POTEN-C Trial: Contouring Atlas

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UTSW

Overview

Details covered include:

- Neurovascular bundle (NVB)
- Internal Pudendal Artery (IPA)
- Penile Bulb and crus of the corpus cavernosum (CC)
- Shaping structure for spared neurovascular elements
- CTV to PTV expansions for PTV1_30Gy and PTV2_SAbR

NVB, IPA, CC should be contoured for all cases, but these will only be used as constraints in the experimental neurovascular sparing arm.

T2 weighted MRI imaging favored for delineation of most structures. More than one image registration may be needed.

Abbreviated standard IDs for each structure should be used for plan submission and are provided with each structure here and in the protocol objectives sheet

Anatomy Overview (courtesy of U Michigan Colleagues)

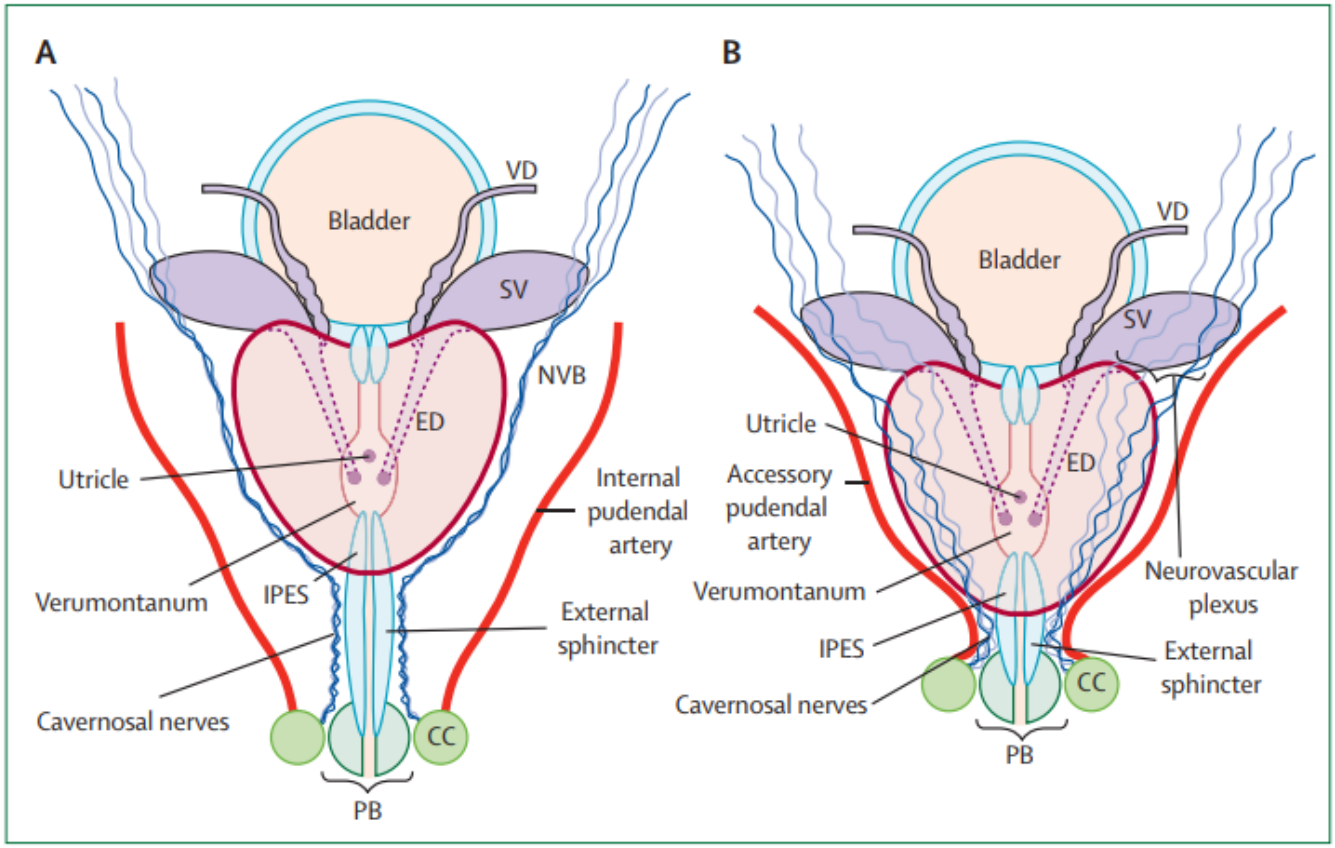


***Figure 5*: Favourable and unfavourable variations in anatomy for preservation of erectile function after radiotherapy**

(A) The most favourable configuration with a classic well-defined neurovascular bundle, long external sphincter with adjacent cavernosal nerves, and a normal internal pudendal artery running far from the prostate and external sphincter. (B) Unfavourable variant anatomy includes a dispersed adherent neurovascular plexus, a short external sphincter, and the accessory pudendal artery variant running close to the prostate apex and external sphincter. CC=corpus cavernosa. ED=ejaculatory duct. IPES=intraprostate external sphincter. NVB=neurovascular bundle. PB=penile bulb. SV=seminal vesicles. VD=vas deferens.

Lee J et al. Lancet Onc

Penile Bulb and Corpora Cavernosa (CC)

Standard abbreviated ID: *PenileBulbCC*

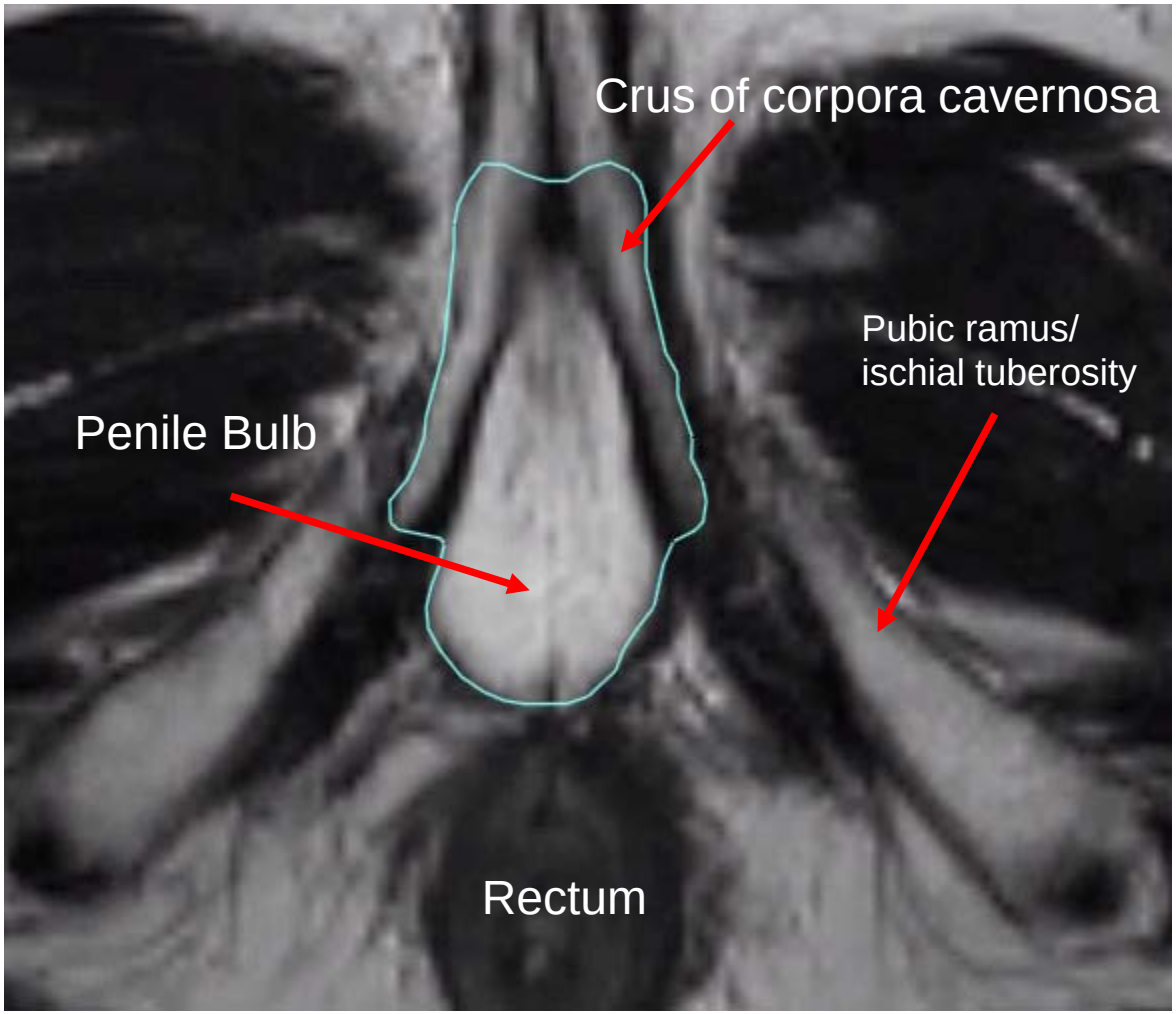
Hyperintense on T2 weighted MRI, while homogenous to surrounding musculature on CT

In addition to MR-CT fusion registration to fiducials to guide CTV contouring, a second registration focused on aligning prostate apex for this and NVB/IPA structures can help

Per protocol:

