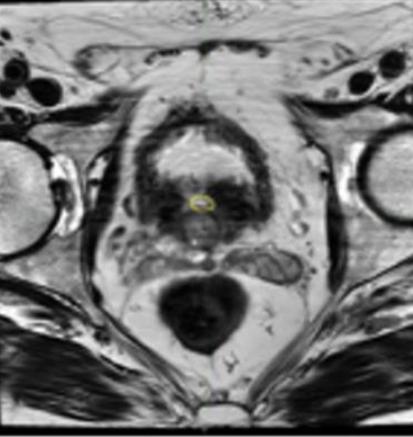
1. Axial T2 → Identifying the bladder neck: the hyperintense signal is representing the urine in the bladder.
2. It is traced further into the parenchyma of the prostate.
3. The sagittal sectional correlation to aid in delineation

The urethra is not always centrally located within the gland

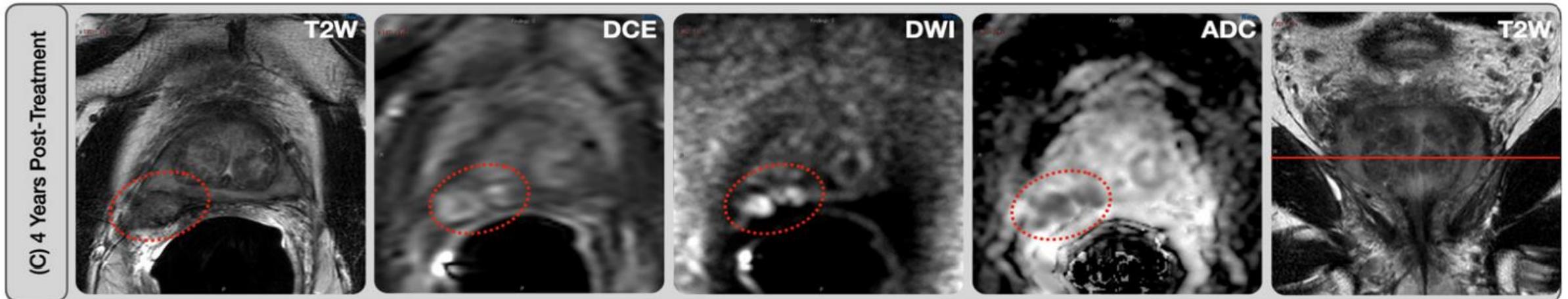
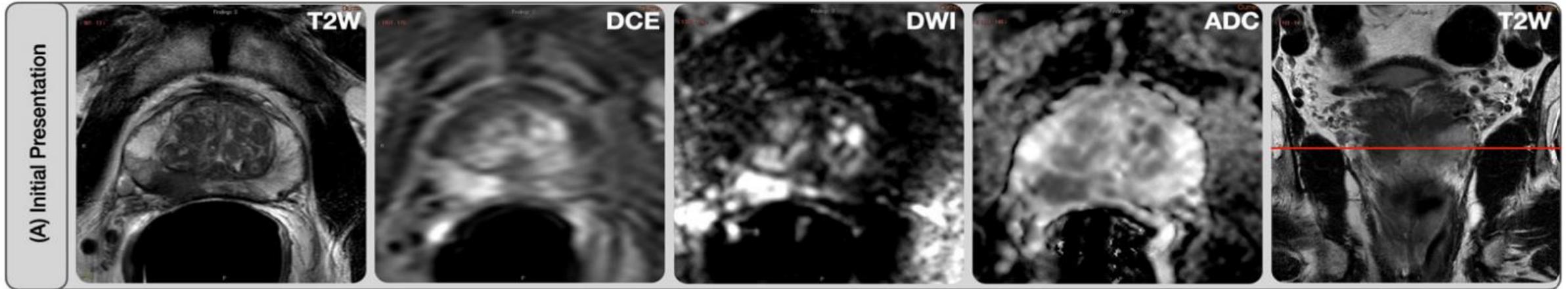


