Prostate Contouring- Guidelines, Tips and Tricks

Dr Vineeta Goel
vineetagoel@yahoo.com

Headings

- 1. Simulation
- 2. Intact Prostate
- 3. Nodal Contouring
- 4. Post op Prostate
- 5. OARs

- Speak to your patient– Everyone is different and these are generally old people
- Understand his bowel bladder habits
- Chronic constipation– Give them laxatives 2-3 days prior to simulation and regularly on T/t
- Bloating of Abdomen- Use charcoal tablets
- Check water intake and advise on hydration
- Check Urine holding capacity and frequency and decide practical bladder protocol

Basics are basic!!

Graf *et al. Radiation Oncology* 2012, **7**:125
http://www.ro-journal.com/content/7/1/125

RADIATI
ONCOLO

RESEARCH Open Acc

Appropriate patient instructions can reduce prostate motion

Positioning and Immobilization

- If Gold fiducials or calypso is placed– then it should be placed at least 5 days before simulation

- Fiducials are useful especially if planar imaging

Positioning

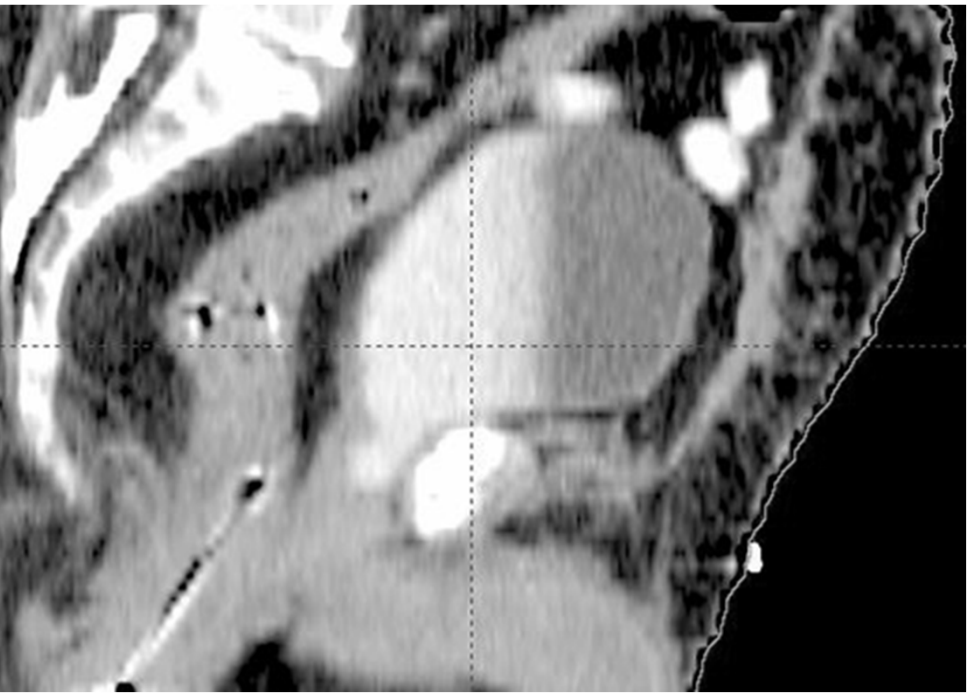
- Supine, Comfortable
- Knee Rest- to correct for Lumbar Lordosis
- Locks knees and prevents side to side movement
- Ankle fix
- Thermoplastic shell and Vacuum bags– Desirable, Not mandatory, No consensus, Institutional Policy

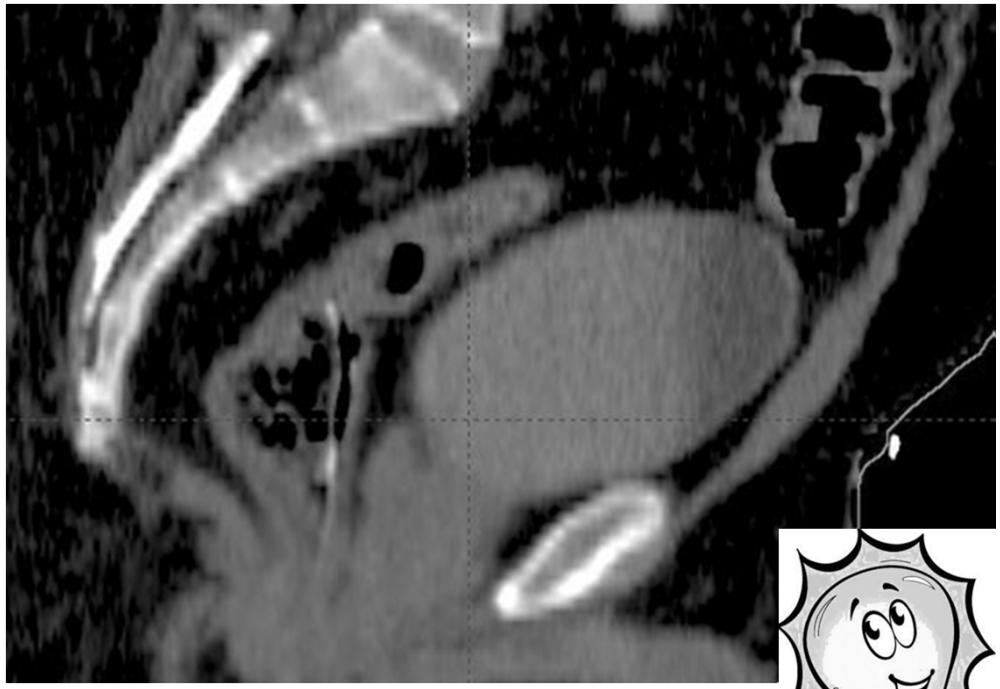
CT Sim

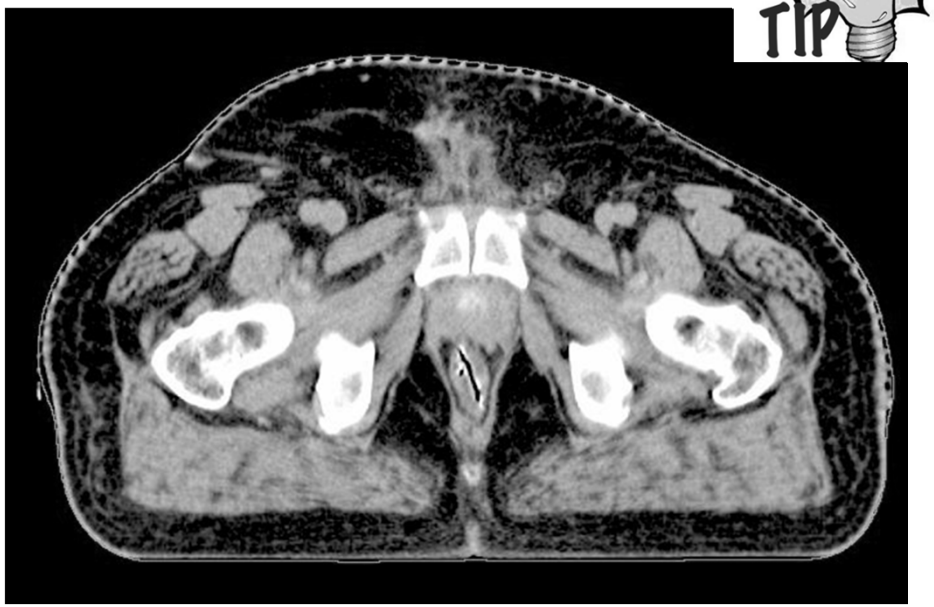
- 2-3mm slice thickness from L3 to mid thigh (not 5mm)
- Check scan to look for empty rectum, full bladder
- Oral Contrast
- IV Contrast after checking KFT
- *Infant feeding tube in Rectum*

- We also take delayed scan after 3-5 minutes of planning scan (don’t use it for planning)
- IV contrast comes in Bladder
- Bladder prostate interface is better identified especially in medial lobe enlargement
- Post op Prostate- identify anastomosis
- Consider doing MRI on flat couch to register with planning CT

Empty Rectum Full bladder







DELAYED SCAN

contrast comes in Bladder
adder prostate interface is better
entified especially in medial lobe
largement
ost op Prostate- identify
astomosis

Difficulties encountered in Contouring on planning CT

Large Interobserver and intraobserver variations

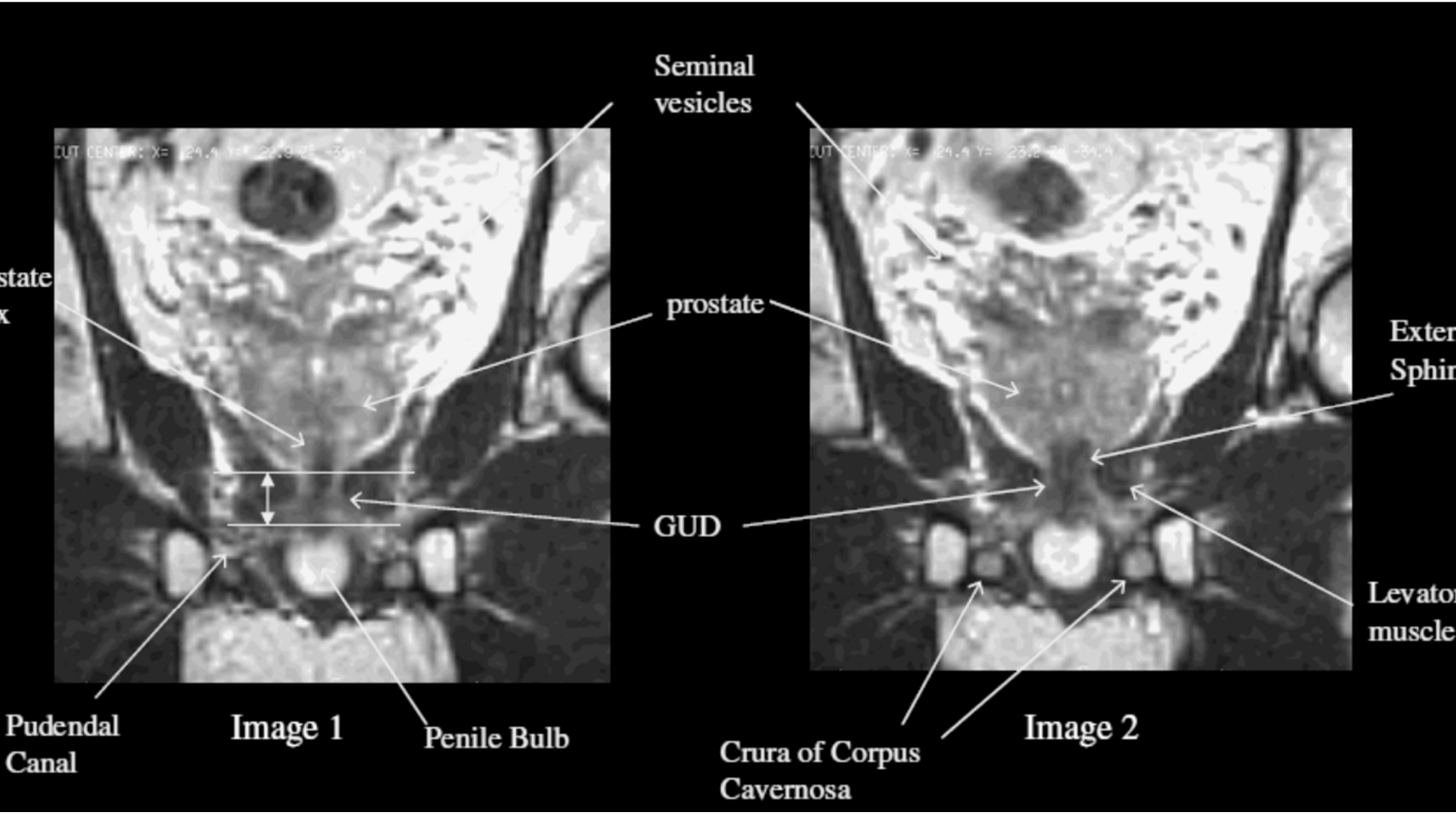
- Delineation of the apex-- implications in late toxicity impotence & erectile dysfunction
- Base of prostate from the fibromuscular bundle
- Capsule from the NV bundle
- Delineation of GTV on CT

MRI

CT Scan overestimates Prostate by 20-60% when compared with MRI

Biggest discrepancy is in apex of prostate– MRI best delineates apex, rogenital diaphragm and plexus Santorini

At base of prostate, SV identified better on MRI


Seminal vesicles
prostate
GUD
Pudendal Canal
Penile Bulb
Image 1
Crura of Corpus Cavernosa
Image 2

MRI helps correctly identify central SV Invasion

sk oup	Low	Intermediate	High
CCN			
stage	cT1c + cT2a and	cT2b – 2c and/or	cT3 or
SA	<10 ng/ml and	>10–20 ng/ml and/or	>20 ng/ml or
eason m	<7	=7	8–10
Amico et al. (1997a, 1998, 1999)			
stage	cT1c – 2a and	cT2b and/or	cT2c – cT3 or
SA	<10 ng/ml and	>10–20 ng/ml and/or	>20 ng/ml or
eason m	<7	=7	8–10

Additional Risk Factors

Percentage Positive Biops Cores

PNI +/-

CTV

	CTV
Low risk & Intermediate risk	Prostate + base of SV
SV involved	Prostate+ whole SV-tip
High risk	Prostate+ SV+LN

Radiotherapy and Oncology 79 (2006) 259–269
www.thegreenjournal.com

Guidelines

Guidelines for primary radiotherapy of patients with prostate cancer

Dirk Boehmer[a,*], Philippe Maingon[b], Philip Poortmans[c], Marie-Hélène Baron[d], Raymond Miralbell[e], Vincent Remouchamps[f], Christopher Scrase[g], Alberto Bossi[h], Michel Bolla[i], on behalf of the EORTC radiation oncology group

Tumour related factors for determining CTV

- SV invasion
- ECE
- PNI

- Determinants of Local Recurrence

SV invasion

- Kestin et all have shown form surgical specimens that Prostatic Ca never involves whole of SV
- Including 2-2.5 cm proximal SV –covers 90% of pathologically involved SV
- Possibility of SV invasion can be calculated by Roach Formula
- Lieberfarb et all in their series of 2009 prostatectomy specimens showed lower incidence of SV invasion and ECE in low risk pts with <50% PPB and intermediate risk pts with <17% PPB