- *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.*

Penile Bulb + Bilateral Crusof CC



Neurovascular Bundles

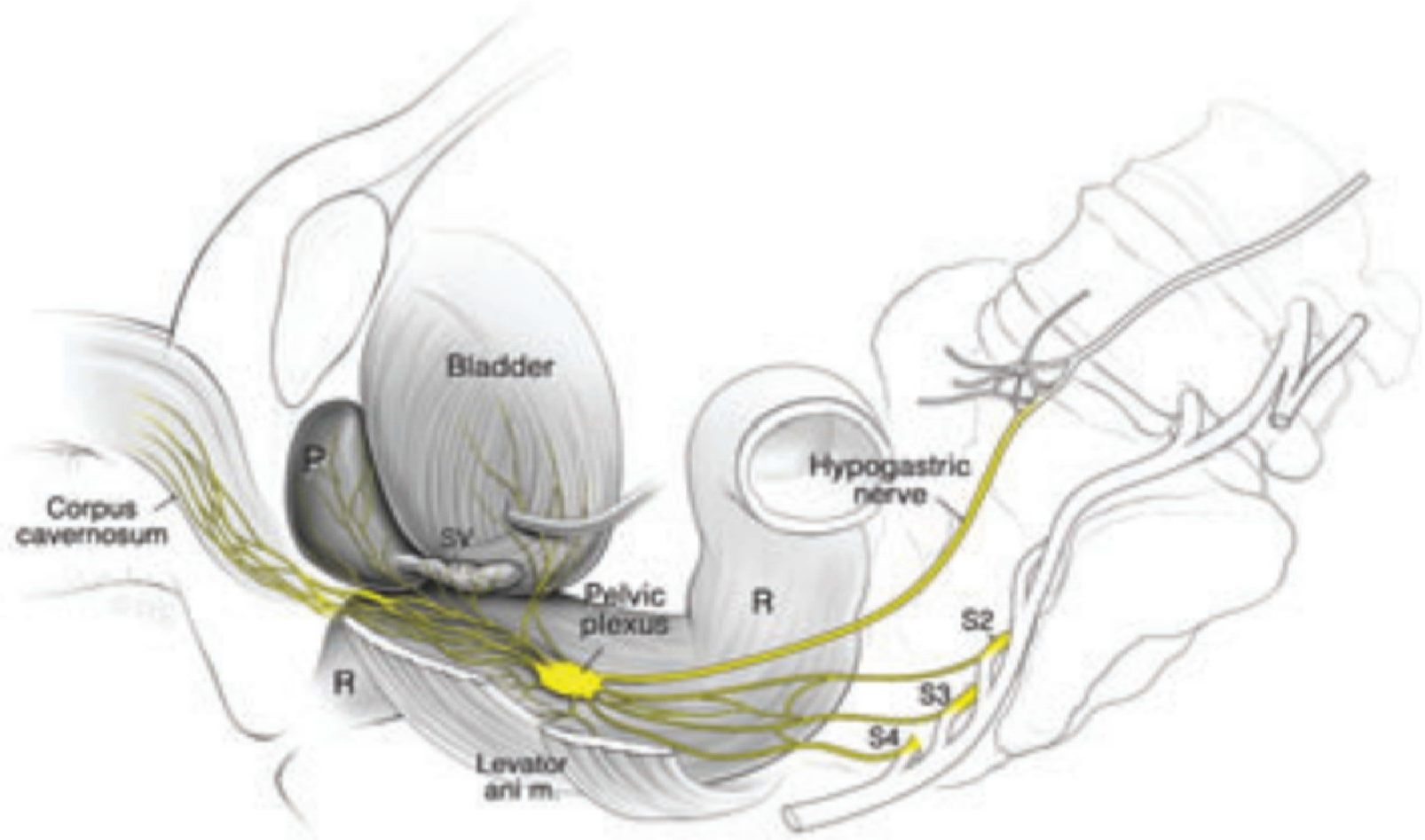
Standard abbreviated ID: *NVB_left* and *NVB_right*

Arise from the pelvic plexus from the lateral surface of the rectum and converge where they then run posterolateral to prostate.

- Prior to converging at the base, the pelvic plexus nerves can be spread across 3 cm with the most anterior nerves intimately associated with the seminal vesicles
- Diverge again at the prostatic apex posterolaterally, where they then pierce the urogenital diaphragm as multiple distinct elements before reaching the corpus cavernosa

Per protocol

- *The neurovascular bundles (NVB) will be contoured as separate structures within 1cm of the PTV2 volume, as visualized on the planning MRI. Particular care will be taken to delineate these structures as they course into the genitourinary diaphragm caudally past the penile bulb until their termination in erectile tissue.*



hony Costello et al. Anatomical studies of the
ar bundle and cavernosal nerves. BJU International 2004.

NVB may demonstrate various patterns – we are looking for best effort to delineate the most clear/dominant group as a packet at posterolateral prostate

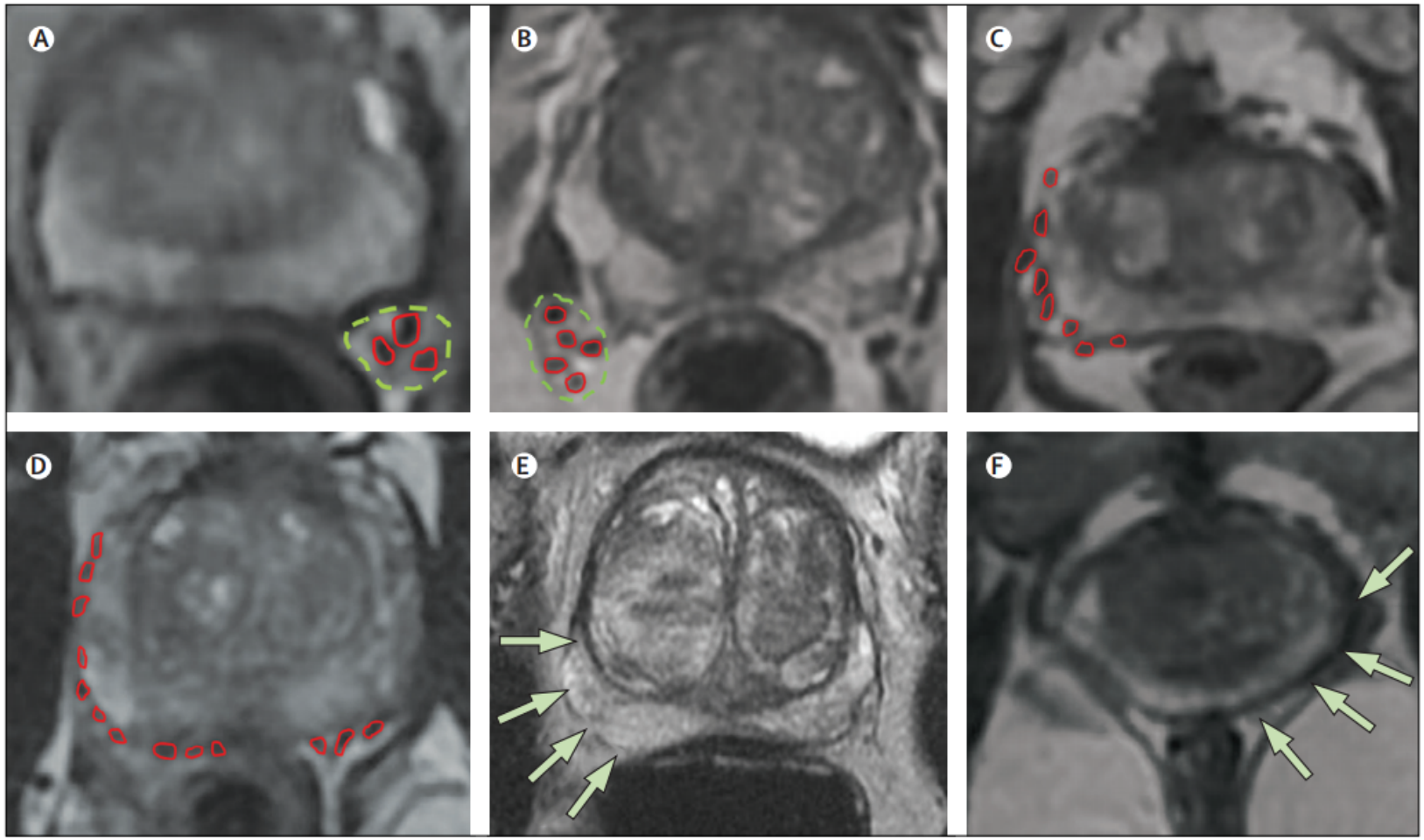
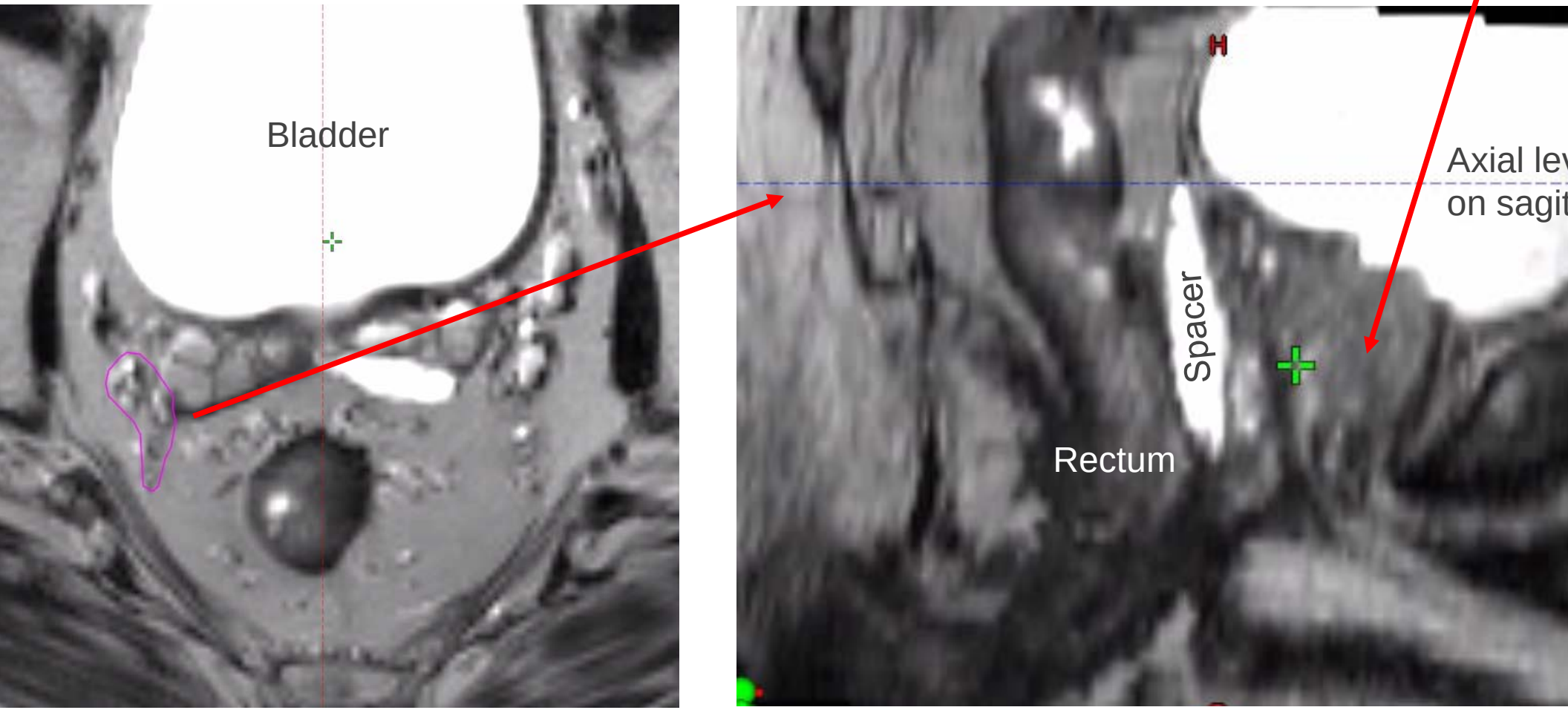