Urethra Contouring

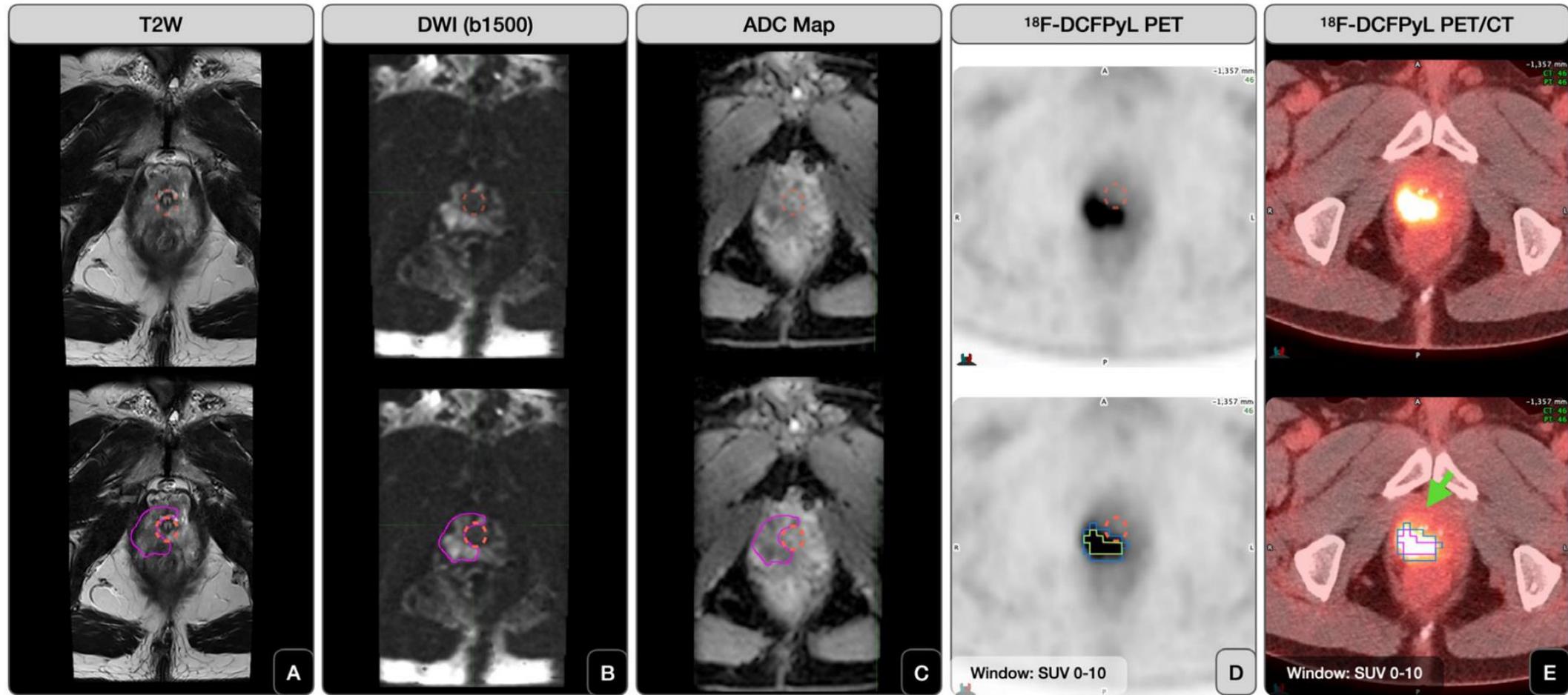
Axial T ₂ -weighted Slices	Annotations for Contouring
 <p data-bbox="219 729 443 758">Axial View Slice 8</p>	<p data-bbox="657 468 1225 601">Membranous urethra extends from prostatic urethra to inferior aspect of urogenital diaphragm, ending just superior to the penile bulb.</p>
 <p data-bbox="219 1188 443 1216">Axial View Slice 10</p>	<p data-bbox="657 915 1225 1079">Inferior prostatic urethra: continuous with membranous urethra and often moderately hyperintense, just anterior to an inverted "V" of hyperintensity that can extend superiorly to the verumontanum.</p>