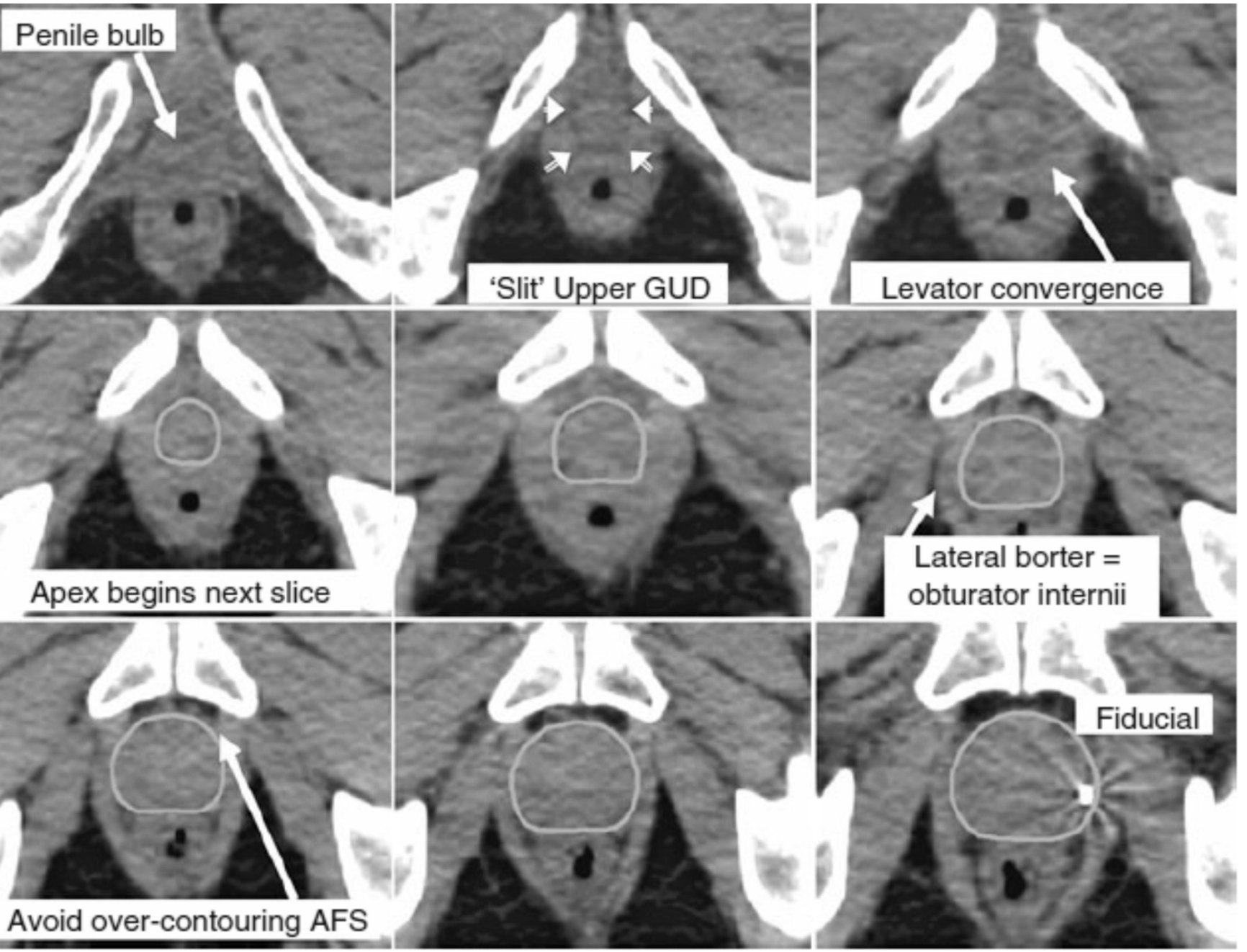
ECE

- Largest study comes from Teh et all who studied radial distance of ECE in 712 prostatectomy specimens
- Focal ECE-38%
- ECE<2mm-19%
- ECE 2-5mm-36%
- ECE >5 mm-7%

- There is significant relationship b/w ECE with GS, Pre T/t PSA, SV and LN positivity

CTV -Intact Prostate

- Generally no GTV
- CTV= Visible boundaries of Prostate on Planning CT
- Begin contouring mid gland where prostate borders are most easily identifiable
- Caudally- identify apex well– take help of MRI coronal view
- Apex lacks capsule
- Lateral= Levator ani
- Anterior- Anterior Fibromuscular stroma
- Posteriorly, rectum is opposed at mid gland

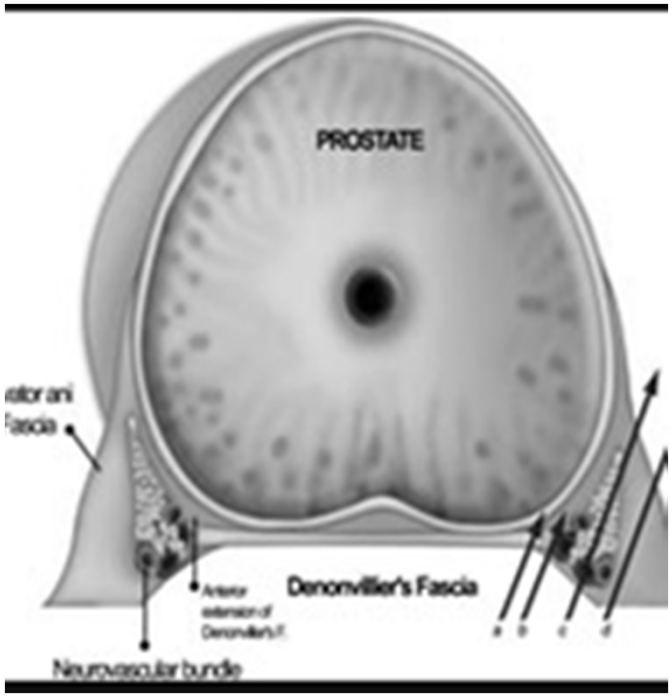


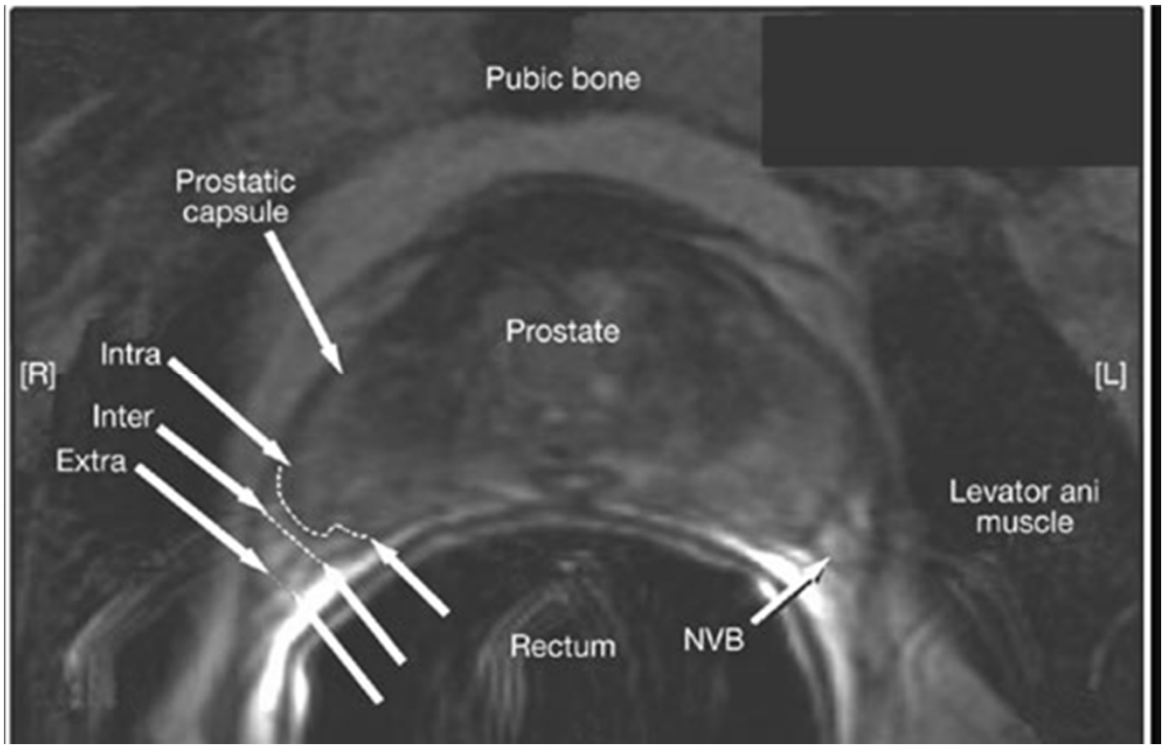
Nancy Lee Text
Book of Contouring

Nancy Lee Text
Book of Contouring

Neuro Vascular Bundle

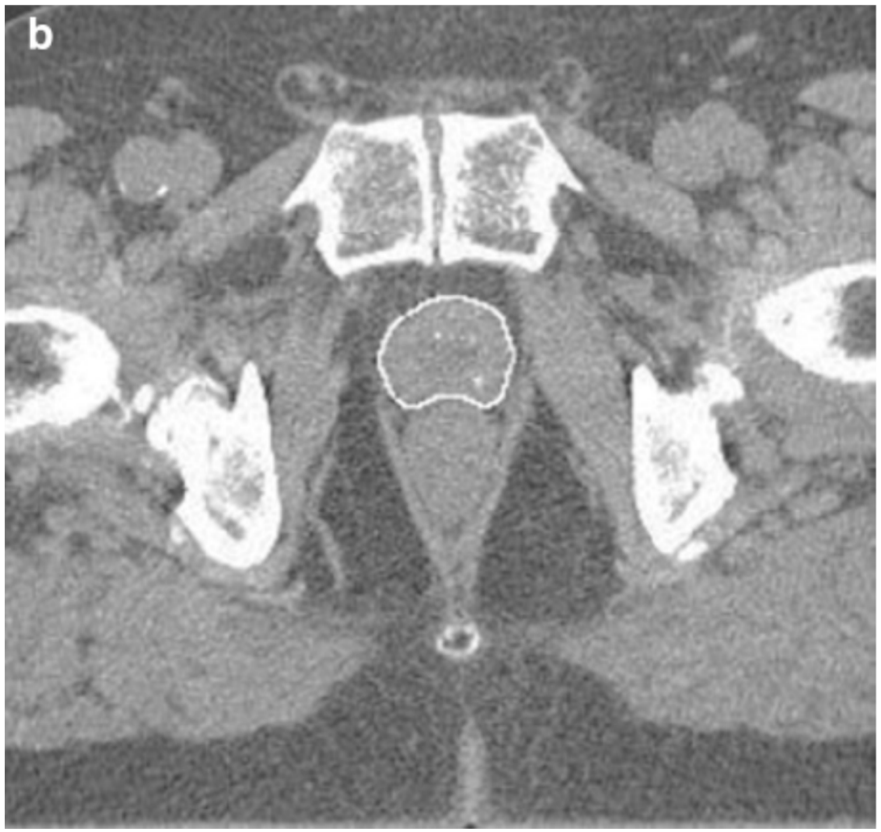
- Careful about Neurovascular bundle placed in posterior oblique direction





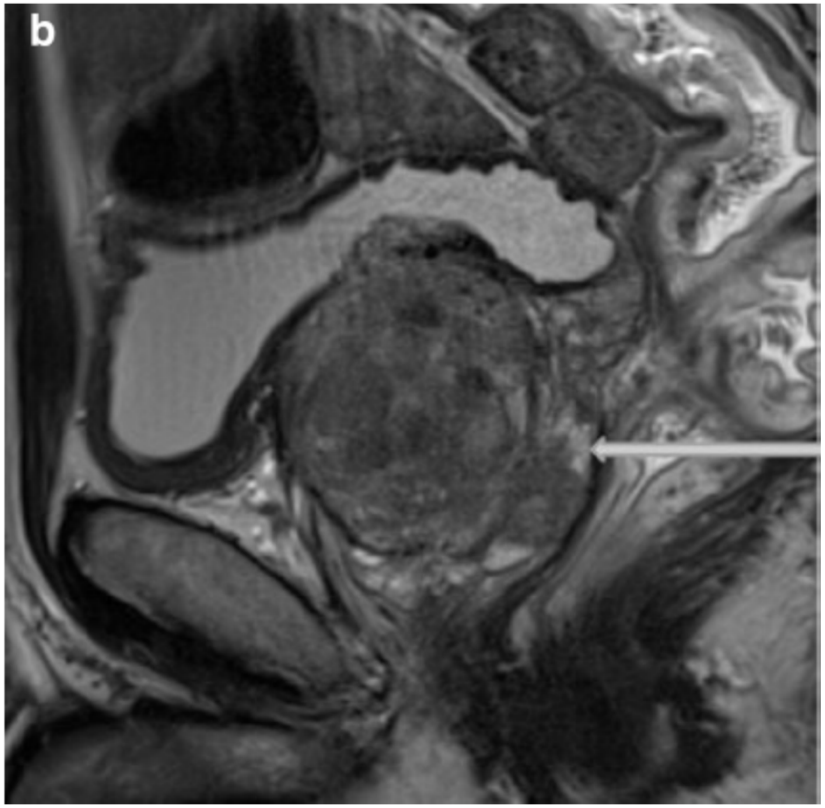
Pathological considerations for defining CTV

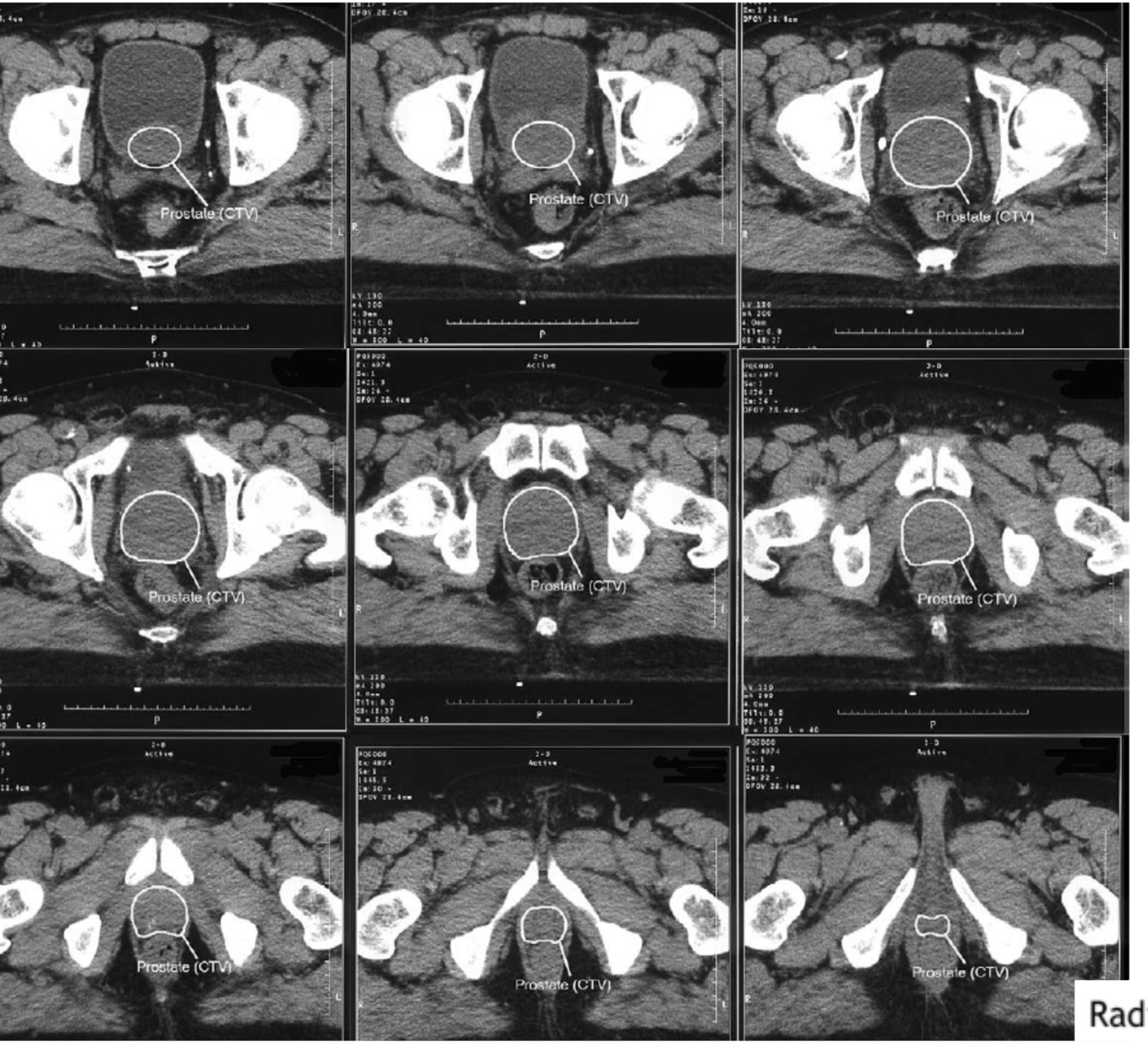
- 1997- D Amico found that in 749 prostatectomy specimens-risk of SV invasion and ECE is <2% in LR patients
- LR Ca Prostate CTV= Prostate Only