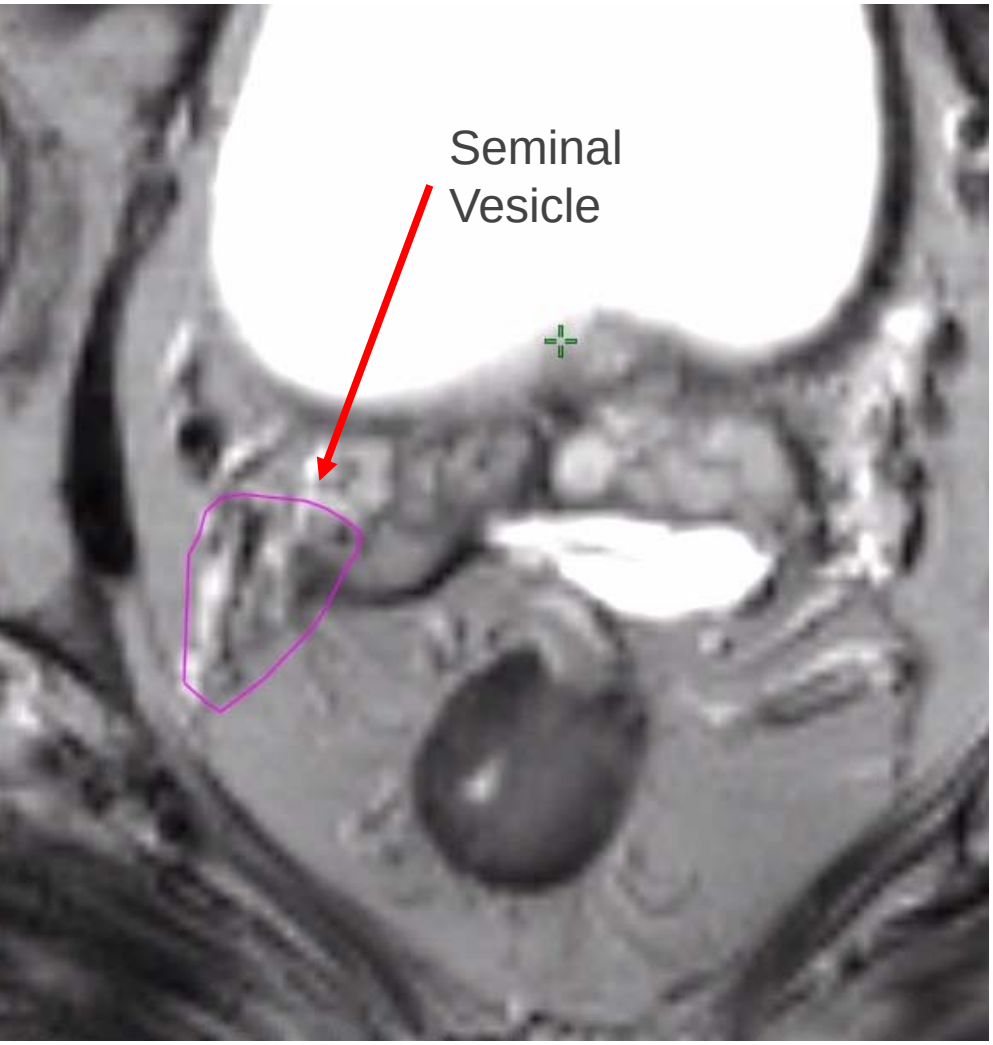
Figure 4: **Nerve bundle variation**
A and B show the classical neurovascular bundle near the posterolateral prostate. Green circles mark classic neurovascular bundles at the posterolateral prostate. Red circles mark individual neurovascular elements sometimes organised into bundles and sometimes distributed broadly around the prostate. C and D show the adherent nerve plexus pattern. E and F show the rare absent variant with no neurovascular elements.

Citation: Lee J et al., Lancet C

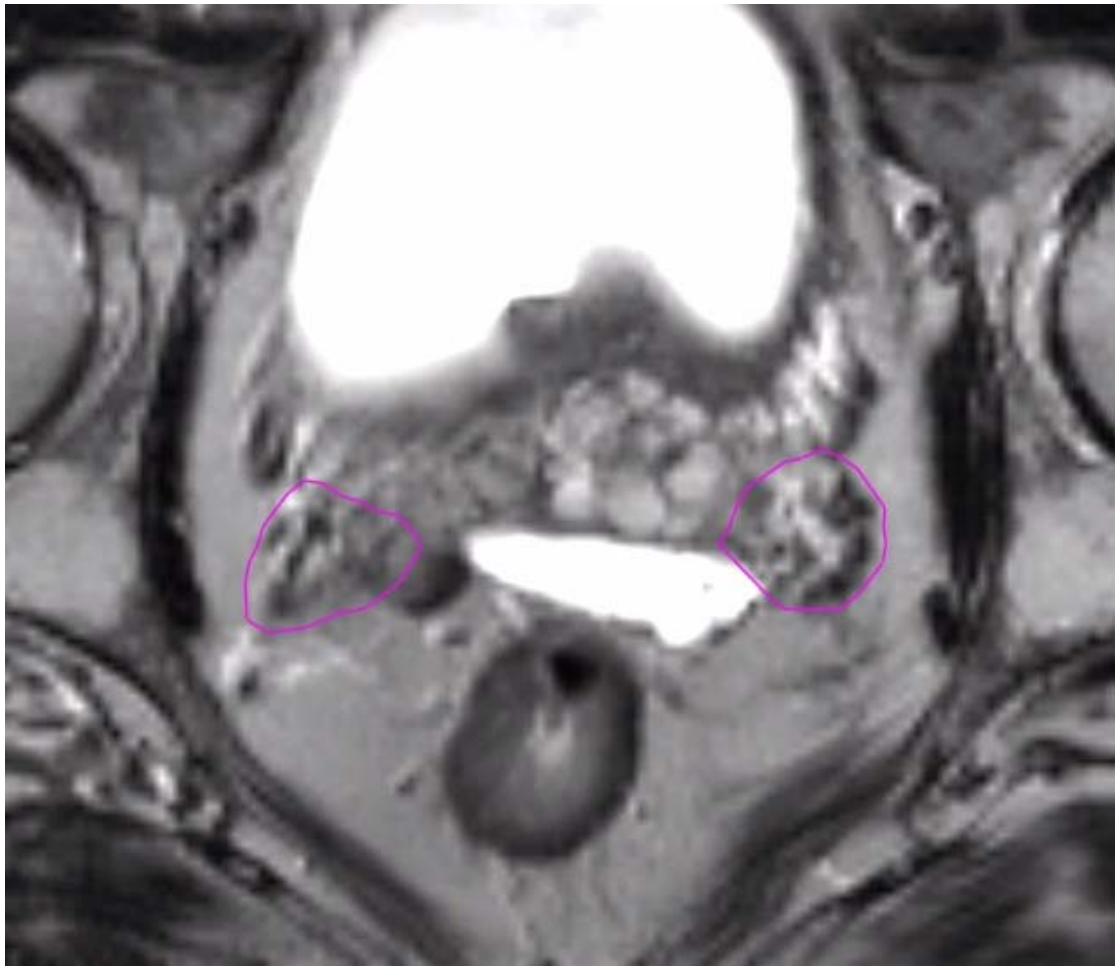
NVB (Magenta): Axial and Corresponding Sagittal