 <p data-bbox="1493 702 1727 731">Axial View Slice 18</p>	<p data-bbox="1939 287 2517 729">Midgland prostatic urethra: The urethra can be difficult to visualize in the upper midgland. It can be helpful to start at apex and track as far superiorly as possible then skip to the prostate base and track the urethra as far inferiorly as possible before returning to the midgland. Consider viewing all three planes while delineating the urethra in the midgland. The urethra may not remain in the mid-sagittal plane because of benign prostatic hyperplasia that causes asymmetry of the prostate.</p>
 <p data-bbox="1493 1176 1727 1205">Axial View Slice 23</p>	<p data-bbox="1939 846 2517 1118">Superior prostatic urethra: identify region of marked hyperintensity (urine) where the bladder neck inserts into the prostate base and trace inferiorly. The superior origin of the urethra must be continuous with the bladder neck; it is often <u>not</u> at the superior tip of the prostate but is on the anterior aspect of the gland.</p>

DIL Contouring



DIL Contouring



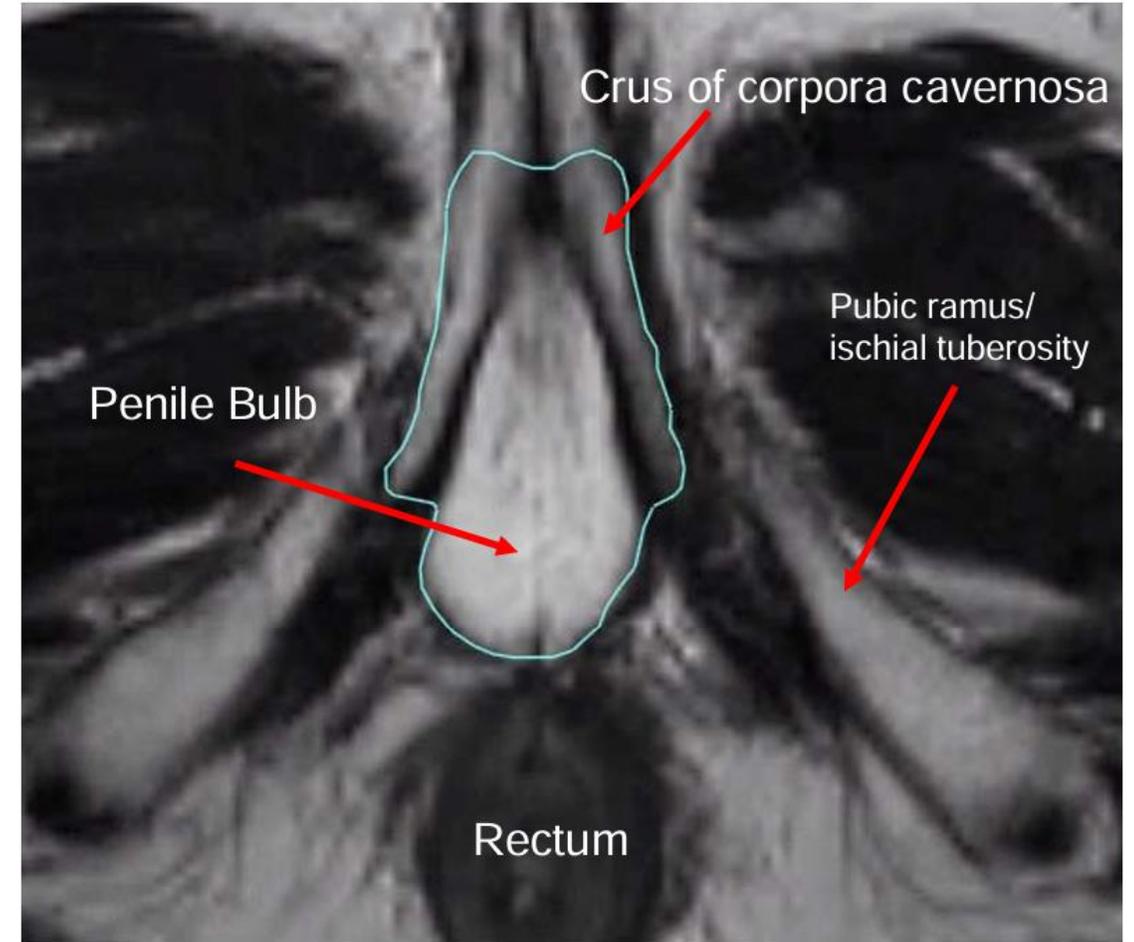
Legend

— MRI Contour	— \geq SUV 10 Contour (SUV 10 \approx 40% SUV _{Max})	— \geq SUV 5 Contour (SUV 10 \approx 20% SUV _{Max})	○ Urethra	➔ Region of mpMRI/PET incongruence (anterior to the urethra)
---------------	---	--	-----------	---