IR and HR

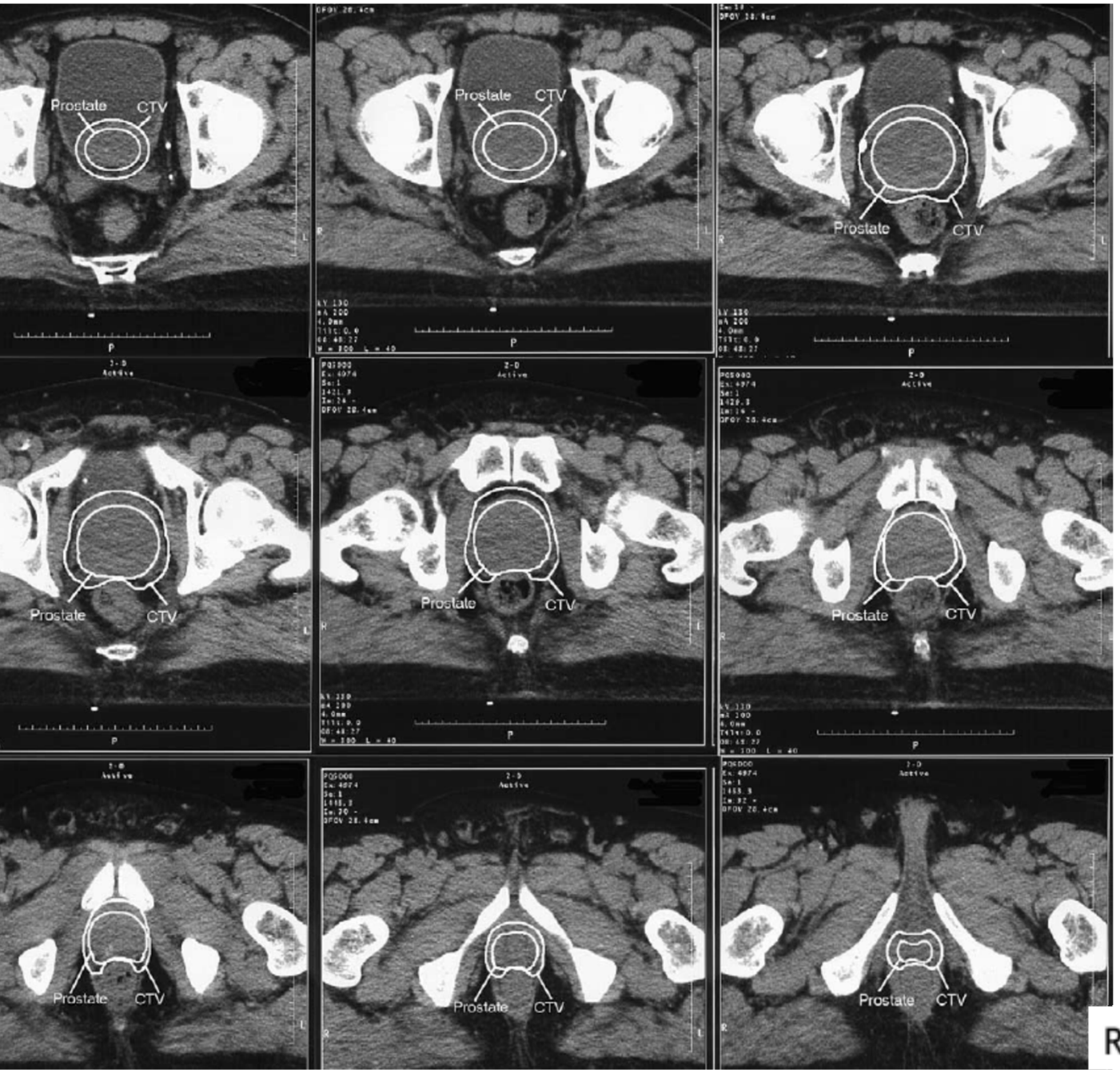
- 90% pathological specimens have ECE up to 4-5 mm from prostate gland; <2% have it beyond 5mm





LR

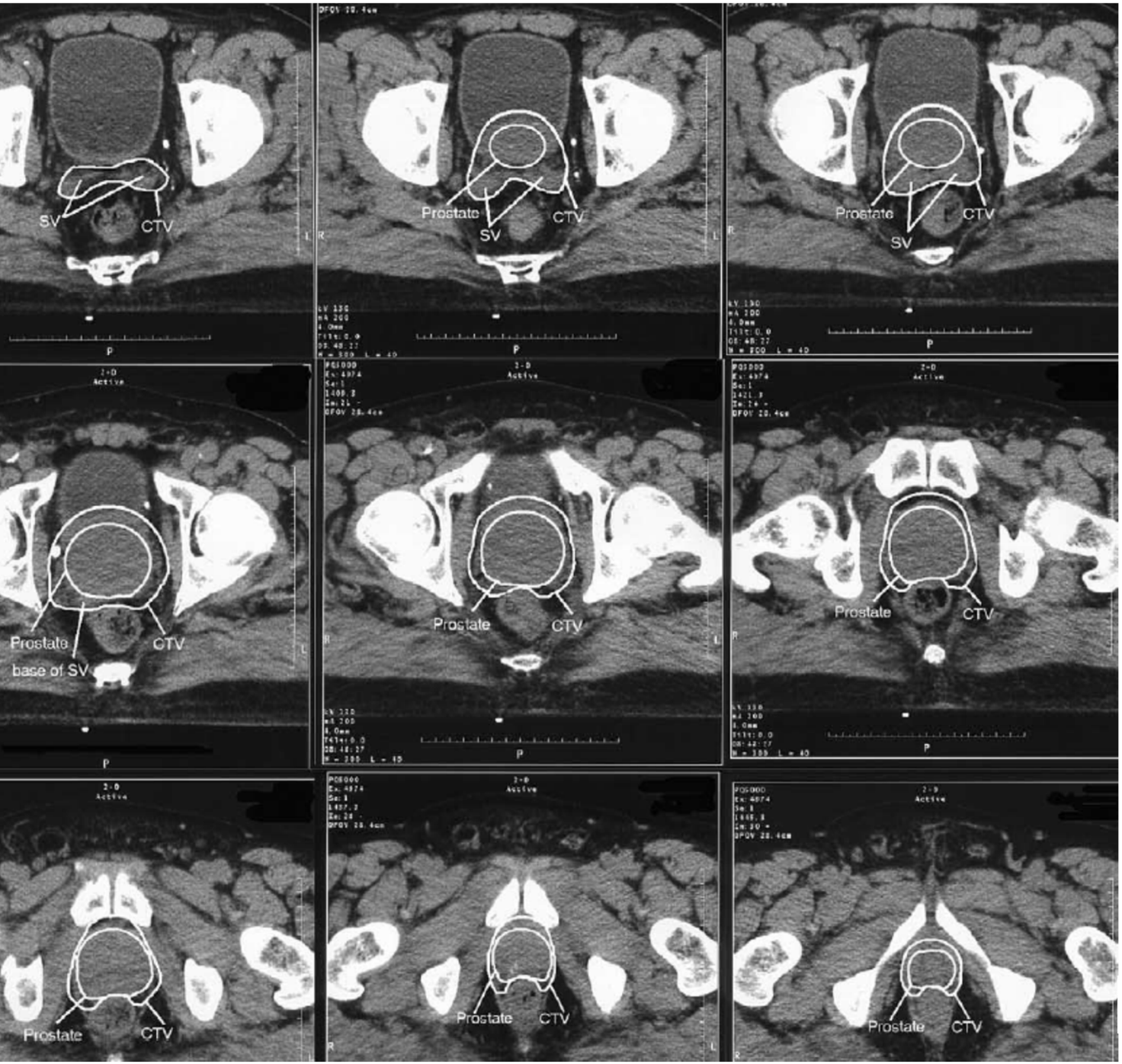
Radiotherapy and Oncology 79 (2006) 259



IR

One may consider adding 5 mm CTV but not on posterior side towards rectume

Radiotherapy and Oncology 79 (2006) 259-2



HR

Radiotherapy and Oncology 79 (2006) 259

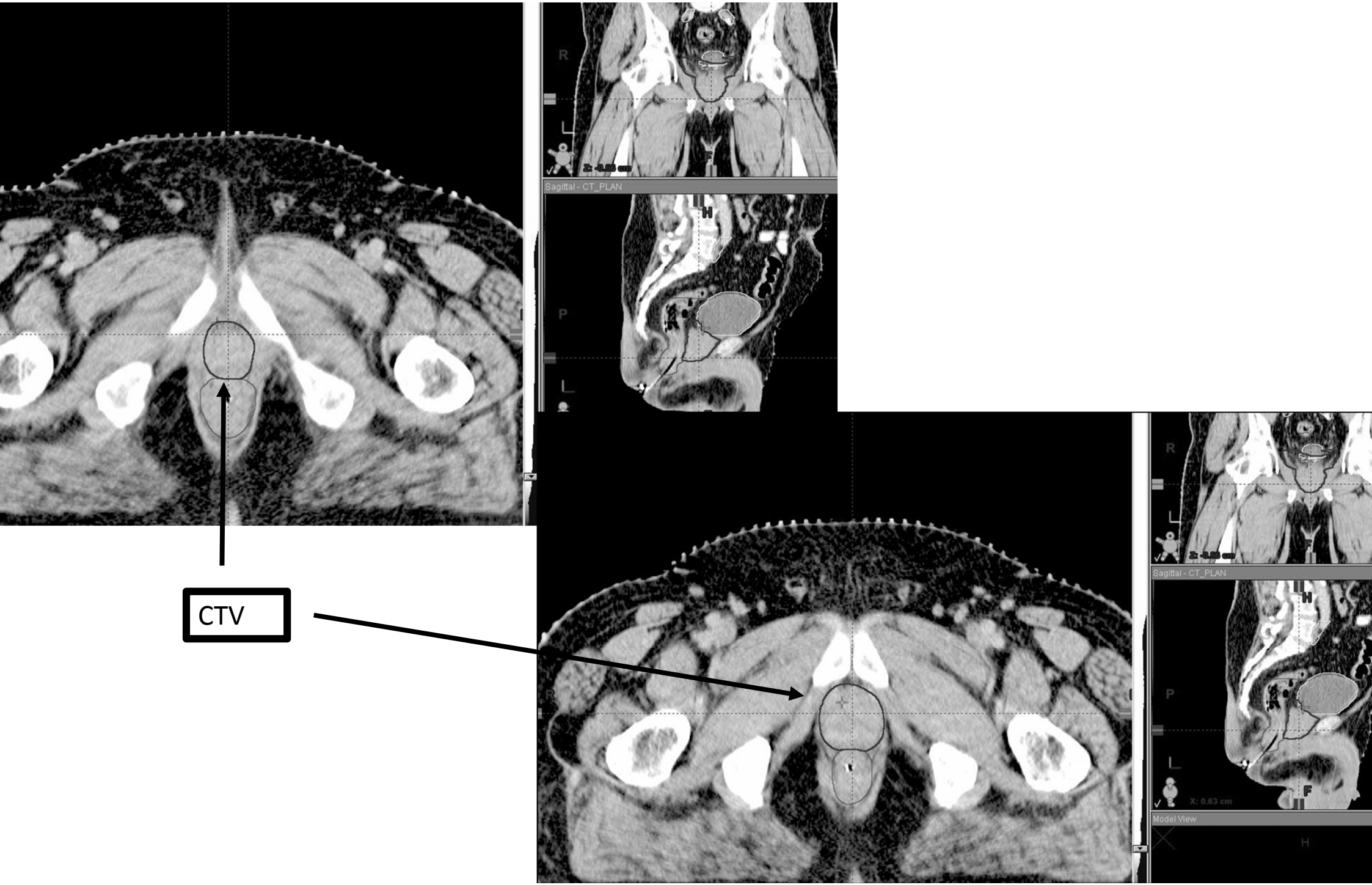
PTV

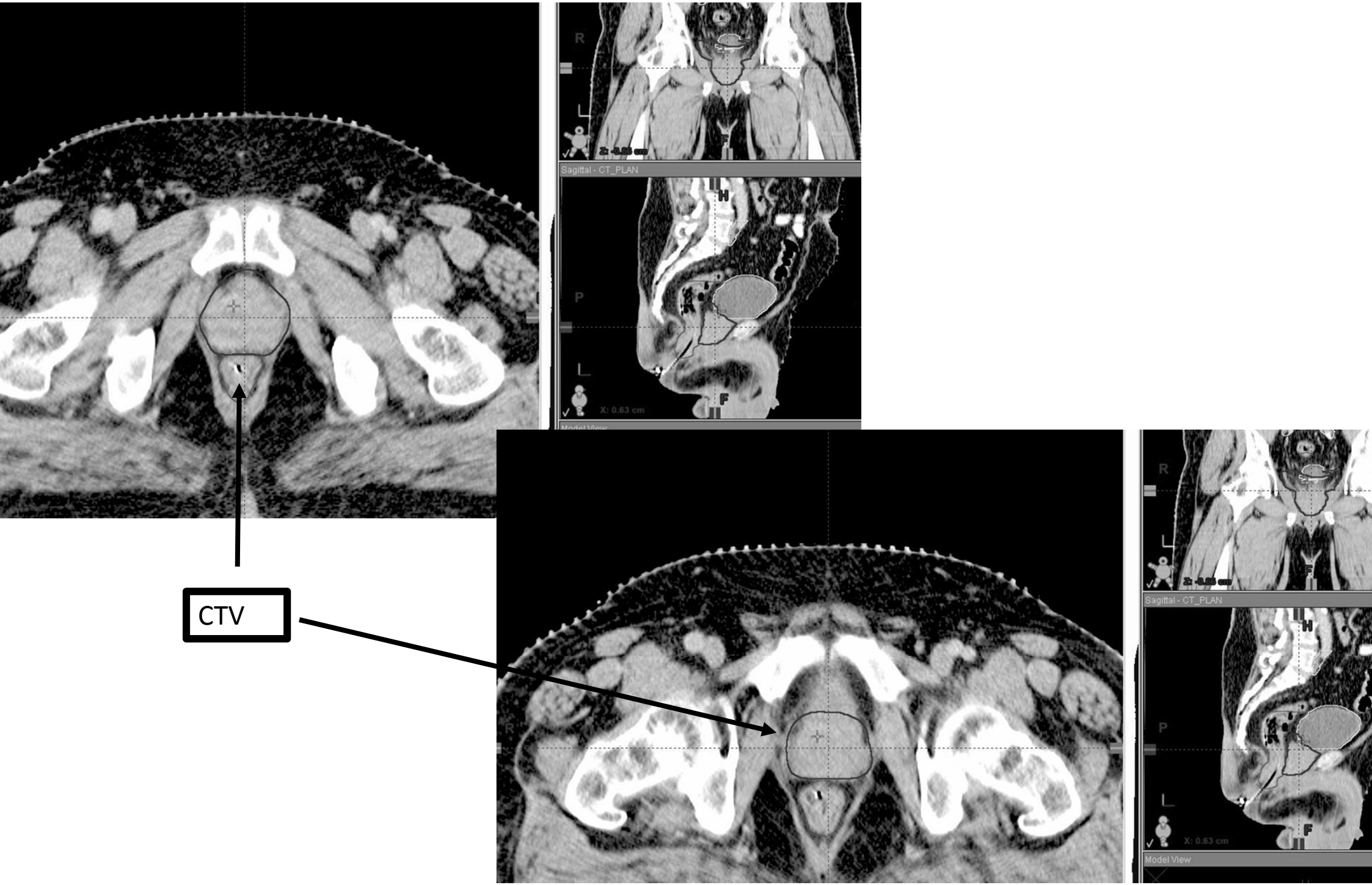
- Safety margin
- Institutional
- 6 mm posteriorly and 8 -10 mm all around
- Auto generation
- No tempering
- Daily imaging