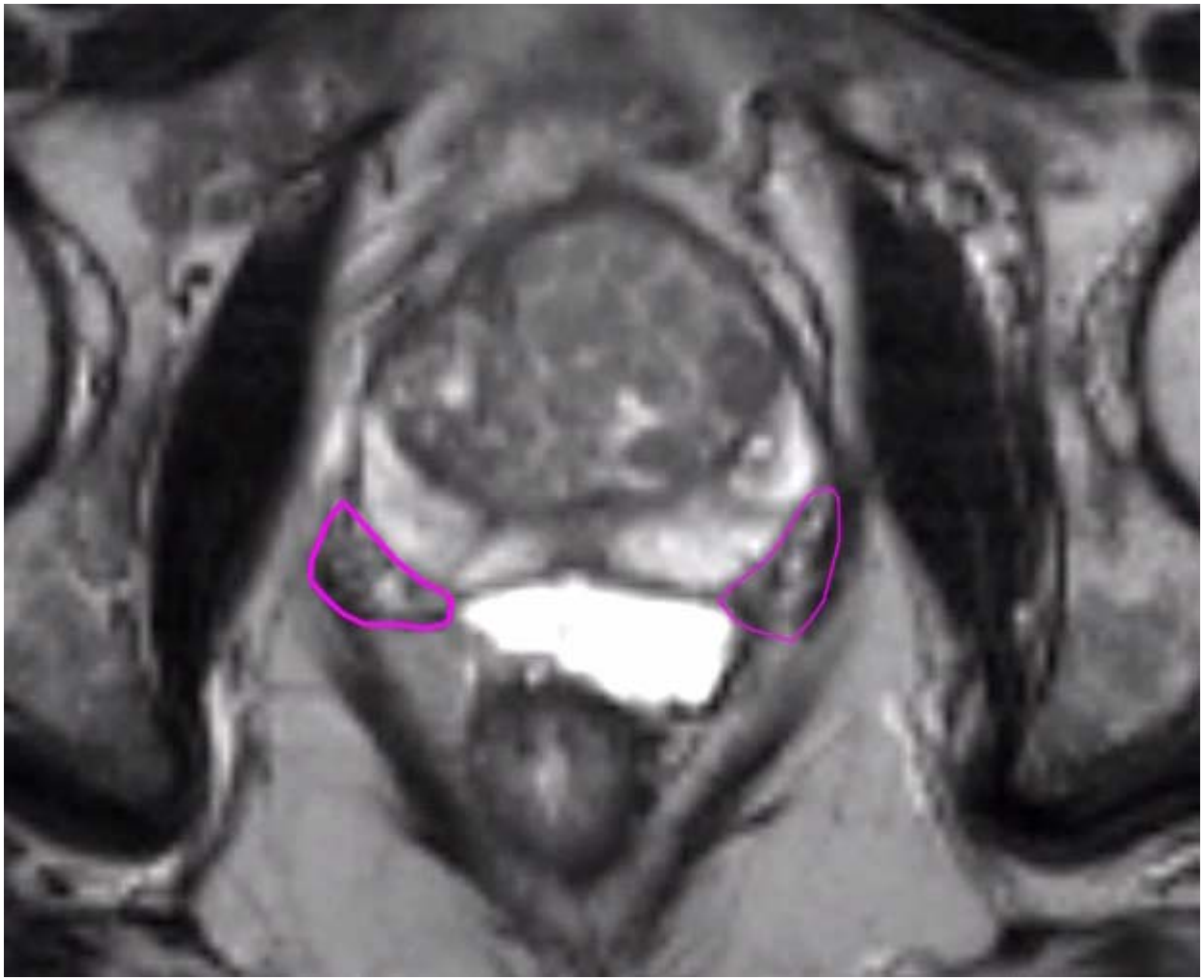


NVB Coursing Caudally Posterolateral to Seminal Vesicles

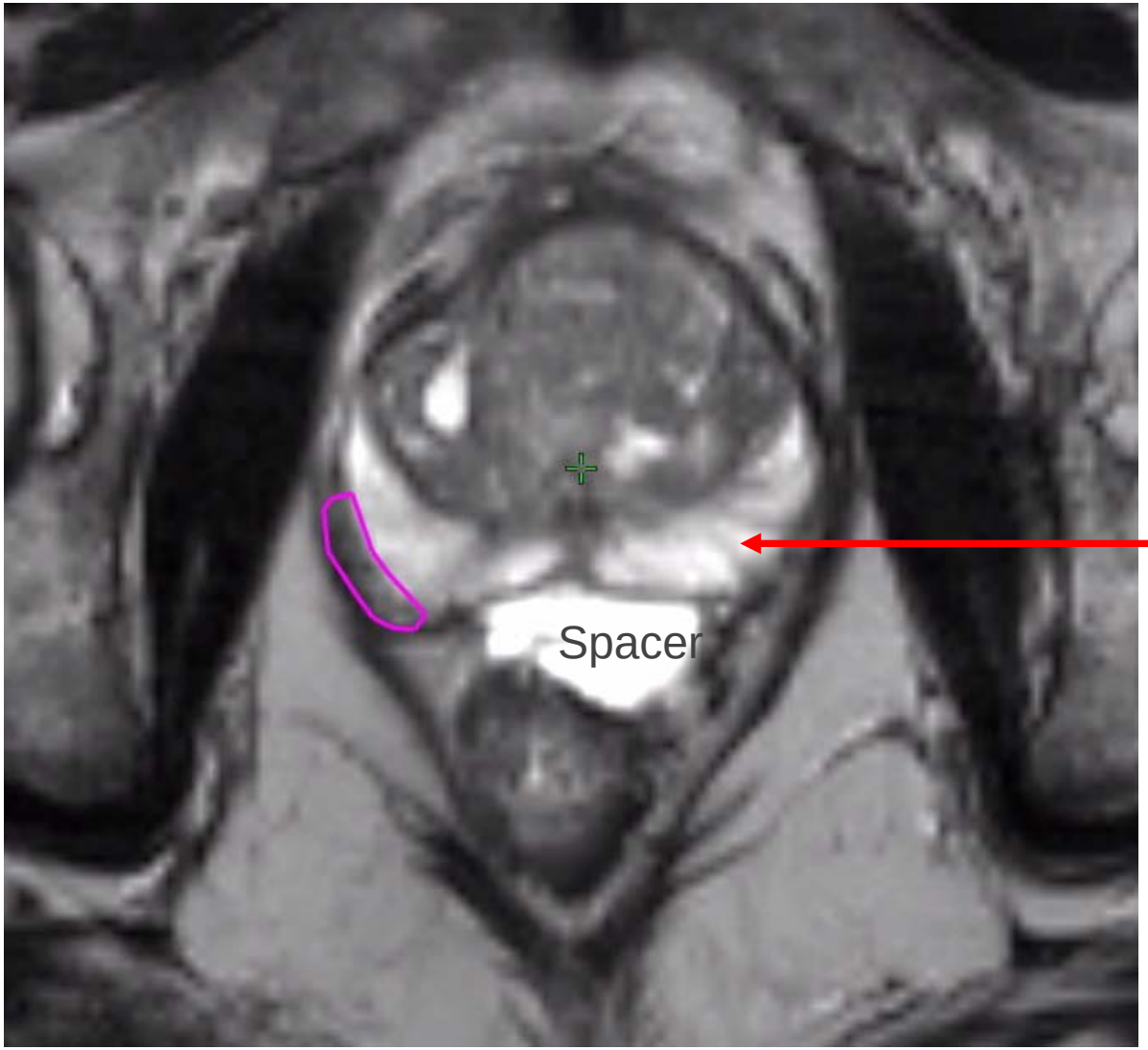


NVB Coursing Caudally (cont.)





NVB Coursing Caudally (cont.): More spread out now



NVB at Prostatic Apex

NVB Traversing Urogenital Diaphragm now Starting to Diverge Again

e smaller cavernosal nerves
he NVB may be difficult to
ualize, but it is nevertheless
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ctile tissue, in order to
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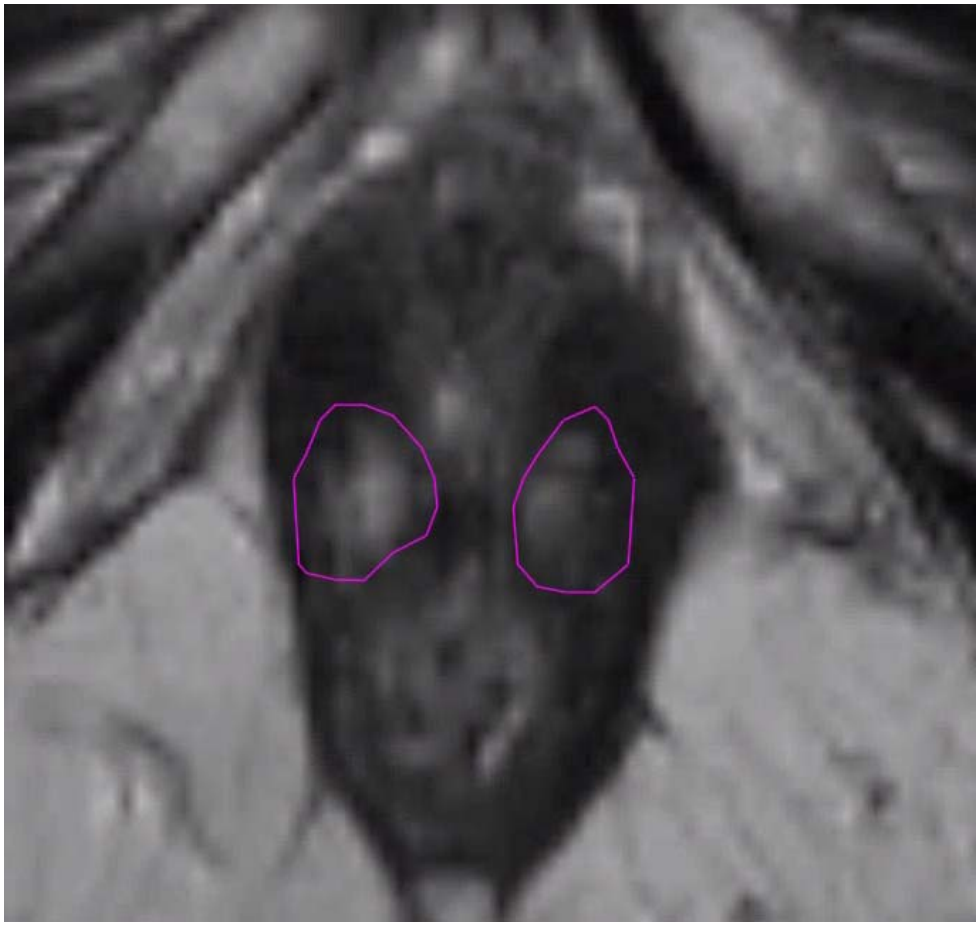
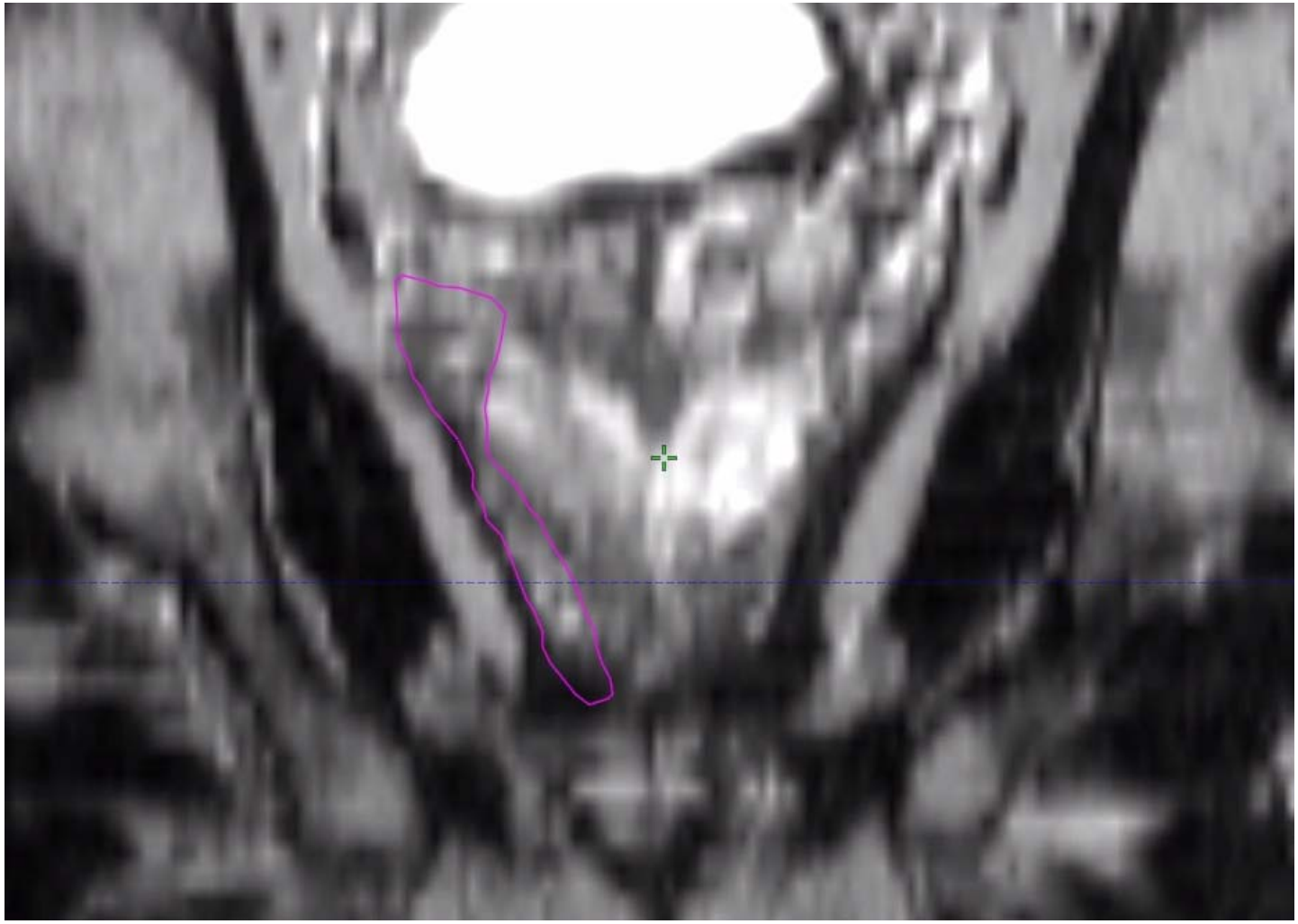
ves