Vessel Sparing RT

Penile Bulb + Bilateral Crus of Corpus Cavernosum

For 2cm caudal to the PTV1_30Gy, the penile bulb will be contoured starting superiorly at the inferior aspect of the pelvic diaphragm (urethral sphincter) and extending inferiorly and anteriorly to encompass adjacent crura of the corpus cavernosum located on the same slice

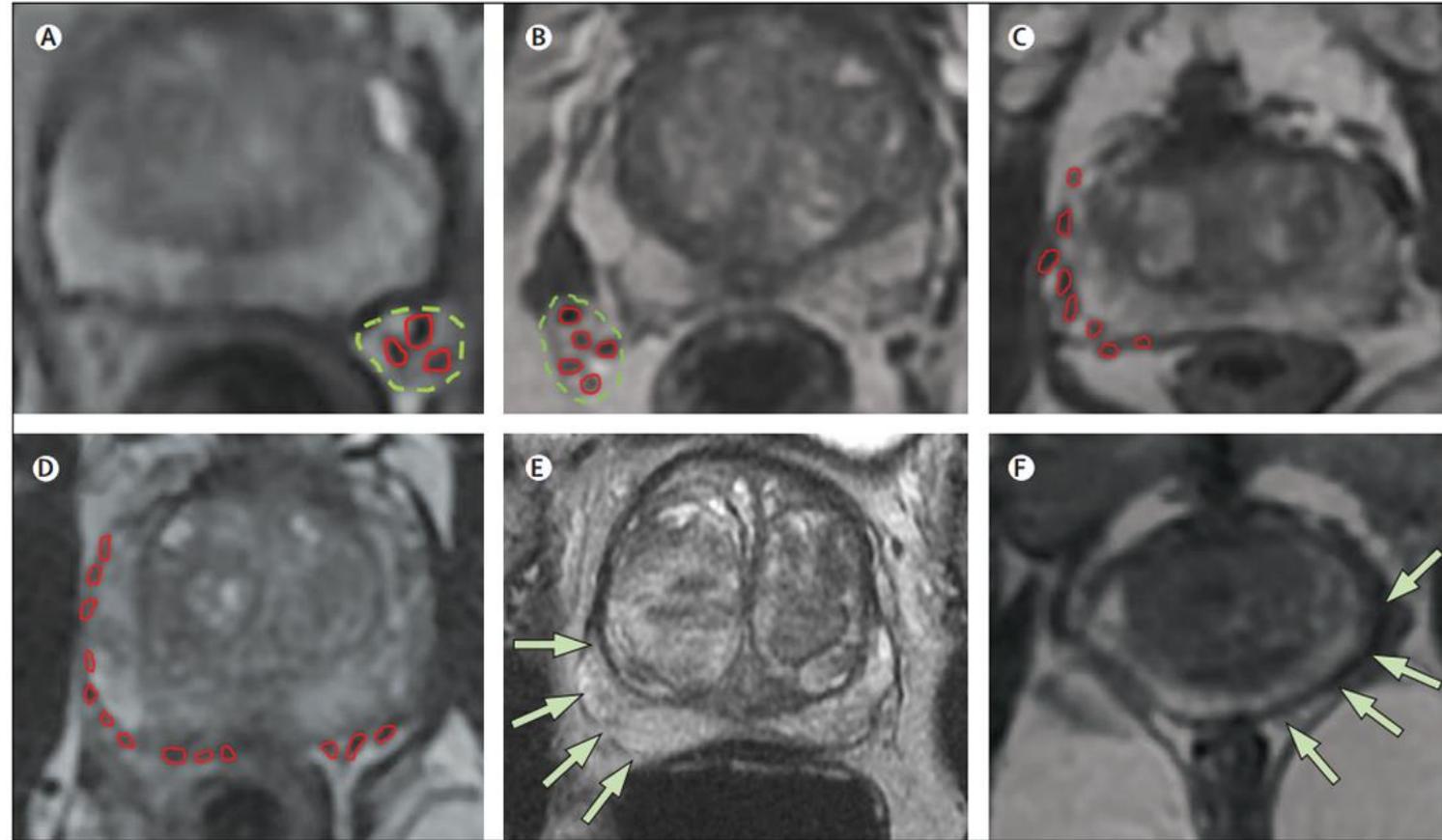


Vessel Sparing RT

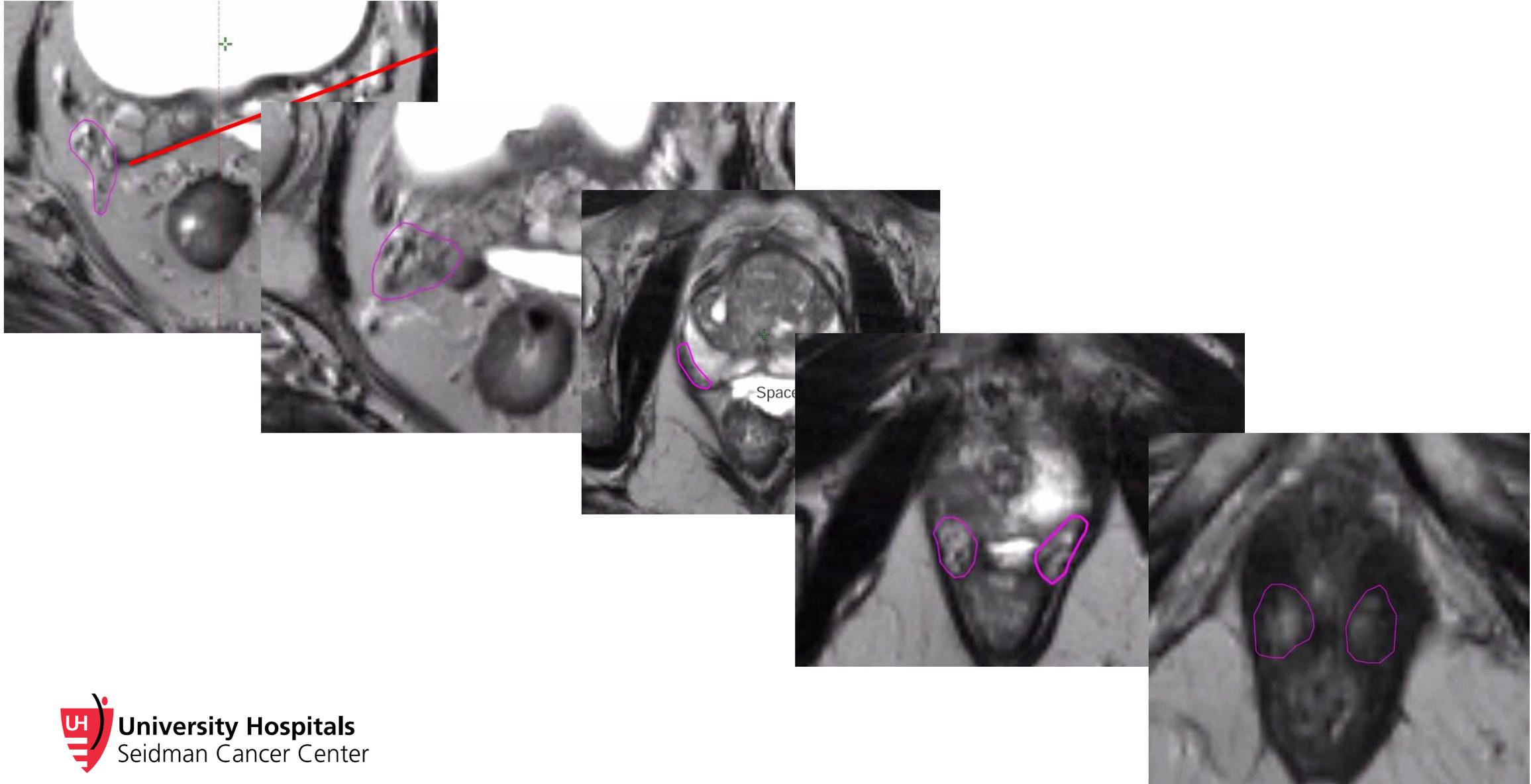
Neurovascular Bundles

Will be contoured as separate structures within 1cm of the PTV.