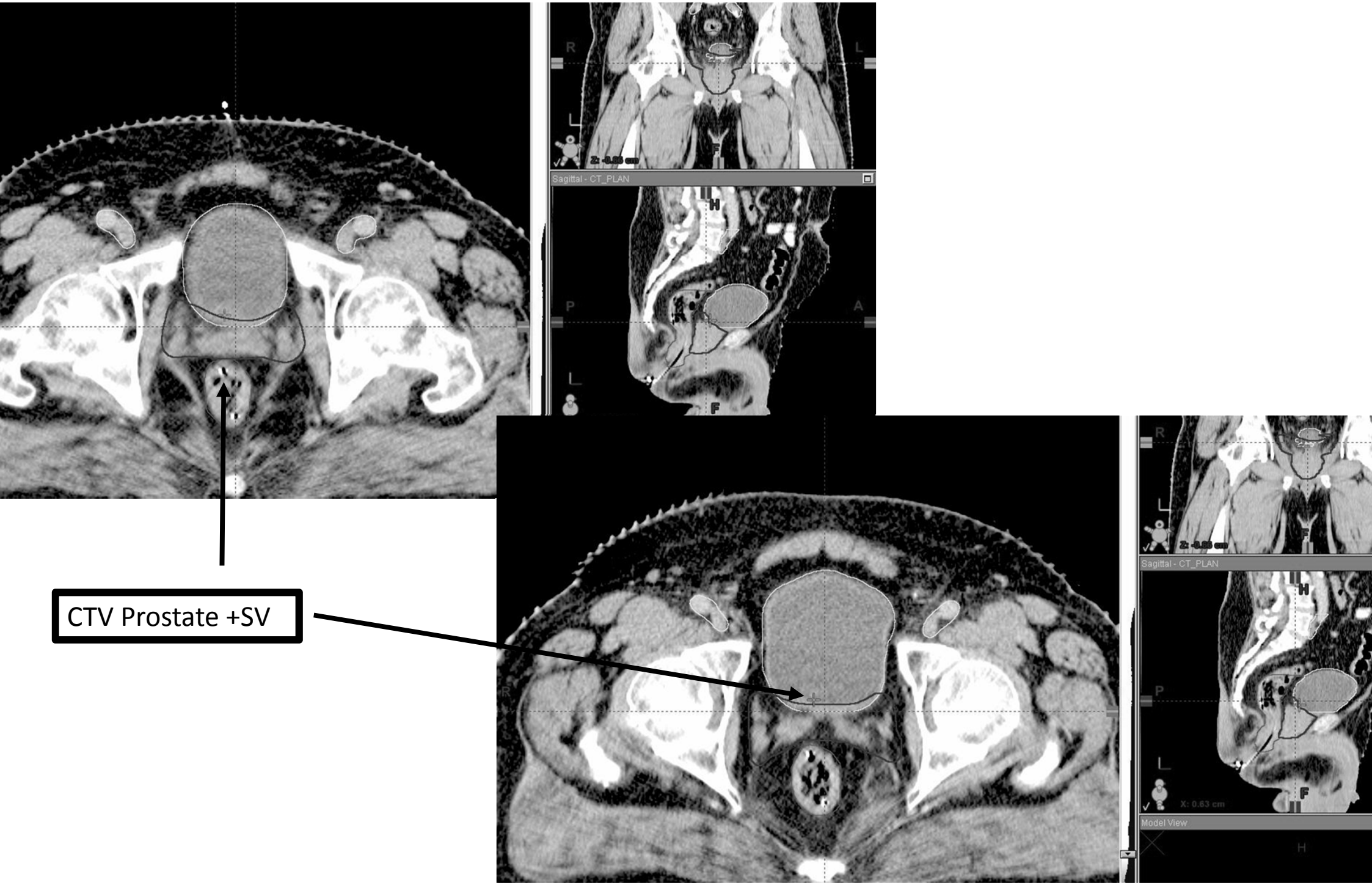
Prostate Moves

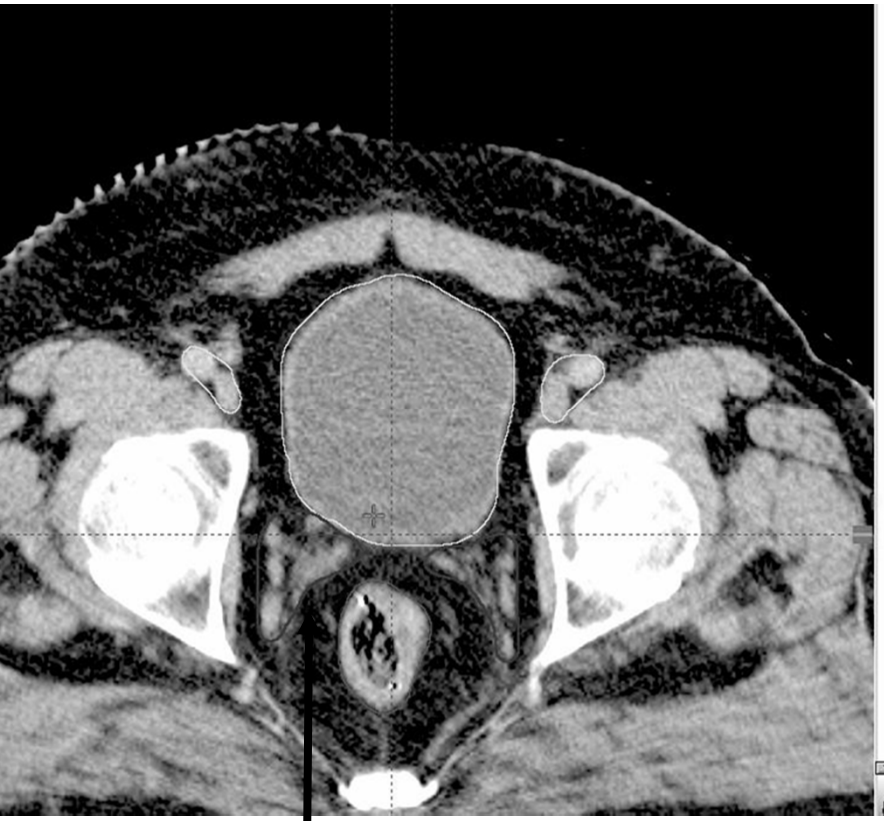
- Intrafraction movement
- 427 patients with gold fiducial , 11,000 measurements
- 66% patients had motion within 2mm and 28% within 3mm

- Daily set up imaging- 5mm PTV margin is adequate
- Weekly imaging 10 mm

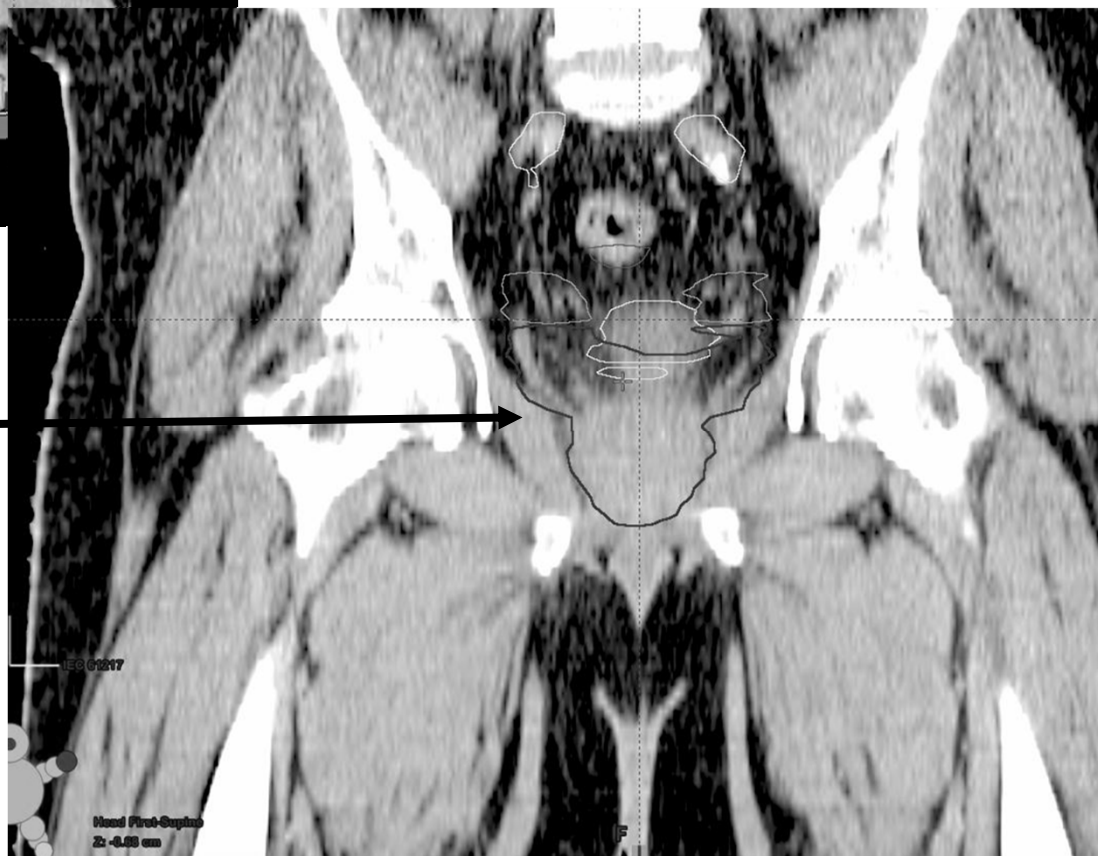

CTV
Sagittal - CT_PLAN
Sagittal - CT_PLAN
Model View

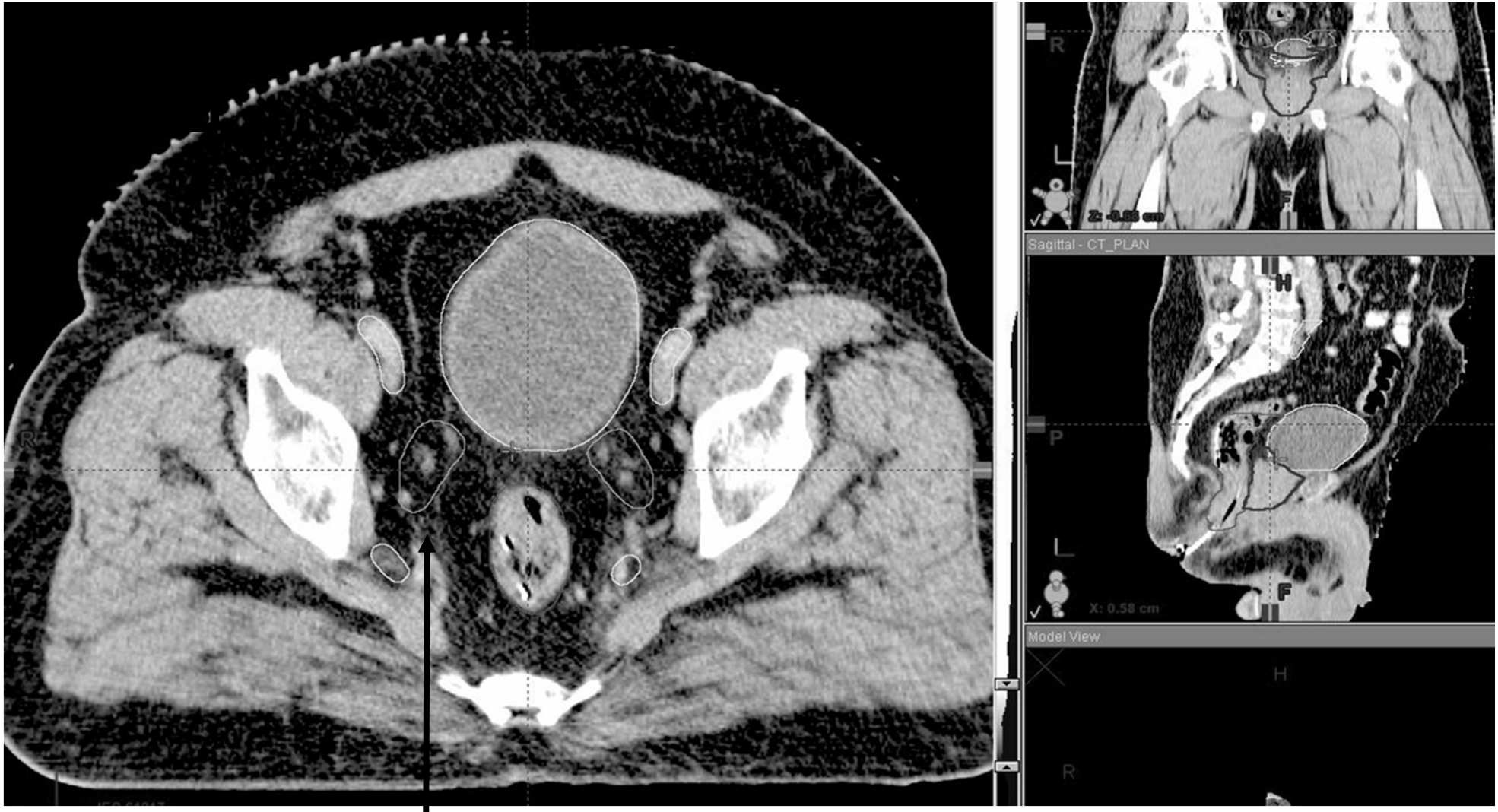

R
L
F
Sagittal - CT_PLAN
H
P
L
F
X: 0.63 cm
Model View
CTV
R
L
F
Sagittal - CT_PLAN
H
P
L
F
X: 0.63 cm
Model View