Coronal with R NVB Posterolateral to Prostate Entering the Urogenital Diaphragm



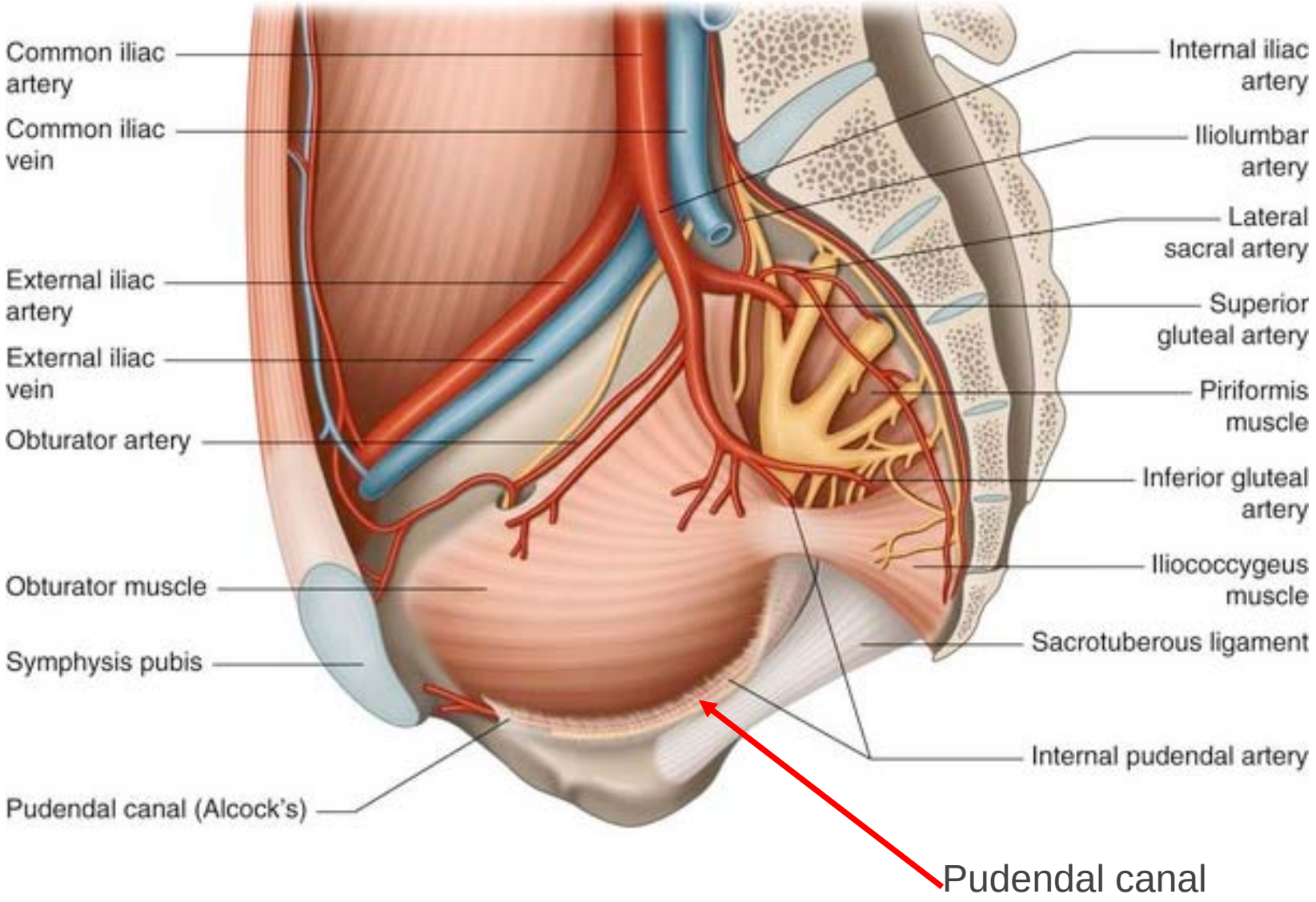
Internal Pudendal Arteries

Standard abbreviated name: *IPA_left* and *IPA_right*

Per protocol (paraphrased):

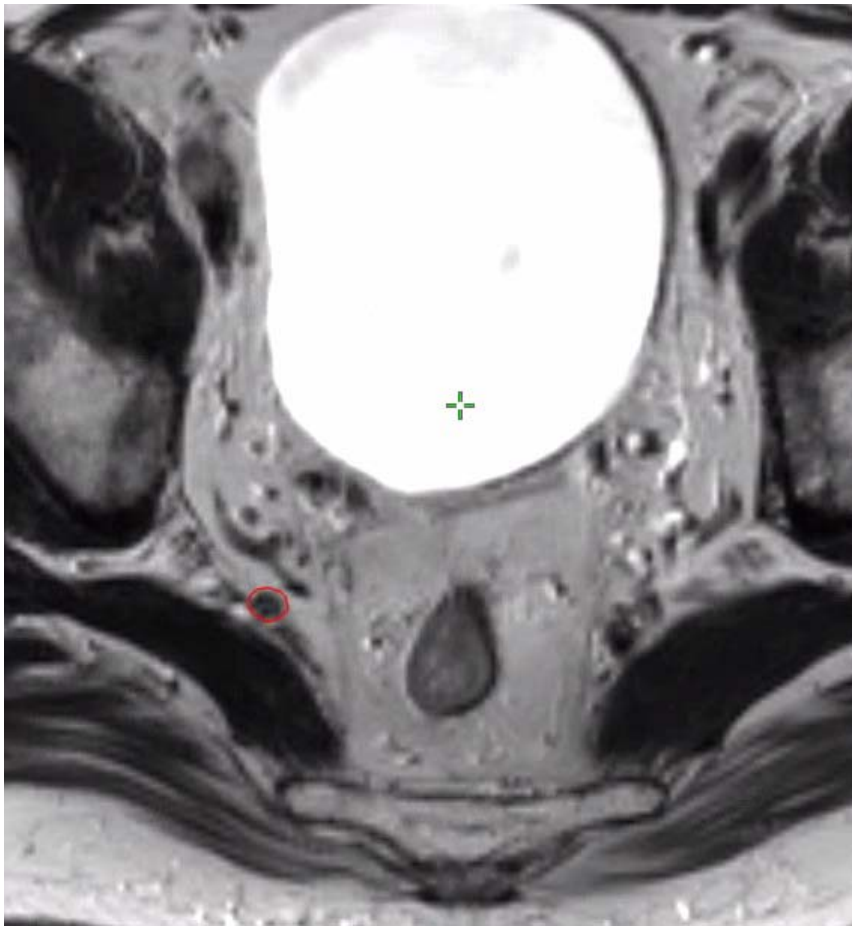
- *Contour using a 5mm brush each artery from the IPA's re-entry into pelvis (via lesser sciatic foramen) OR 1cm cranial to the PTV1_30Gy (whichever is more cranial). From this point on, the artery can be identified as it courses anteromedially within the pudendal canal (medial edge of obturator internus) 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, which may be identified by a capillary blush (bulbar arteries) on an IV contrast push during pelvic phase.*

CT IV contrast with pelvic phase timing (~10 seconds after push at least 3cc/sec), axial T
MRI imaging +/- time of flight echo sequence may be used to aid contouring

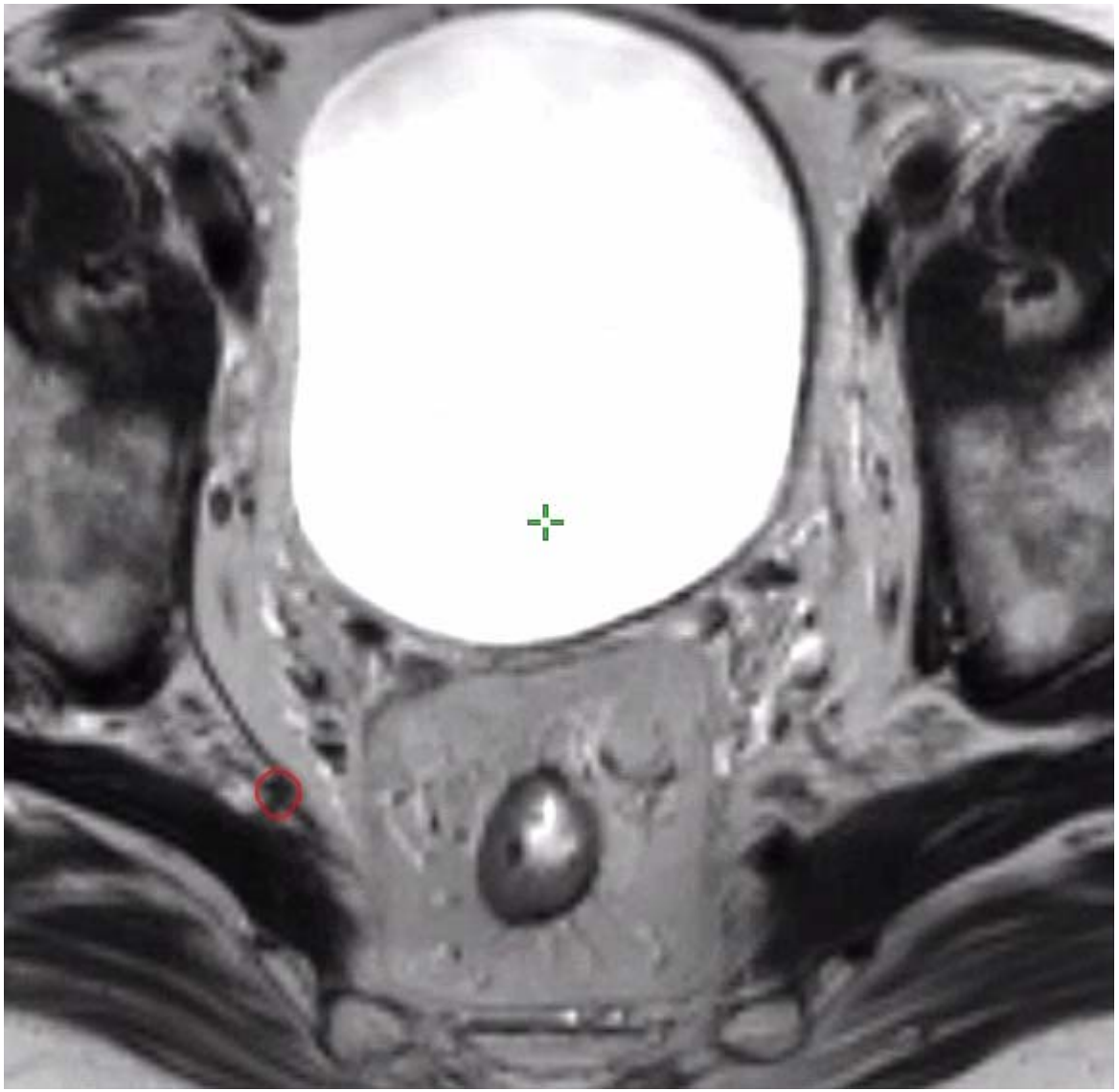

Common iliac artery
Common iliac vein
External iliac artery
External iliac vein
Obturator artery
Obturator muscle
Symphysis pubis
Pudendal canal (Alcock's)
Internal iliac artery
Iliolumbar artery
Lateral sacral artery
Superior gluteal artery
Piriformis muscle
Inferior gluteal artery
Iliococcygeus muscle
Sacrotuberous ligament
Internal pudendal artery
Pudendal canal

Right IPA Exiting Pelvis

IPA (red) originates as a branch of the internal iliac artery in the posterolateral pelvis, exiting the pelvis below the superior gluteal artery at the lower aspect of the greater sciatic foramen. In this case, the cranial starting point was chosen as 1cm along the artery cranial to the PTV.