Particular care will be taken to delineate these structures as they course into the GU diaphragm caudally past the penile bulb until their termination in erectile tissue.



Vessel Sparing RT



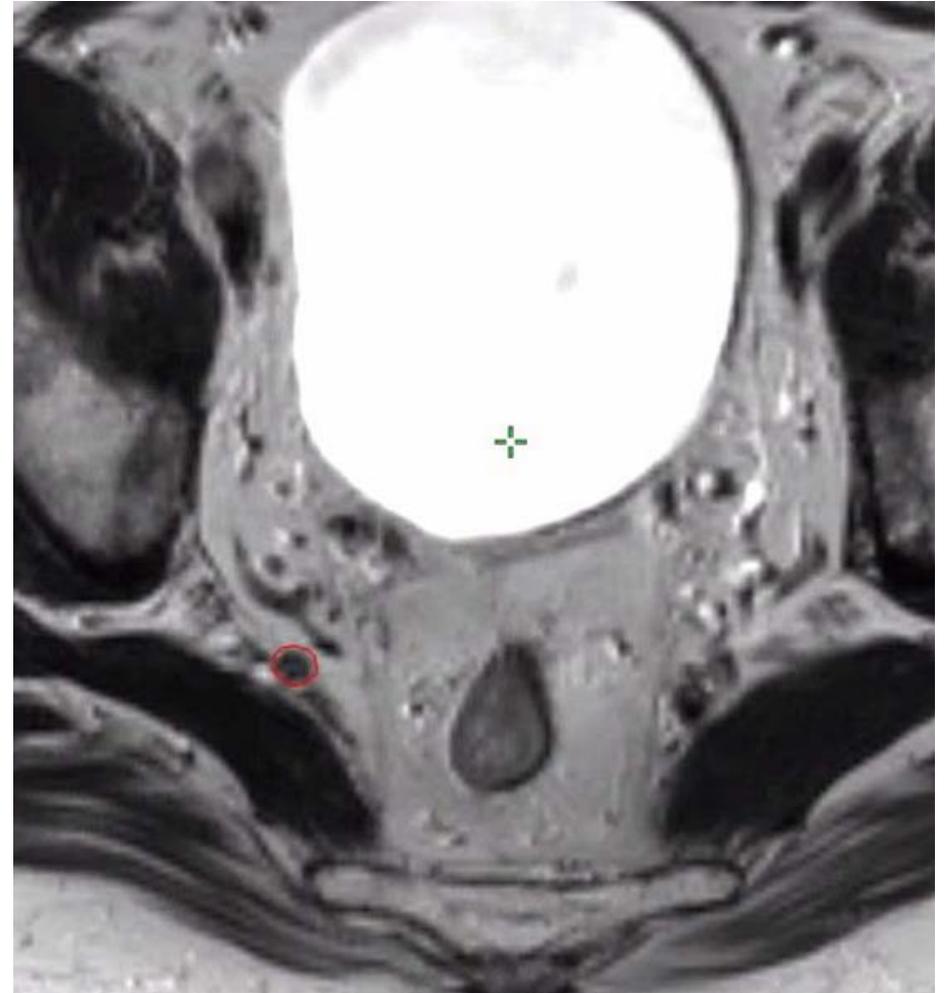
Vessel Sparing RT

Internal Pudendal Arteries

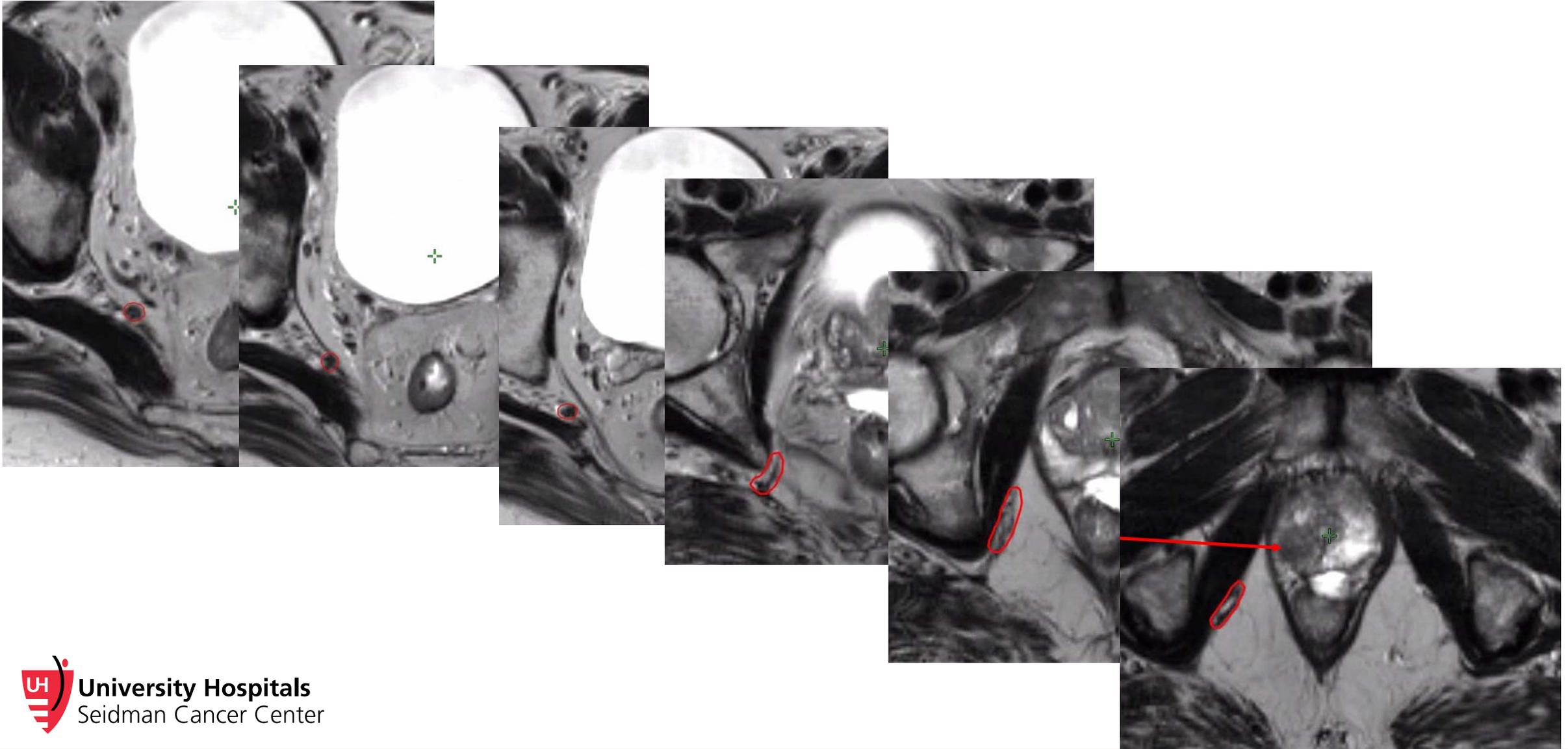
Contour using a 5mm brush each artery 1cm cranial to the PTV1_30Gy.

From this point on, the artery can be identified as it courses anteromedially within the pudendal canal (medial edge of obturator internus) giving off minor arteries to prostate/bladder/rectum before giving rise to the penile artery at the perineum (not encompassing the branch leading to the scrotal artery).

Contouring may stop caudally where the penile artery branch of the IPA enters the erectile tissues.



Internal Pudendal Artery





Thank you



University Hospitals

Seidman Cancer Center



CASE WESTERN RESERVE
UNIVERSITY EST. 1826

Radiation Oncology Reimagined



@DrSpratticus