Sagittal - CT_PLAN
Sagittal - CT_PLAN
Model View
CTV Prostate +SV

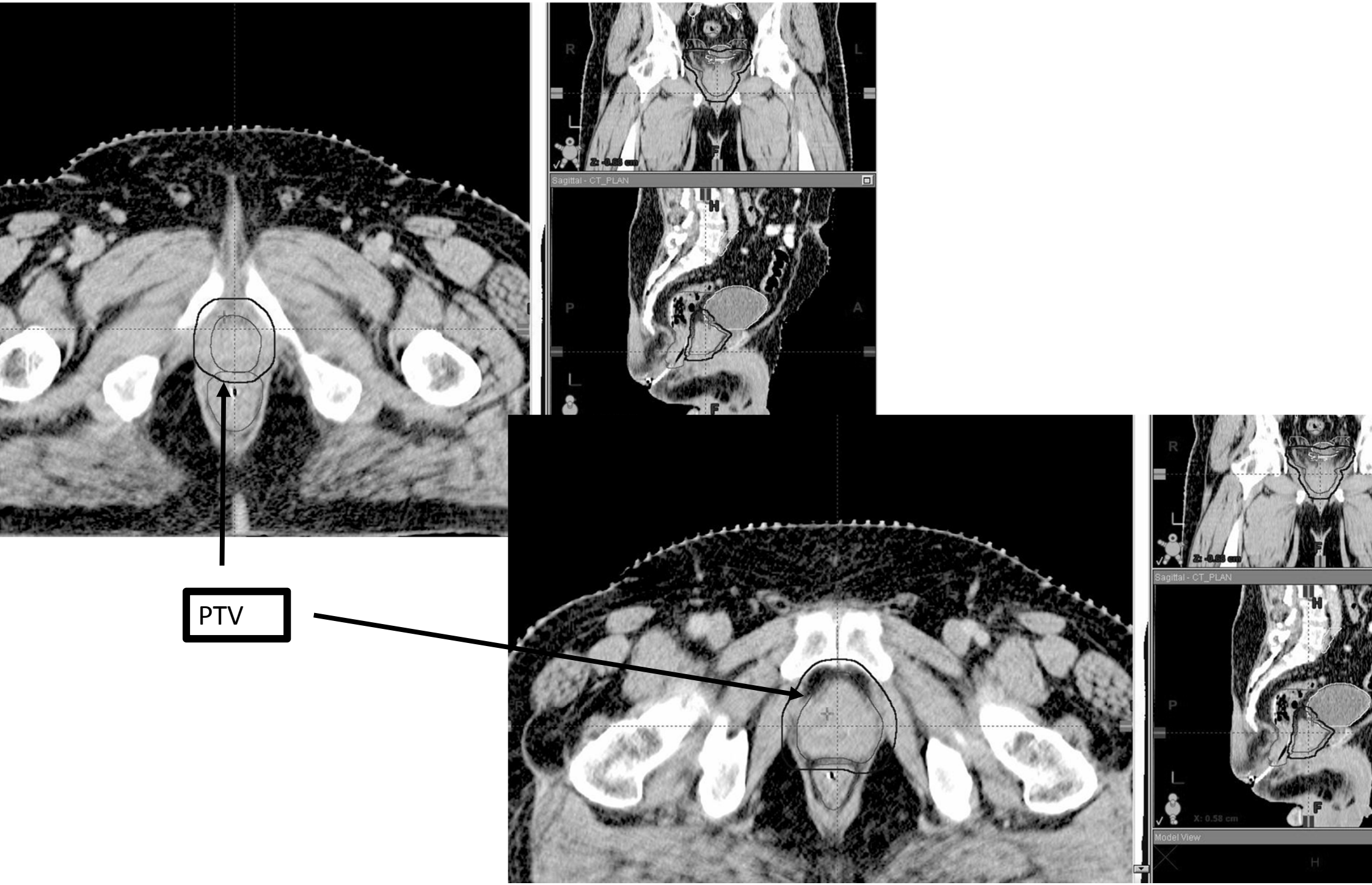


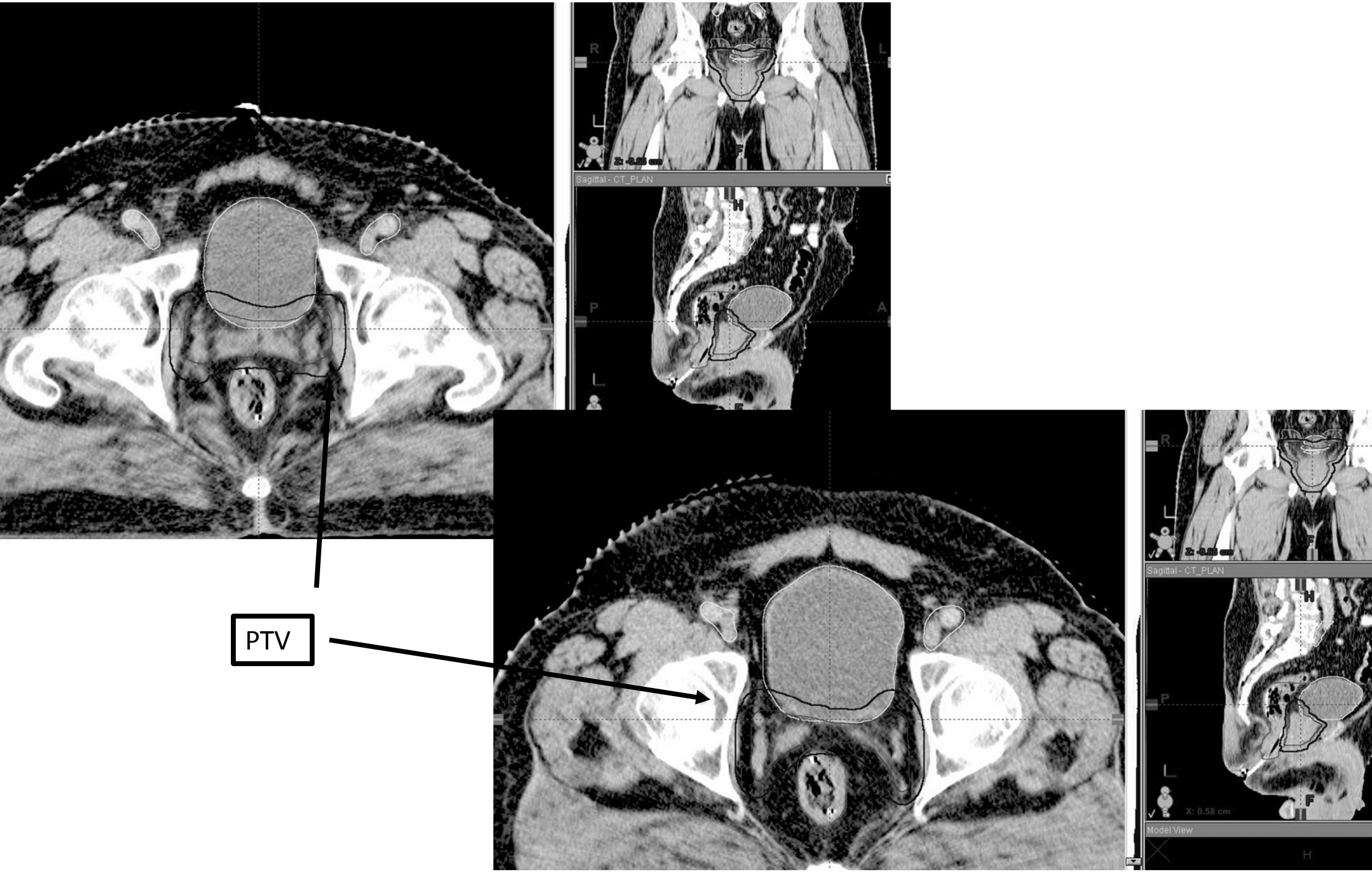
CTV SV





CTV Distal SV


R
L
F
Sagittal - CT_PLAN
H
P
A
L
F
PTV
R
R
L
F
Sagittal - CT_PLAN
H
P
L
F
X: 0.58 cm
Model View
H


Sagittal - CT_PLAN
Sagittal - CT_PLAN
Model View
PTV

Sagittal View CTV
PTV HR

J Radiat Oncol Biol Phys. 2009 June 1; 74(2): 383–387. doi:10.1016/j.ijrobp.2008.08.002.

TOG GU Radiation Oncology Specialists Reach Consensus on lvic Lymph Node Volumes for High-Risk Prostate Cancer

International Journal of Radiation Oncol biology • physics

www.redjournal.or

Clinical Investigation

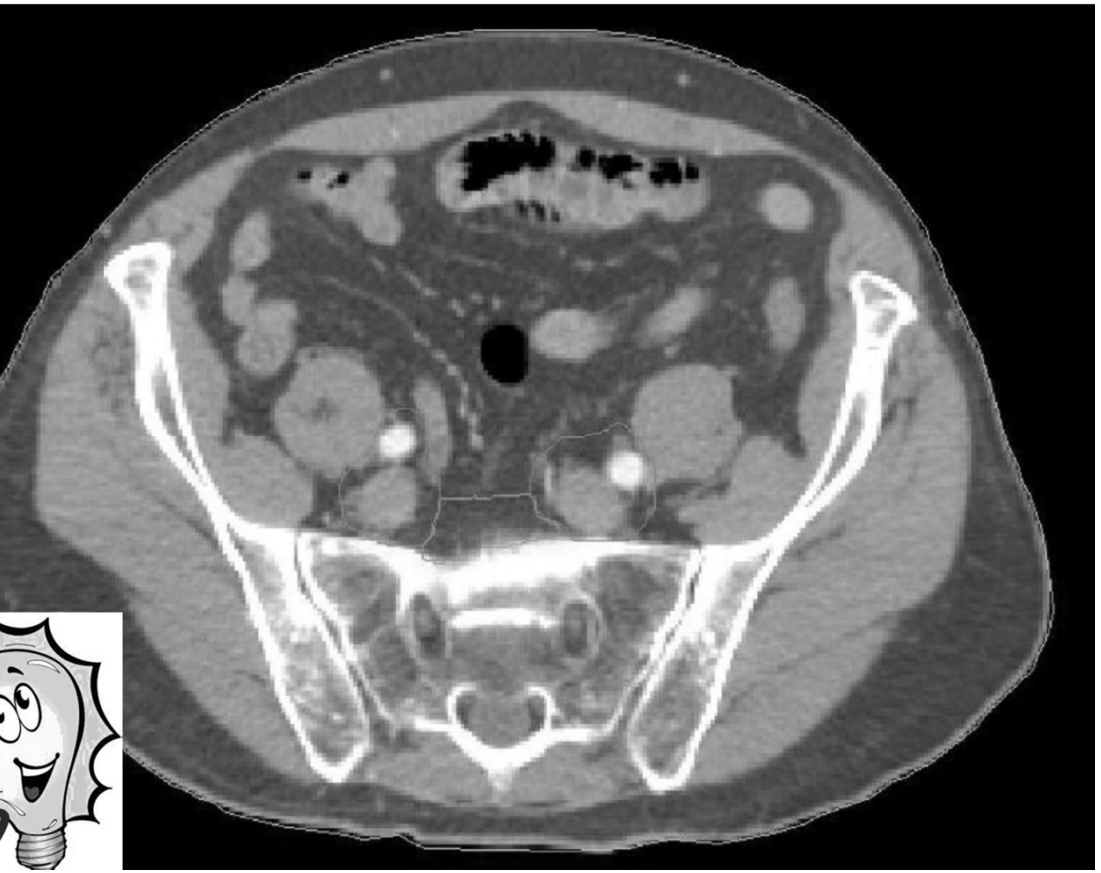
Consensus Guidelines and Contouring Atlas for Pelvic Node Delineation in Prostate and Pelvic Node Intensity Modulated Radiation Therapy

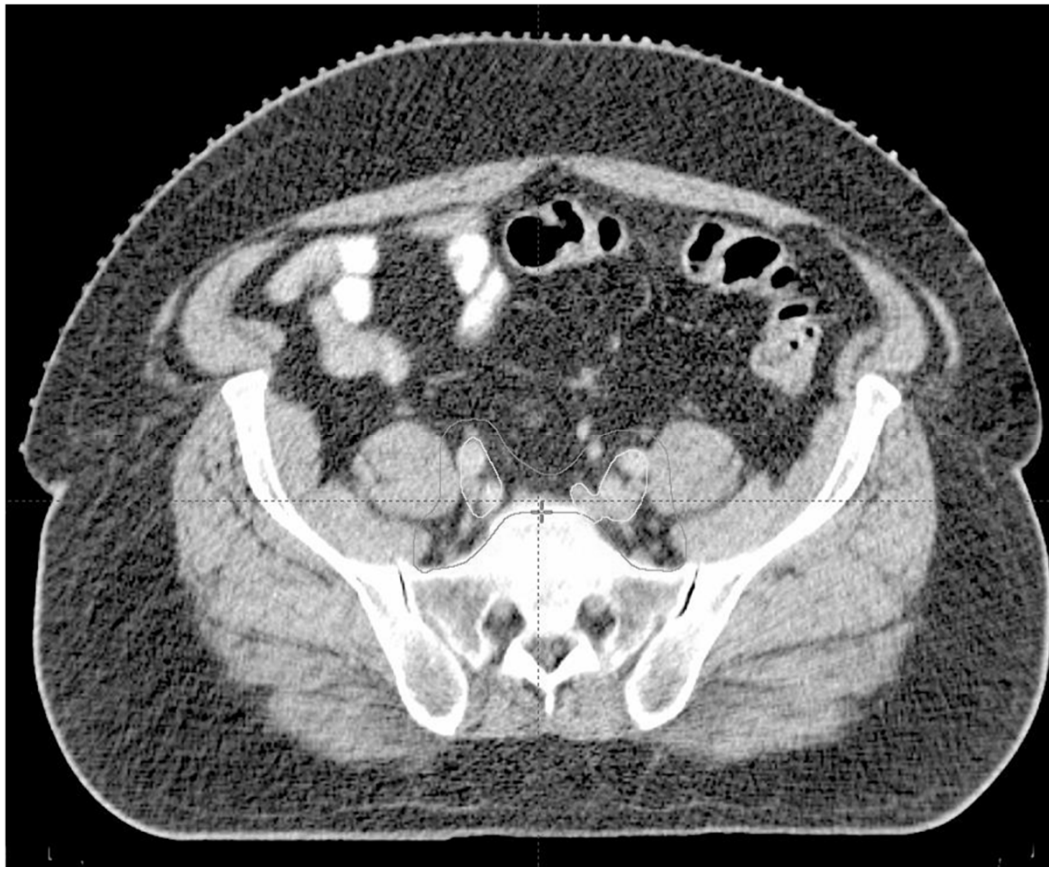
derstanding of which LNs are to be included comes from
Surgical series of LND
Radiological series using Lymphotropic Nano particle based MRI which can discriminate b/w normal and abnormal MRI with high sensitivity and specificity

LN to be included

- Distal Common iliac LN
- Internal and External iliac LN
- Pre sacral (S1-3)
- Obturator LN

Cranial- L5-S1 Interspace
At level of Distal common Iliac And proximal Presacral LNs



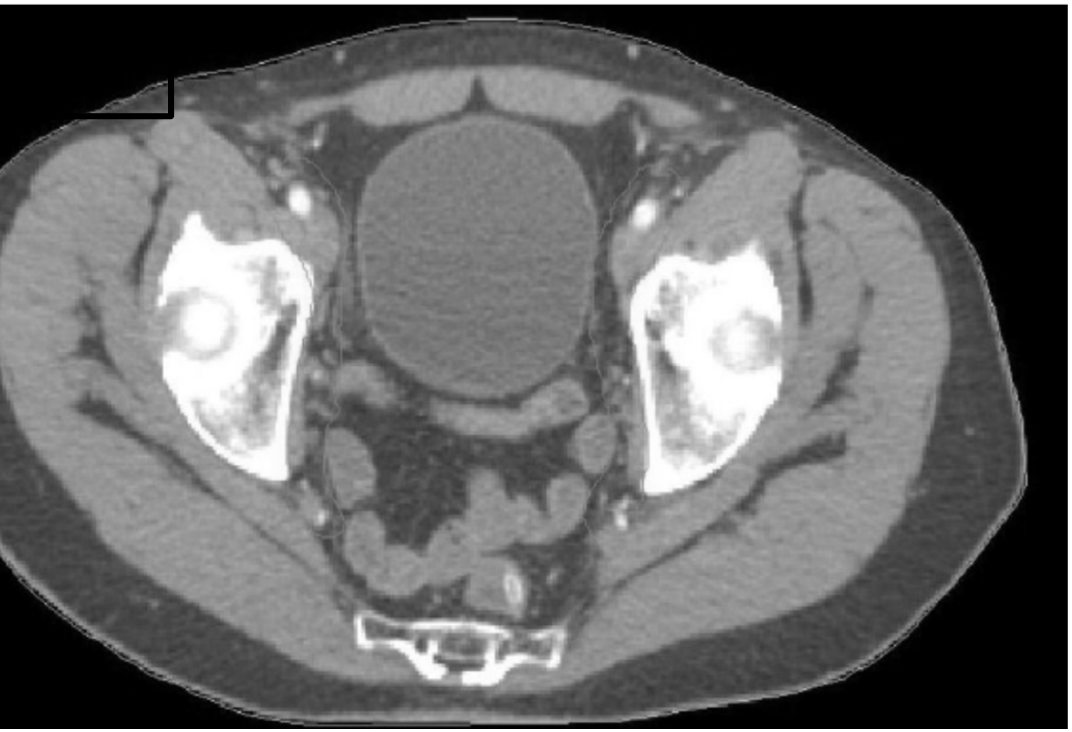


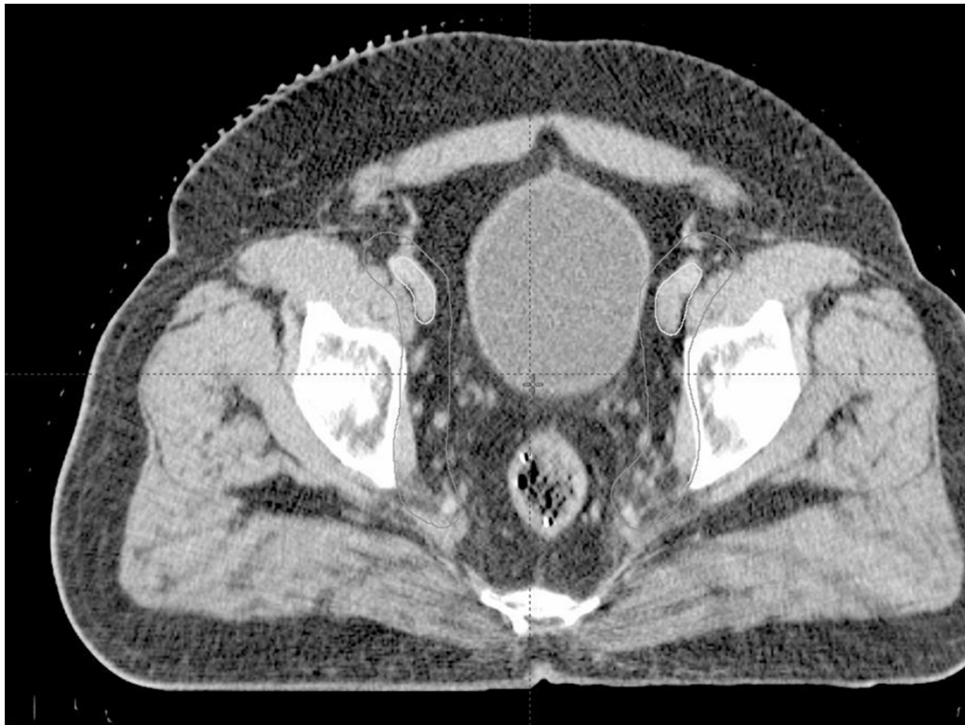
Place 7 mm margin around iliac vs connecting external and internal iliac contours