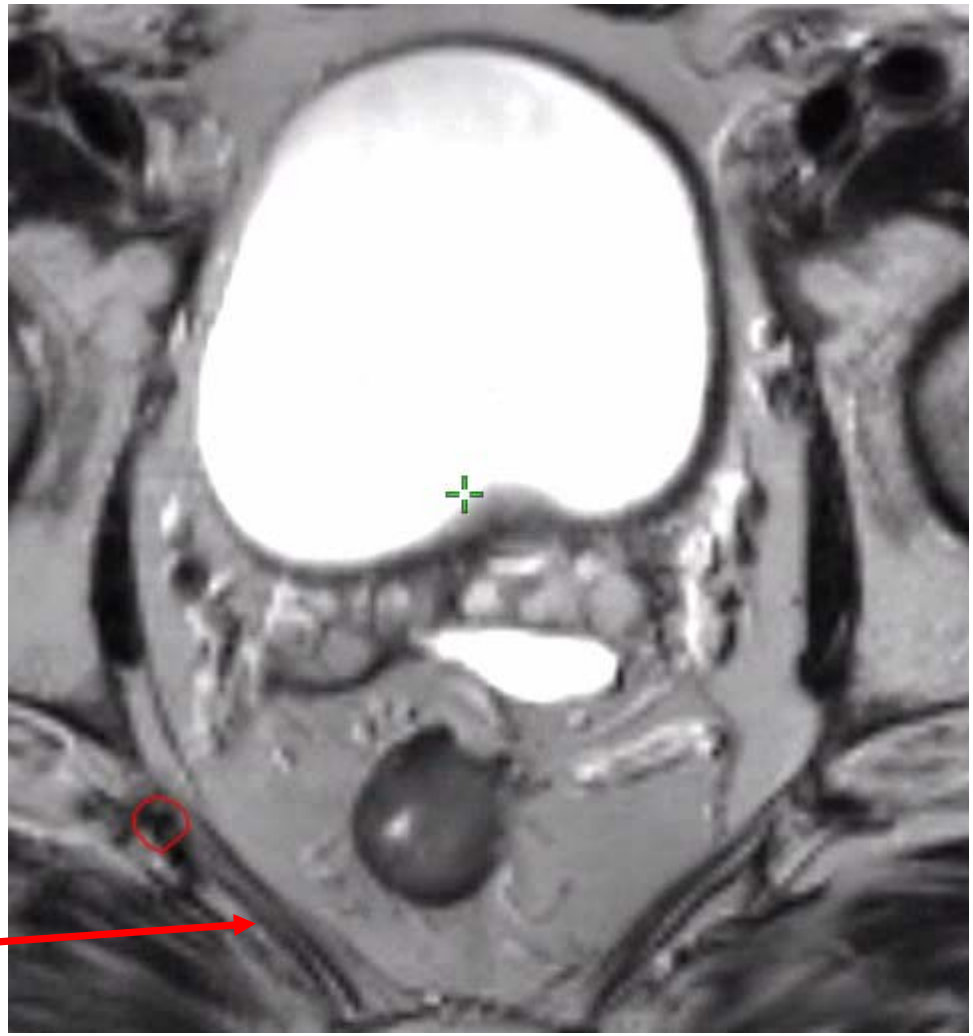


Dropping Caudally



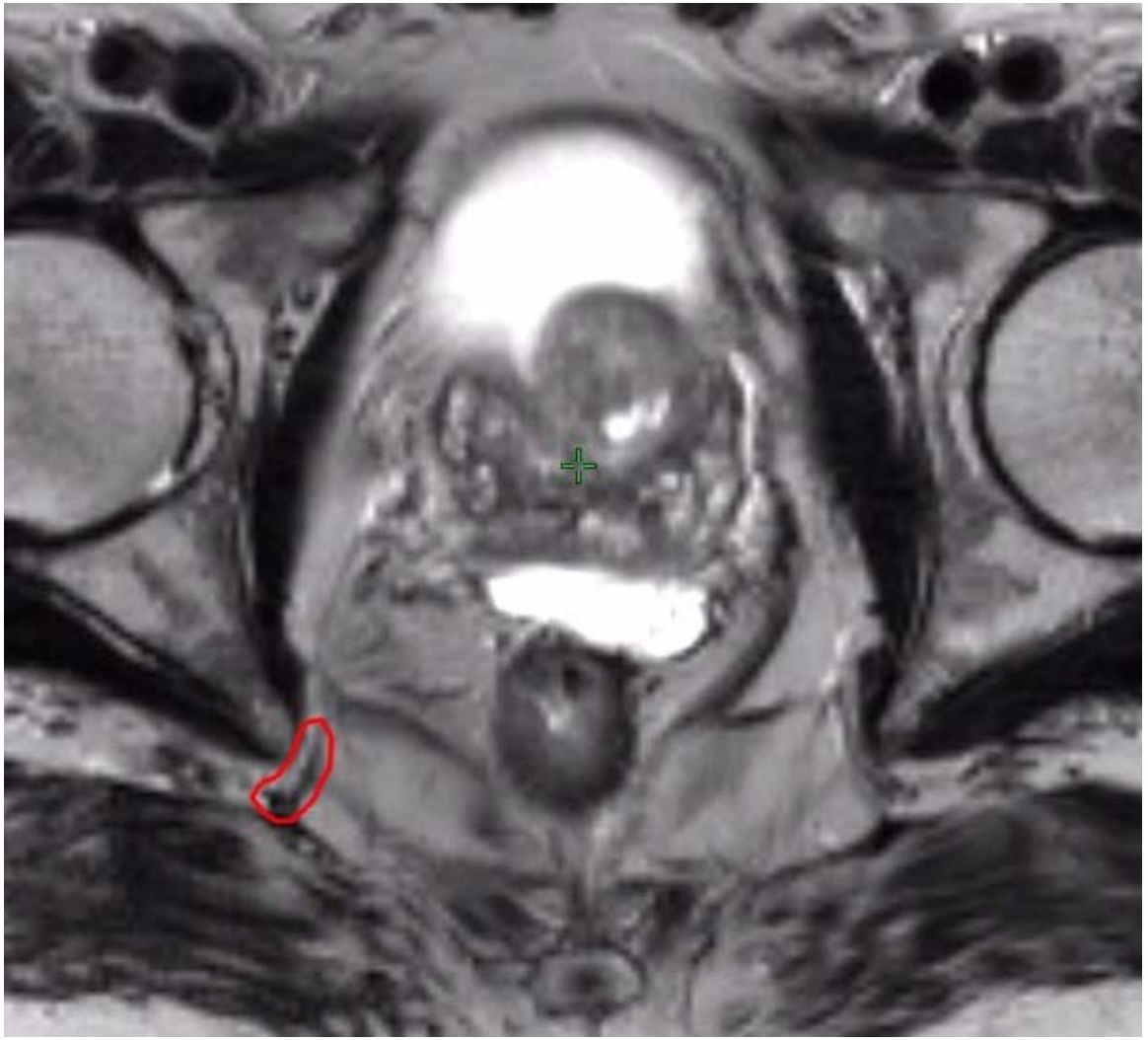
Exiting Greater Sciatic Foramen

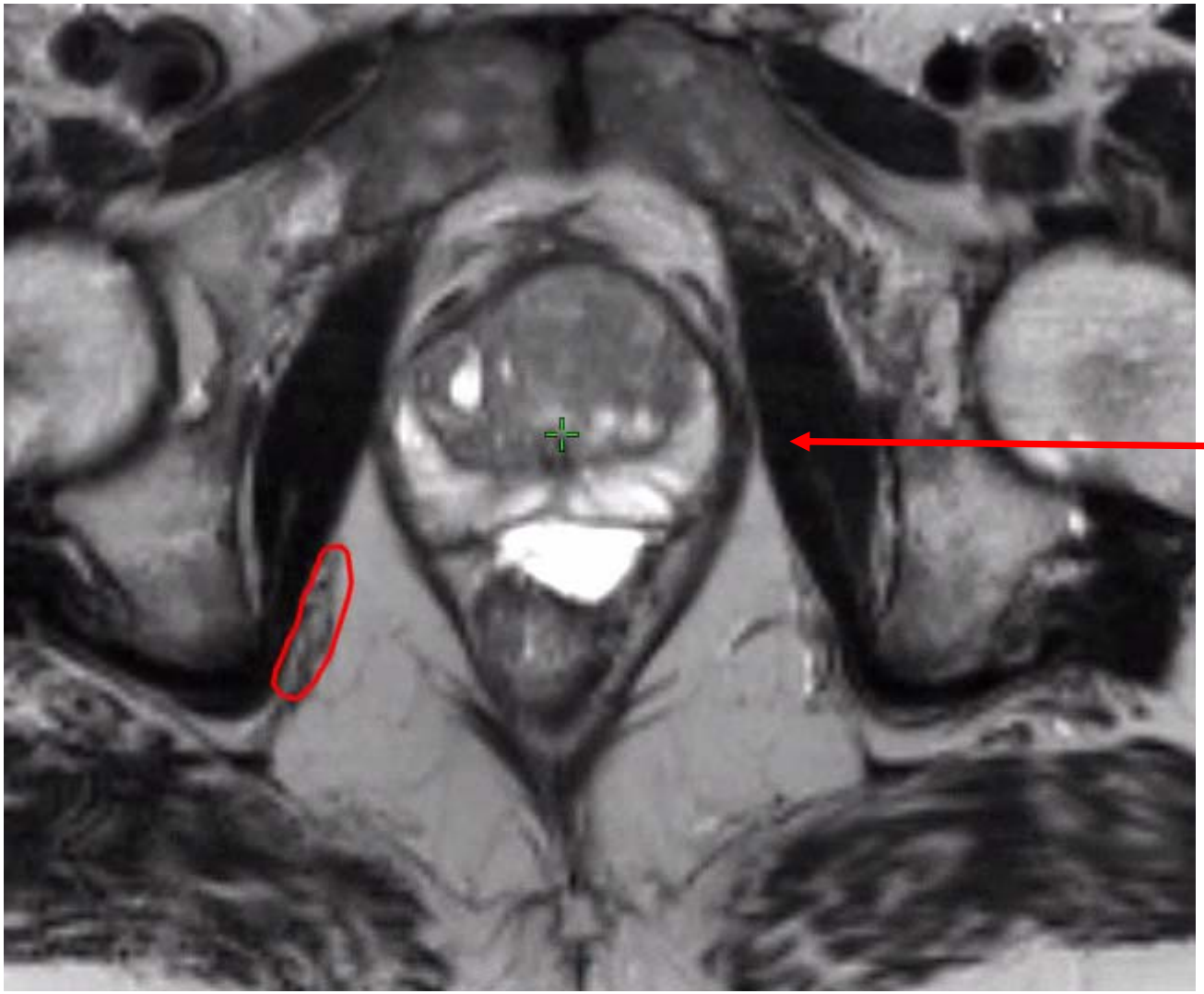
Wrapping around Sacroiliac Ligament



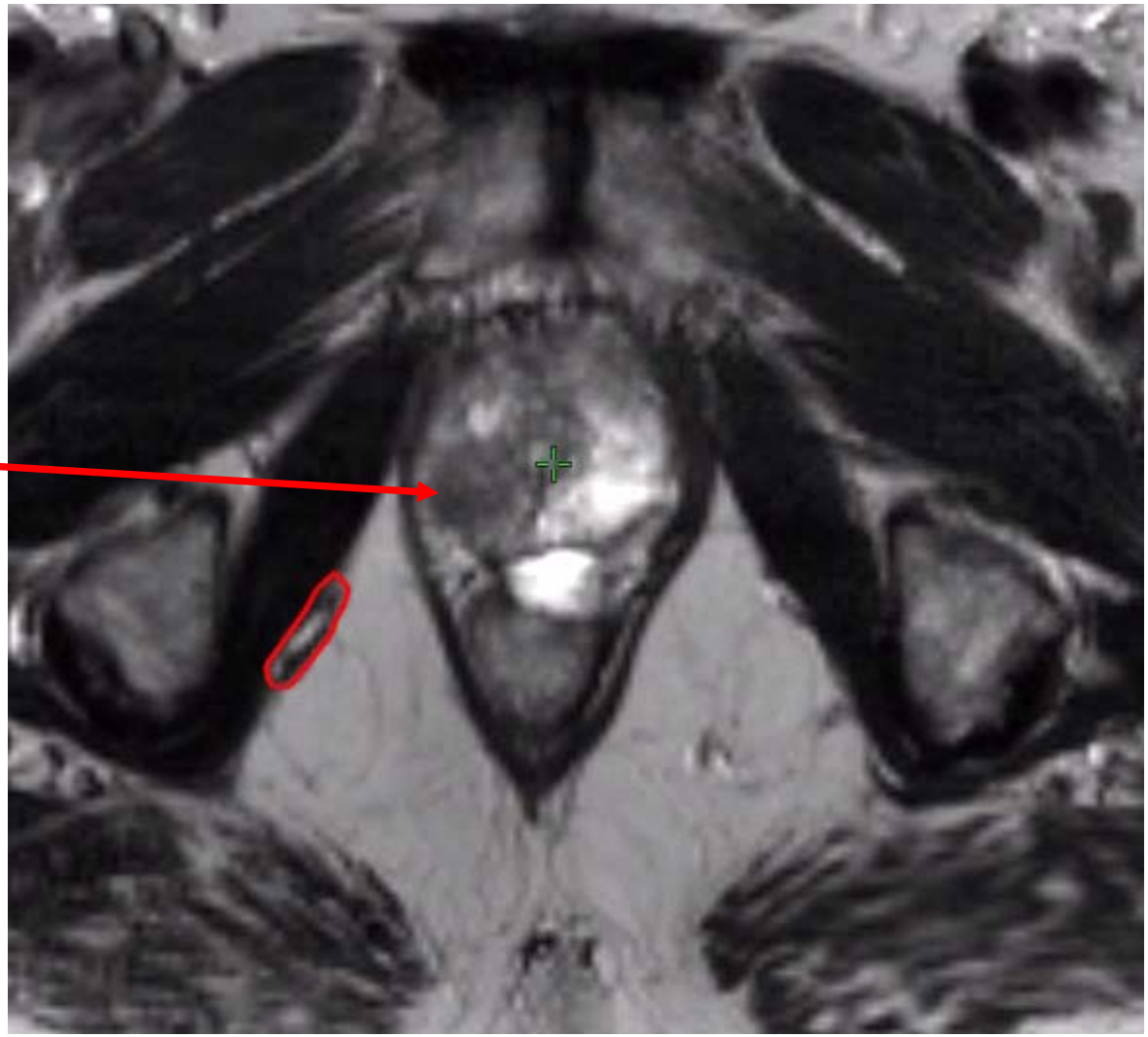
Sacroiliac Ligament

-entering pelvis through Lesser Sciatic Forame