Connecting strip has to be 18 mm wide

Presacral LNs –S1-S3- 10 mm strip anterior to sacral bone carving out bladder, bone and bowel

Stop External Iliac LN contouring at top of femoral head





Stop Obturator LN contouring at top of pubic symphysis

Post Op Ca Prostate

- CTV definition in post Op setting is complicated
- 1. change in anatomy caused by surgery
- 2. Limited information on pre op location of prostate
- Four Contouring Guidelines are there

POF

- Retropubic space
- Bladder Neck
- VUA

- Distinguish whether its post op RT or Salvage RT

- If it’s a salvage RT do MRI to identify GTV recurrence/ residual for dose escalation

Radiotherapy and Oncology 84 (2007) 121–127
www.thegreenjournal.com

e radiotherapy - EORTC

Guidelines for target volume definition in post-operative radiotherapy for prostate cancer, on behalf of the EORTC Radiation Oncology Group

Philip Poortmans[a,*], Alberto Bossi[b], Katia Vandeputte[c], Mathieu Bosset[d],

DEVELOPMENT OF RTOG CONSENSUS GUIDELINES FOR THE DEFINITION O CLINICAL TARGET VOLUME FOR POSTOPERATIVE CONFORMAL RADIAT THERAPY FOR PROSTATE CANCER

JEFF M. MICHALSKI, M.D.,* COLLEEN LAWTON, M.D.,† ISSAM EL NAQA, PH.D.,* MARK RITTER,

Int. J. Radiation Oncology Biol. Phys., Vol. 76, No. 2, pp. 361–368, 2010

-prostatectomy radiation therapy: Consensus guidelines f the Australian and New Zealand Radiation Oncology Genito-Urinary Group

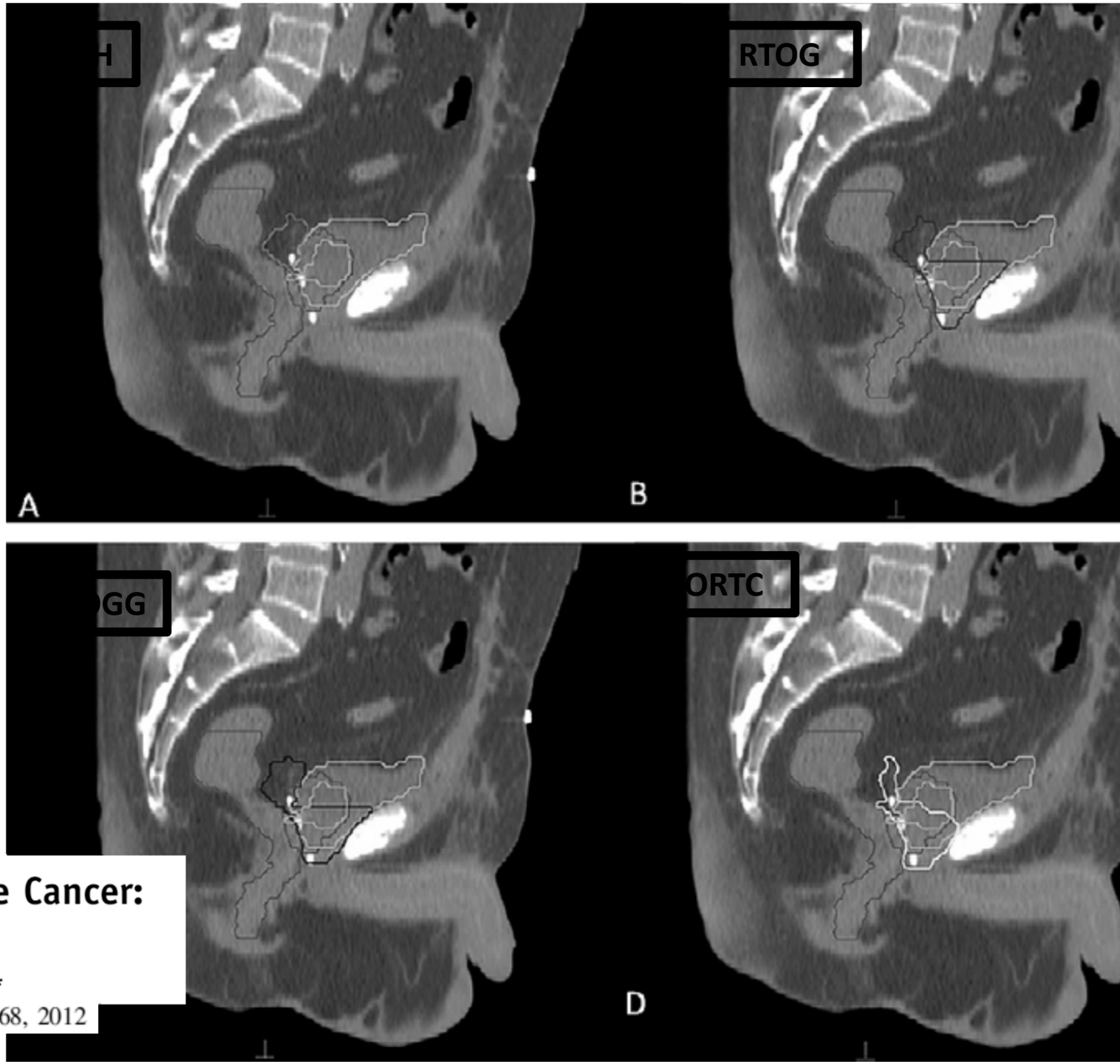
A. Sidhom[a,*], Andrew B. Kneebone[a], Margot Lehman[b], Kirsty L. Wiltshire[c],
y L. Millar[d], Rahul K. Mukherjee[e], Thomas P. Shakespeare[f], Keen-Hun Tai[g]
erapy and Oncology 88 (2008) 10–19

Post Op Ca Prostate

Postoperative Radiotherapy in Prostate Cancer: The Case of the Missing Target

Jennifer Croke, M.D.,* Shawn Malone, M.D., F.R.C.P.C.,*
Nicolas Roustan Delatour, M.D.,† Eric Belanger, M.D., F.R.C.P.C.,†
Leonard Avruch, M.D., F.R.C.P.,‡ Christopher Morash, M.D., F.R.C.S.C.,§
Cathleen Kayser, M.R.T.(T.), C.M.D.,* Kathryn Underhill, B.Sc.(Hons.),*
and Johanna Spaans, M.Sc.*

ur Guidelines



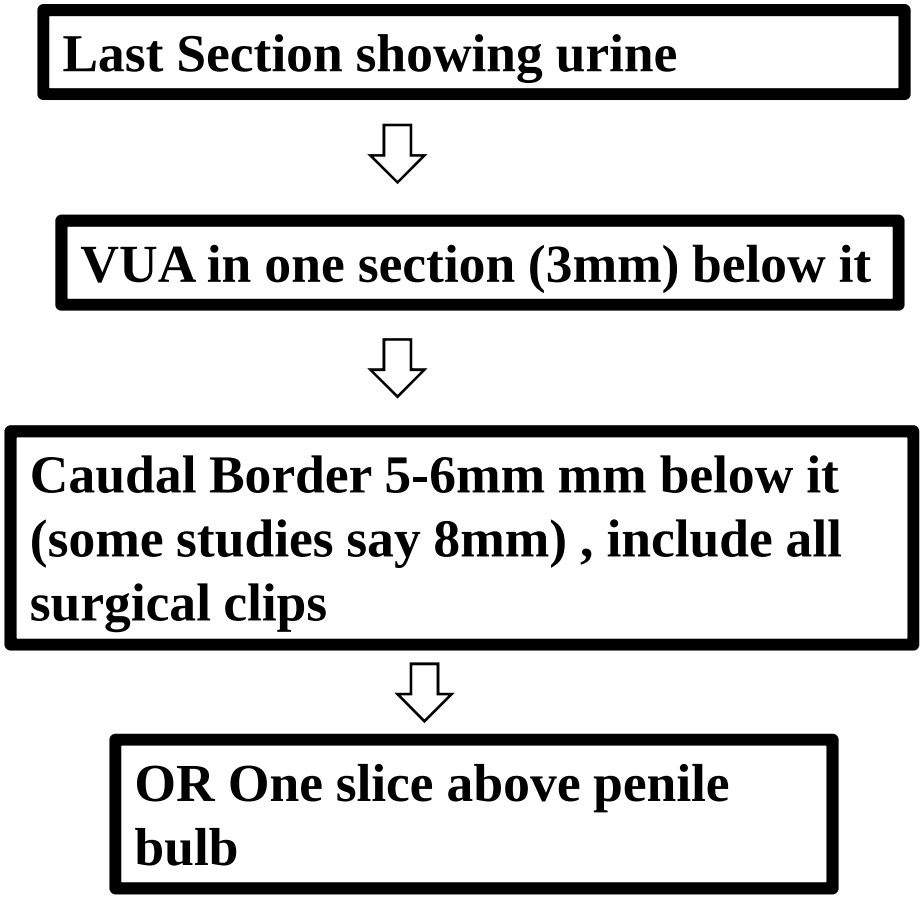
erative Radiotherapy in Prostate Cancer:
se of the Missing Target

Croke, M.D.,* Shawn Malone, M.D., F.R.C.P.C.,*

iation Oncol Biol Phys, Vol. 83, No. 4, pp. 1160–1168, 2012

CTV Delineation
Planning CT thickness 2.5-3mm

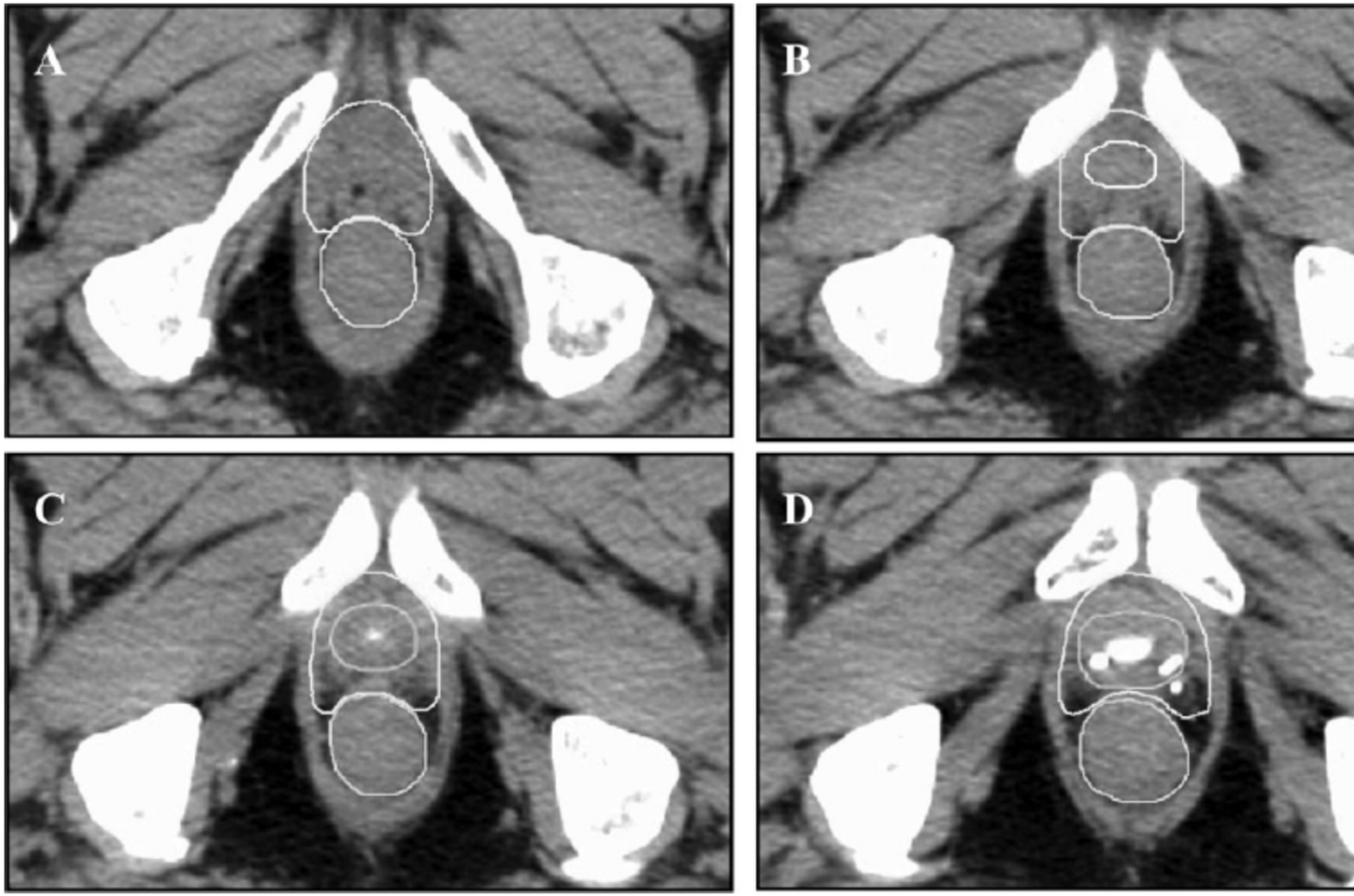
- *Inferior Border-* 5 mm below VUA but should be extended to include all surgical clips inferiorly
- VUA is first slice below where urine is last visible
- If VUA is not clearly identified, inferior border will be slice above the penile bulb



Radiotherapy and Oncology 88 (2008) 10–19

Anterior

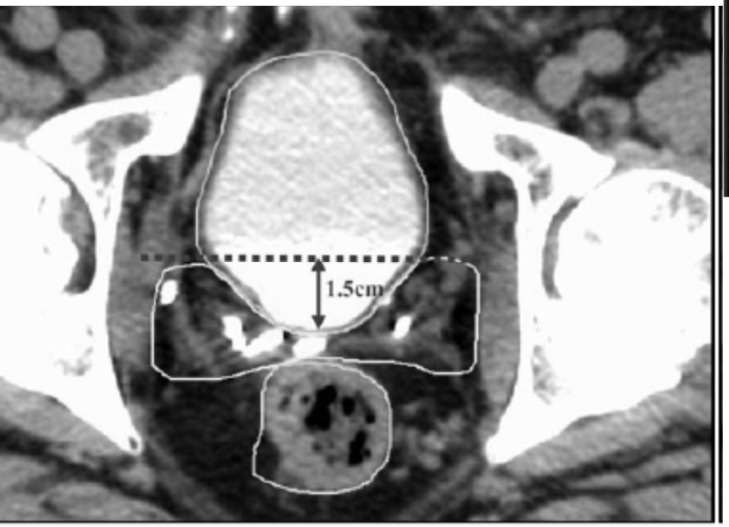
from the lower border
f CTV to 3cm superior,
nterior border of CTV is
ne post aspect of
ymphysis pubis

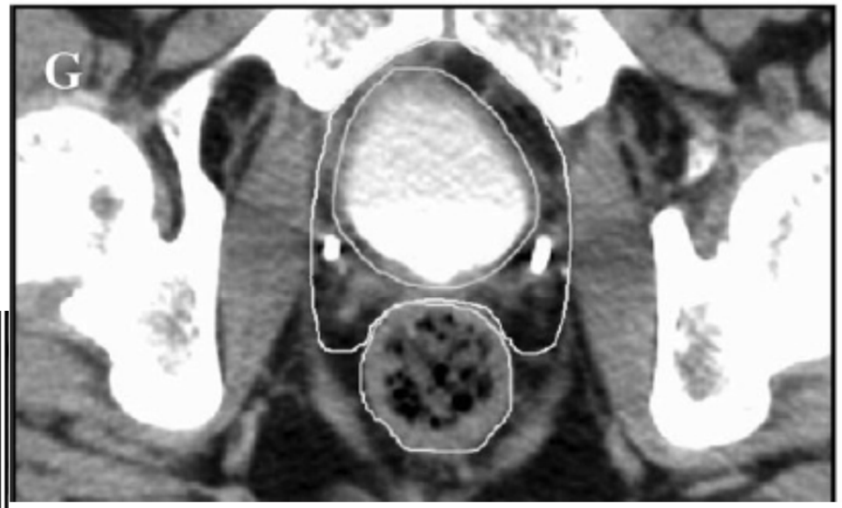


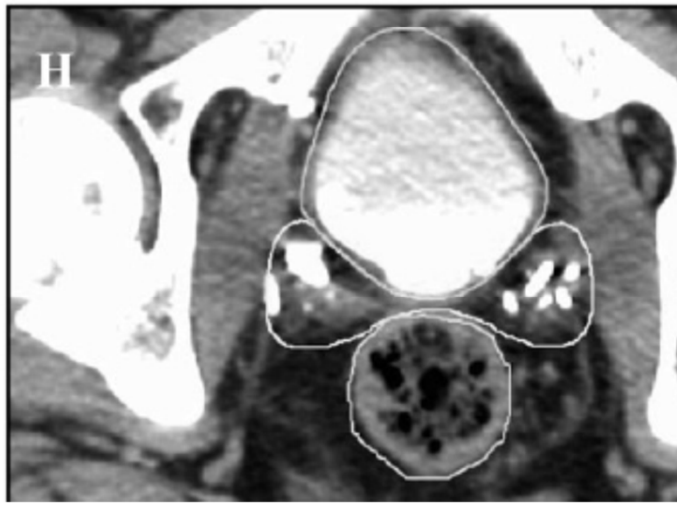
Radiotherapy and Oncology 88 (2008) 10–19

Anterior

More superiorly, nterior border of CTV cludes post 1.5 cm of adder







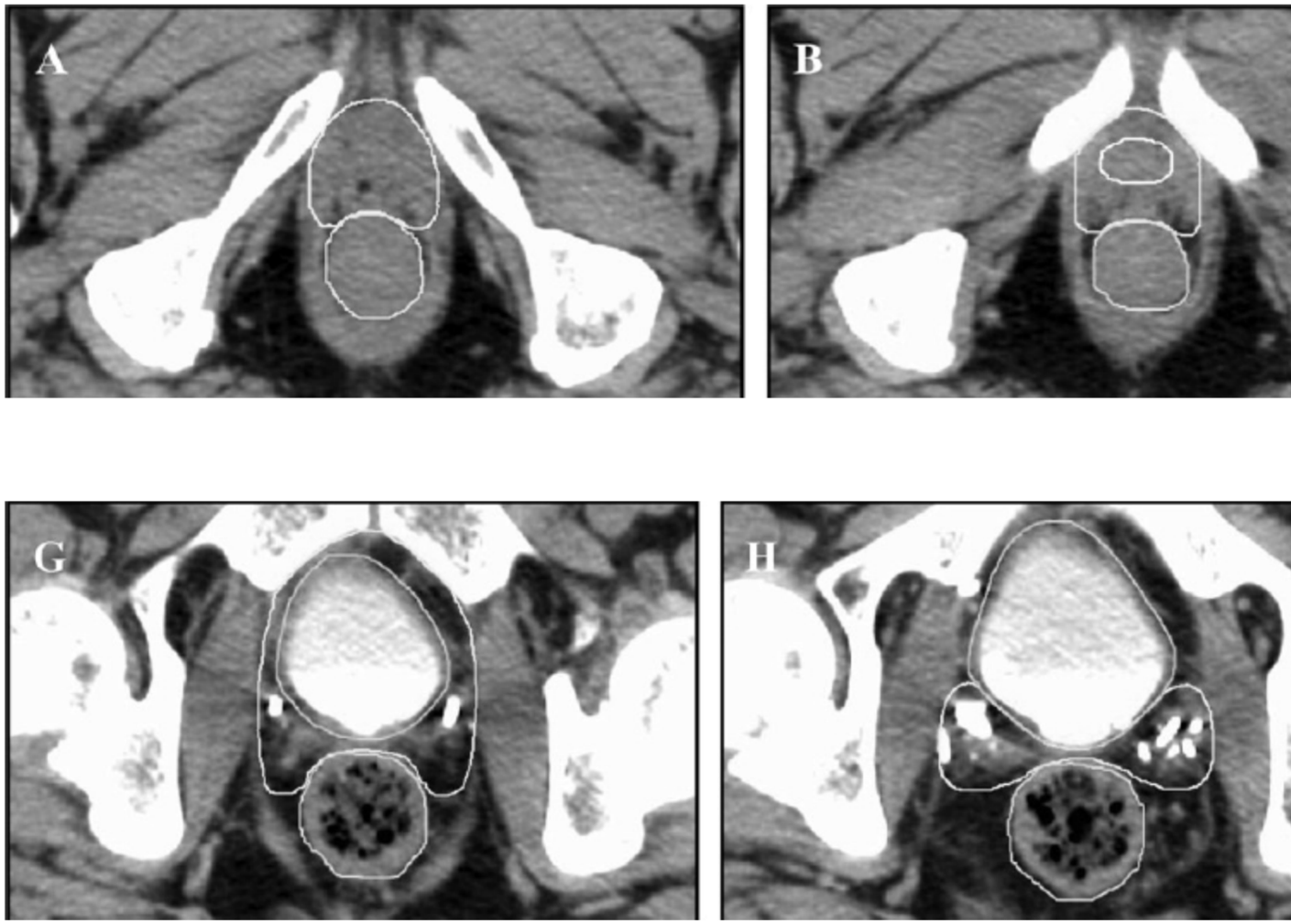
Posterior

- Caudally- Anterior rectal wall
- Cranially- anterior MRF

Radiotherapy and Oncology 88 (2008) 10–19

ateral Border

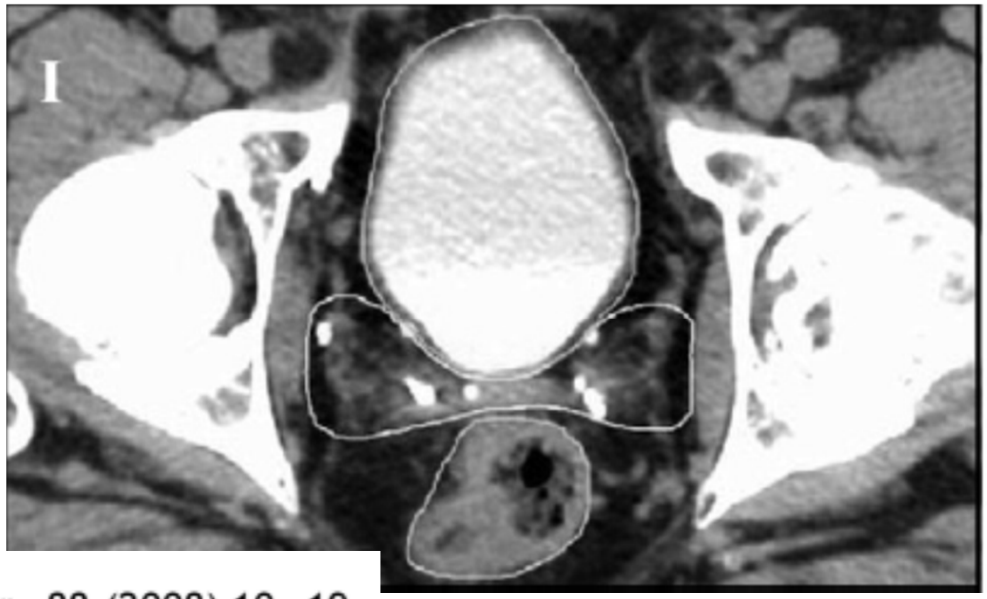
- L ani and
- Obturator
- Internus
- Ms



Radiotherapy and Oncology 88 (2008) 10–19

Superior Border

- Include all residual SV especially if pathologically involved
- Include distal portion of Vas deferens

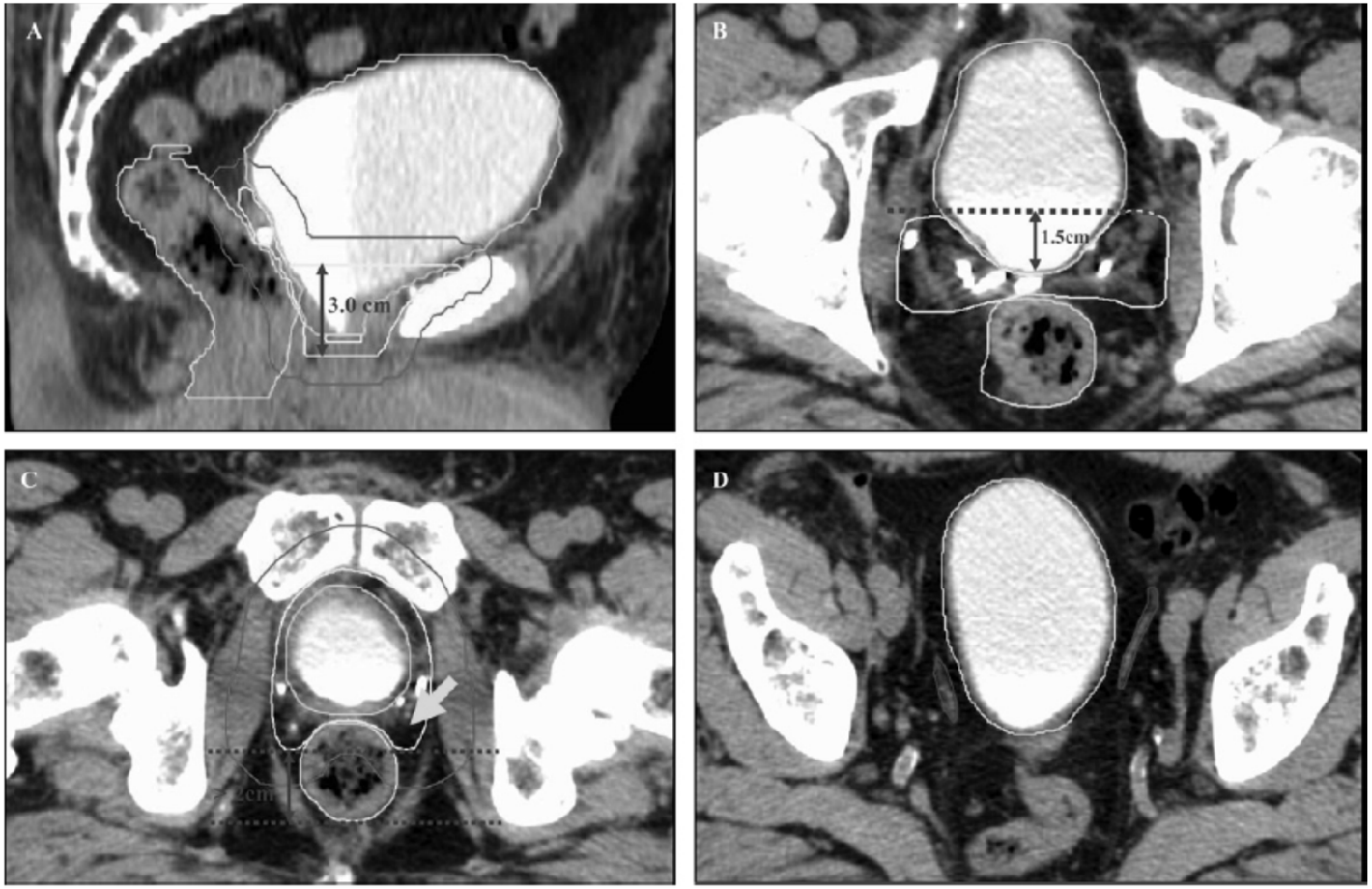


herapy and Oncology 88 (2008) 10–19

PTV 10mm

pace bound by L Ani and
ectum is potential site for
currence—so pay attention
it

istance b/w post part of
TV and Post wall of rectum
ould be > 2cm to avoid
rcumferential rectal
diation



Radiotherapy and Oncology 88 (2008) 10–19

Reason behind these proposed margins

Caudal

- Although the transacted urethra above the urethral sphincter defines inferior most extent of surgical bed, retraction and manipulation of tissues can result microscopic seeding immediately inferior to VUA
- Distance b/w VUA and inferior border of surgical bed is almost 5 mm and PB is never exposed to surgical cavity

Wiltshire et all IJROBP Vol 69, No 4, pp1090, 2007

Anterior

- Anterior Caudal Border- Post edge of symphysis pubis up to top of symphysis pubis– anterior surgical plane follows posterior edge of symphysis pubis

- Anterior Cranial Border-posterior 1.5 cm of Bladder wall– posterior bladder wall bounds the anterosuperior surgical plane
- Substantial deformation of bladder and rectum to fill the space previously occupied by prostate gland, anterior extension is estimated to be about 1.5 cm

Wiltshire et all IJROBP Vol 69, No 4, pp1090, 2007

Lateral

- Lateral caudal boundary- medial border of L Ani and Obturator Internus– as in the caudal aspect of surgical volume, pelvic muscles bound the lateral dissection

- Lateral Cranial Boundary- was the sacro recto genito pubic fascia, lateral to NV bundle