Obturator
Internus
Muscle

IRI and biopsy
strated prostate
at the R apex and
state. The L side
need to be spared
circumstance.



IPA Terminating at Level of the Crus

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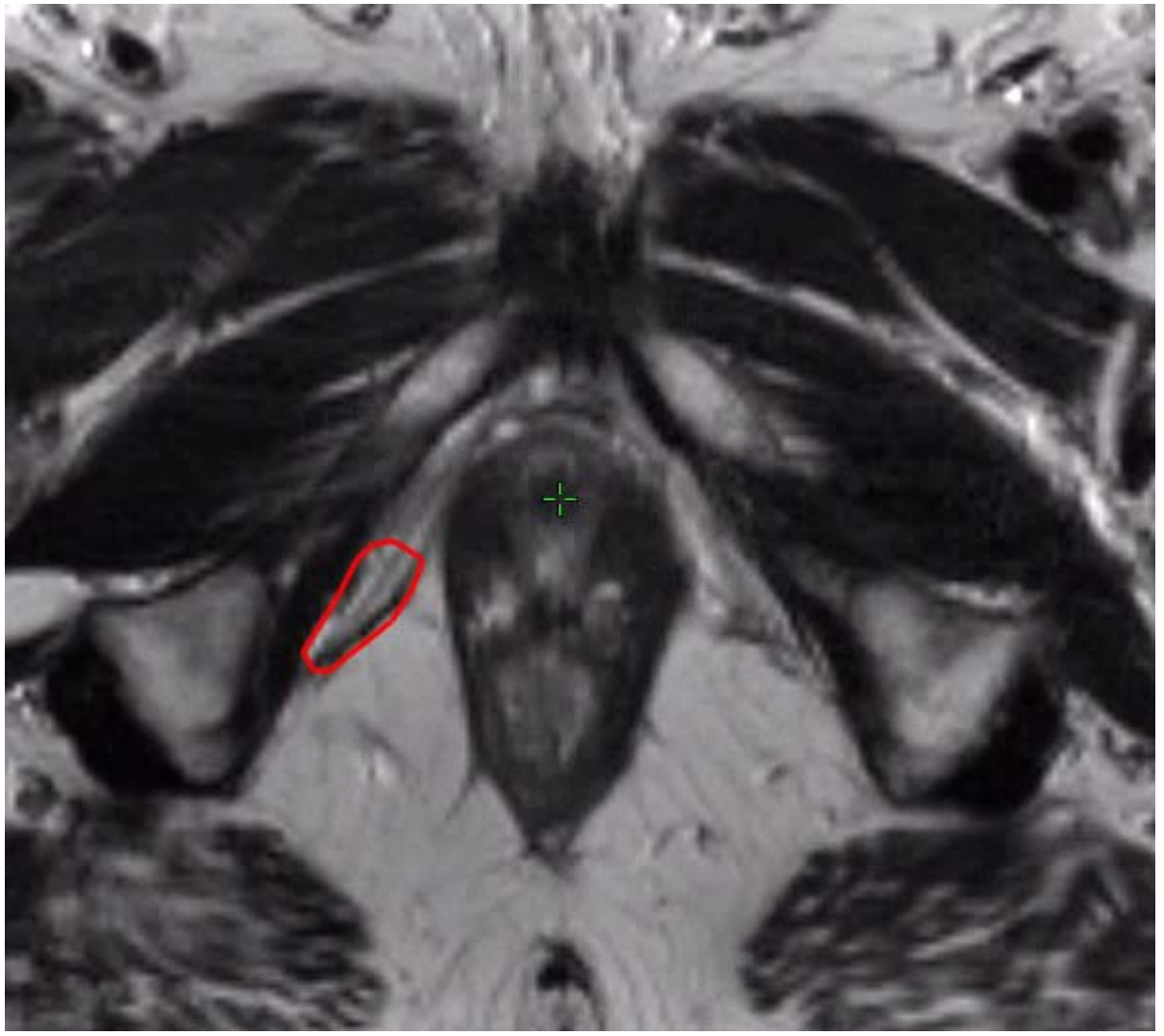
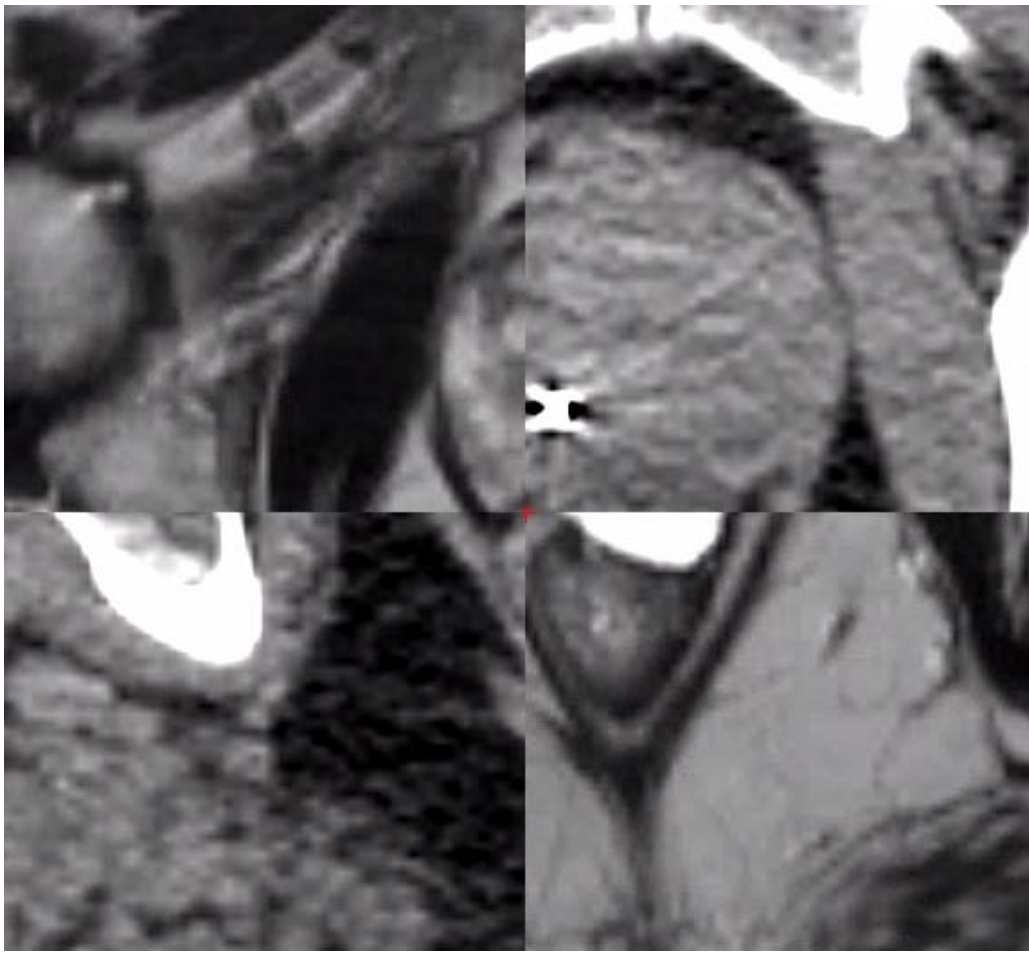


Account for Fusion Mismatch

Note for the CT-MRI registration shown that the patients left side matches better than his right side

Thus, important to use the MRI as a guide while taking care to identify correlate of the IPA on CT

Repeat fusion, contrast enhanced pudendal arteries, or adjustment to the CT contours based on local tissue changes are acceptable means to correct this error

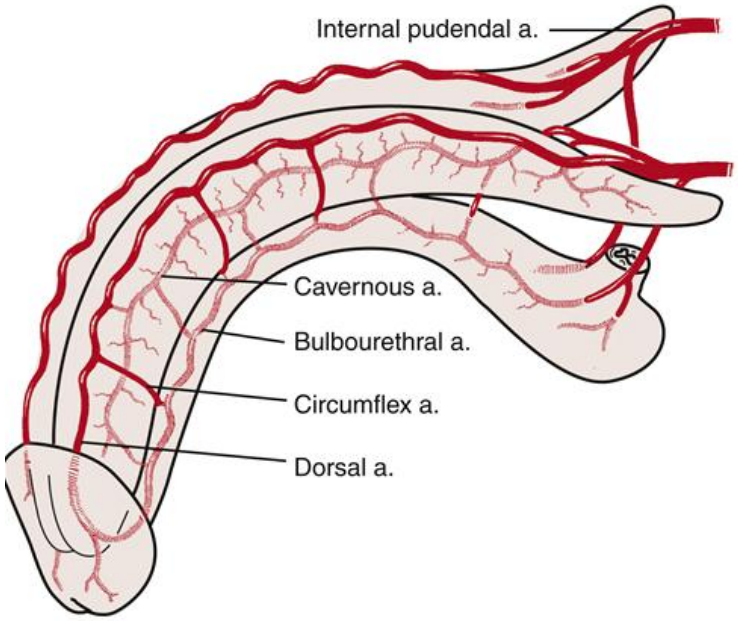


CT fused to planning T2 MRI
(two images not aligned on the right)

Termination of the IPA

Common penile artery is a terminal branch of the IPA along with the scrotal artery

The penile bulb/crus of the corporal cavernosa structure ideally will capture vasculature distal to this termination on this protocol



Shaping Structure for Neurovascular Elements

Standard abbreviated name: *Shaping5mm*

Create union of IPA (on side to be spared), NVB (on sided to be spared), and penile bulb + corpora cavernosum structure, using boolean or other similar tool

Take care to ensure that none of these spared elements overlap with your CTV, favoring accurate delineation of the prostate target

Expand by 5mm to make shaping structure PRV for creation of PTV2_SAbR on the experimental neurovascular sparing arm

GTV, CTV, and PTV Structures: Standard Arm

GTV = gross disease delineated on MRI (if identifiable PIRADS v2 score 3-5 lesions)

CTV = prostate +/- insertion of seminal vesicle on prostate (physician discretion)

PTV1_30Gy = NOT USED

PTV2_SAbR = CTV + 3mm expansion.

- Each institution may elect to treat to 40 Gy or 45 Gy at site activation

GTV, CTV, and PTV Structures

GTV = gross disease delineated on MRI (if identifiable PIRADS v2 score 3-5 lesions)

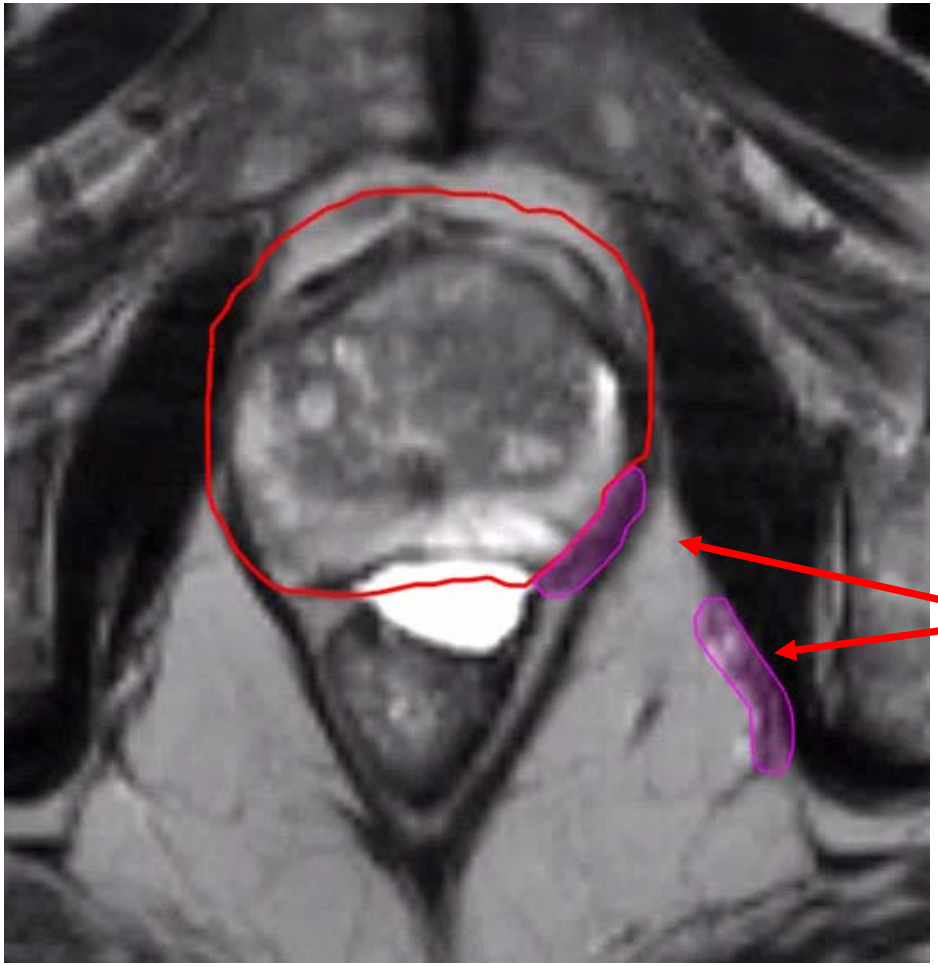
CTV = prostate +/- insertion of seminal vesicle on prostate (physician discretion)

PTV1_30Gy = CTV + 3mm, excluding the neurovascular structures to be spared (i.e. left NVB, left IPA, penile bulb + corpus cavernosum)

PTV2_SAbR = PTV1_30Gy, excluding the 5mm PRV around these neurovascular structures (*Shaping5mm* structure).

- Each institution may elect to treat to 40 Gy or 45 Gy at site activation

PTV1_30Gy

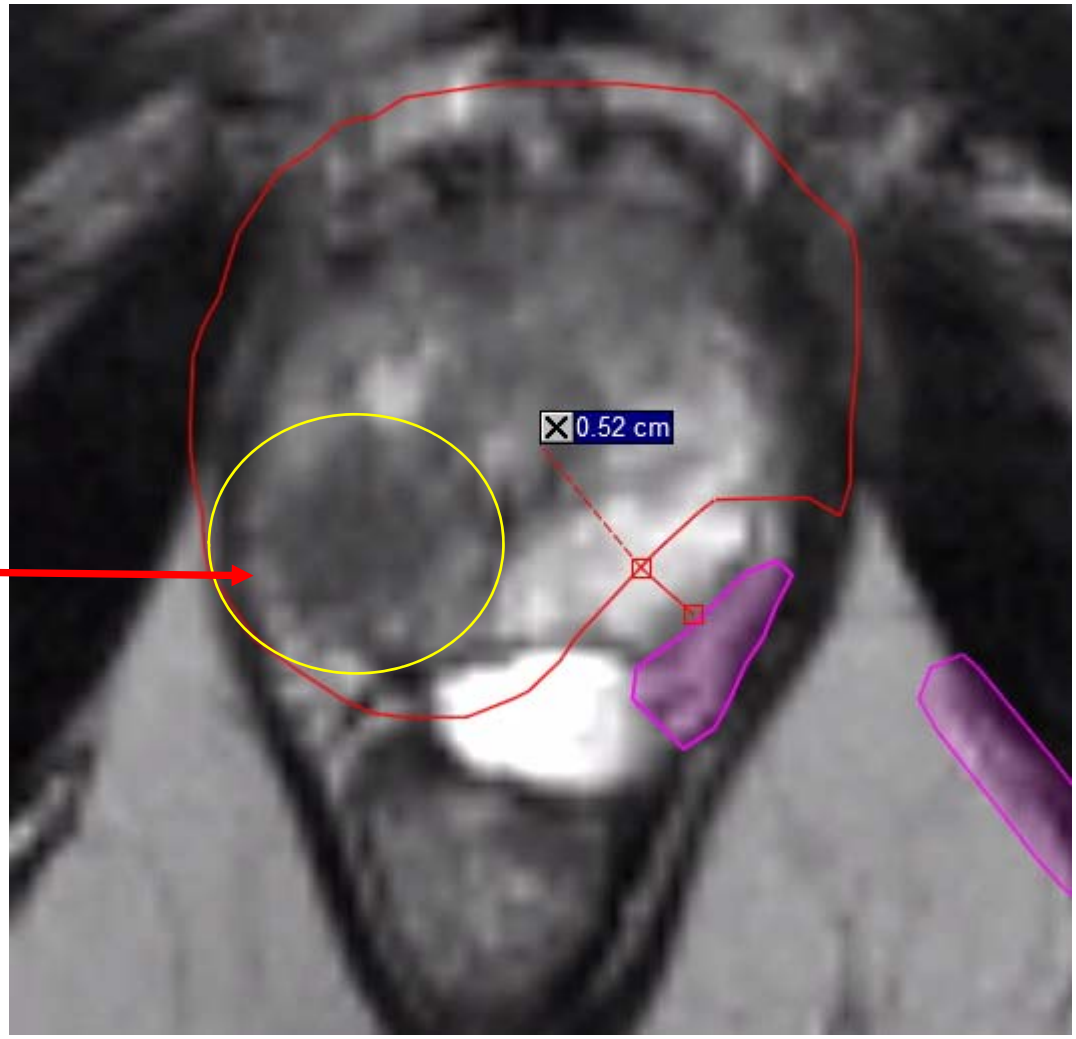


Purple contour is the comb
of left NVB, left IPA, and p
and corpus cavernosum in
case, given right sided loca
of disease.

On the experimental neuro
sparing arm, this combined
structure should be exclud
PTV1_30Gy, as demonstra
here, taking care to ensure
prostate itself is encompas

PTV2_SAbR (40-45 Gy in 5 fractions)

se on the R side.
t side neurovascular
nts spared from full
dose



PTV2_SAbR is then c
by *excluding* the
Shaping5mm PRV fro
PTV1_30Gy volume.

Thank you for your trial participation

Please feel free to contact the POTEN-C team with any questions via:

- https://www.poten-c.org
- Directly reaching out to Sarah Neufeld (Trial Coordinator) at 214-648-1836
- PI. Neil.Desai@UTSouthwestern.edu

Other resources:

- Example cases on PowerPoint and videos (coming soon) of contour/plan reviews will be posted to website