Wiltshire et all IJROBP Vol 69, No 4, pp1090, 2007

Posterior

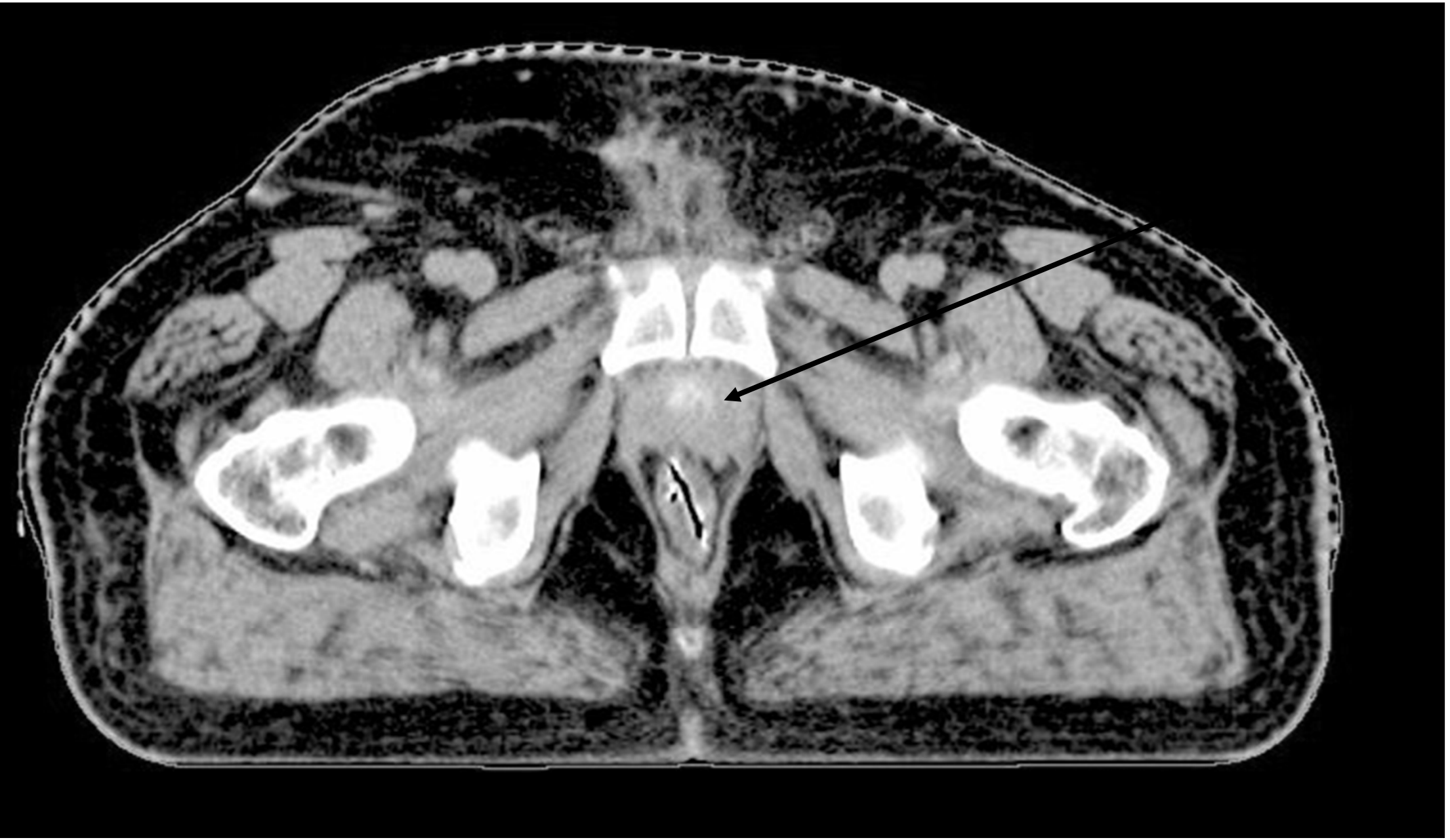
- Posterior Caudal boundary- anterior rectal wall and L ani
- During surgery, rectum is empty and rectal wall has no tone, which eliminates convexity b/w levator ani and anterior rectal wall
- Surgical dissection plane (Denovillier's fascia) follows the anterior edge of rectal wall and L ani
- Posterior cranial boundary –Mesorectal fascia– surgical plane is anterior to mesorectal fascia

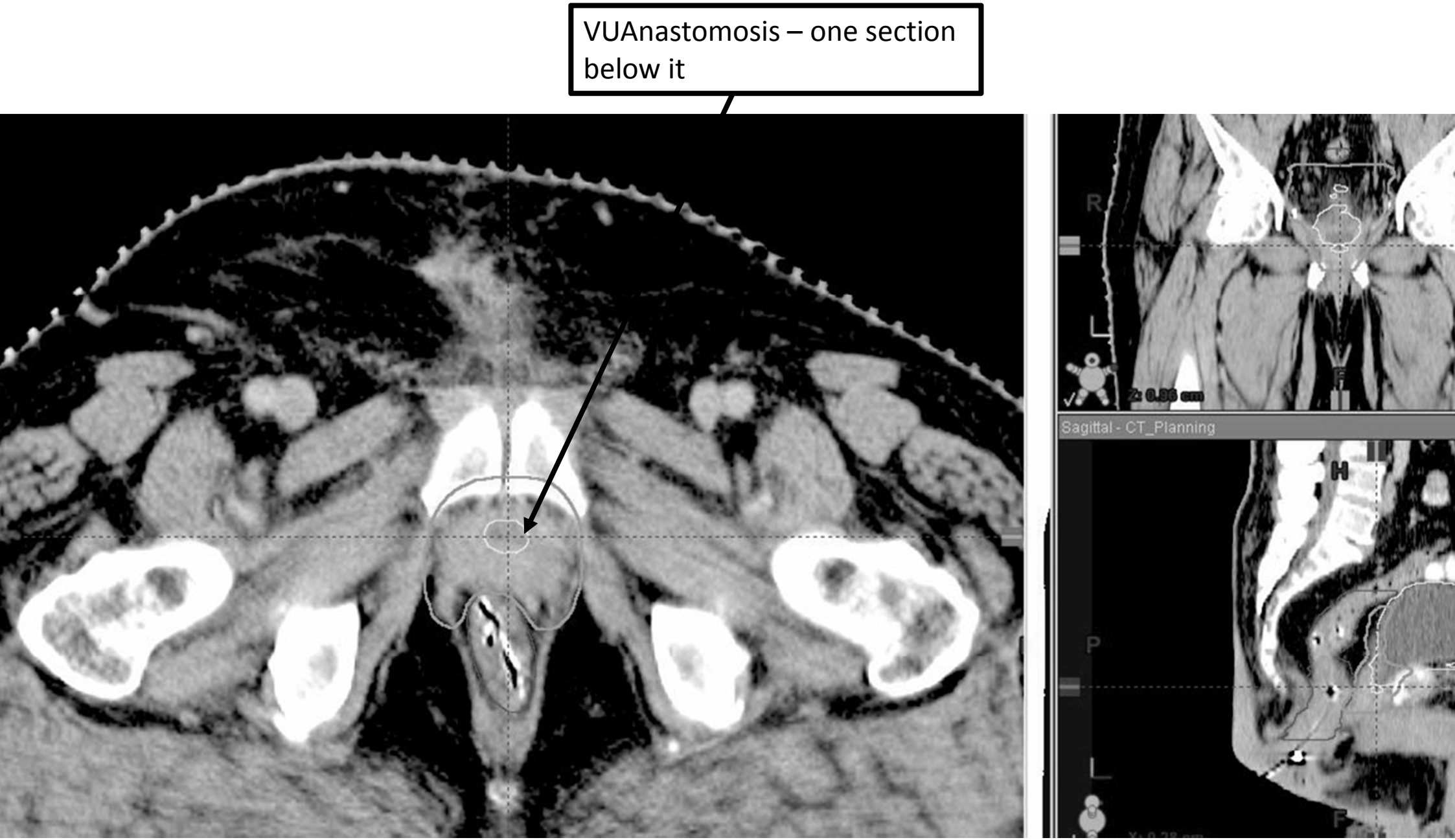
Wiltshire et all IJROBP Vol 69, No 4, pp1090, 2007

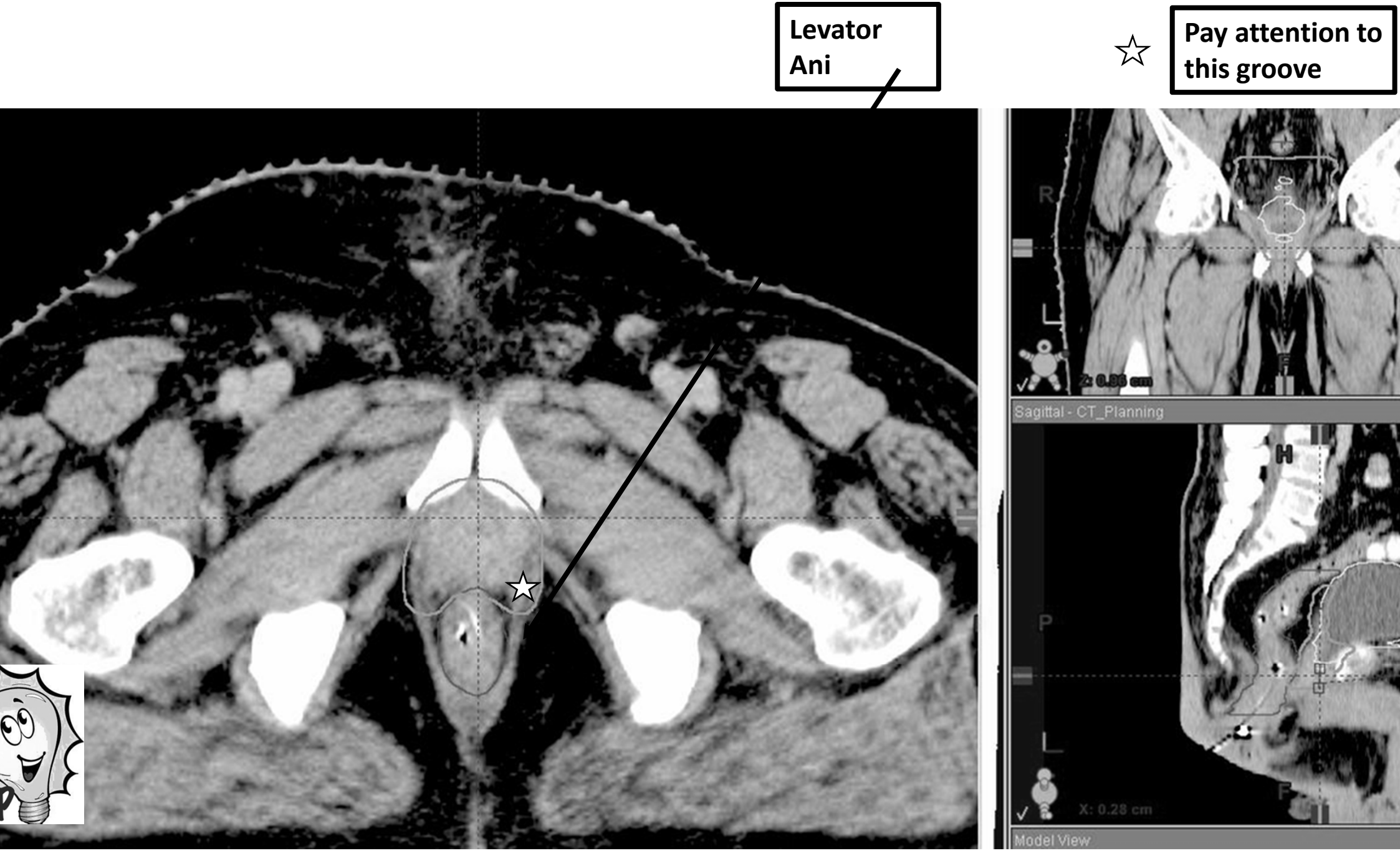
Cranial

- Cranial boundary- superior surgical clips (if present) or 5mm above inferior border of vas deferens
- Retained SV were included when pathologically involved
- Vas deferens was transacted at the cranial aspect of surgical bed, commonly using surgical clip
- In absence of surgical clip, transacted VD is difficult to visualize; therefore 5mm is added to cover for this uncertainty

Wiltshire et all IJROBP Vol 69, No 4, pp1090, 2007

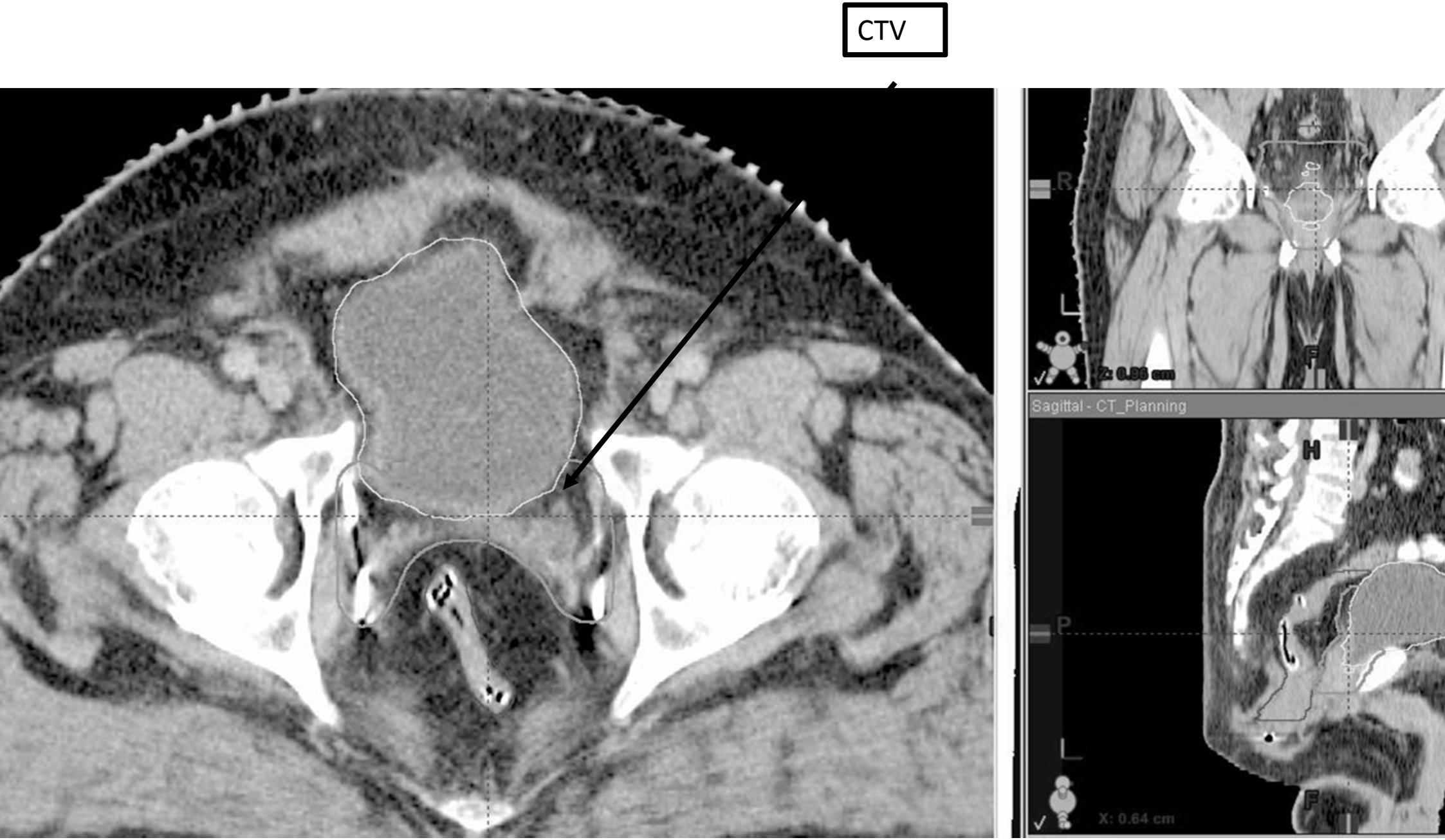



VUAnastomosis – one section below it
R
L
Sagittal - CT_Planning
H
P
L
F

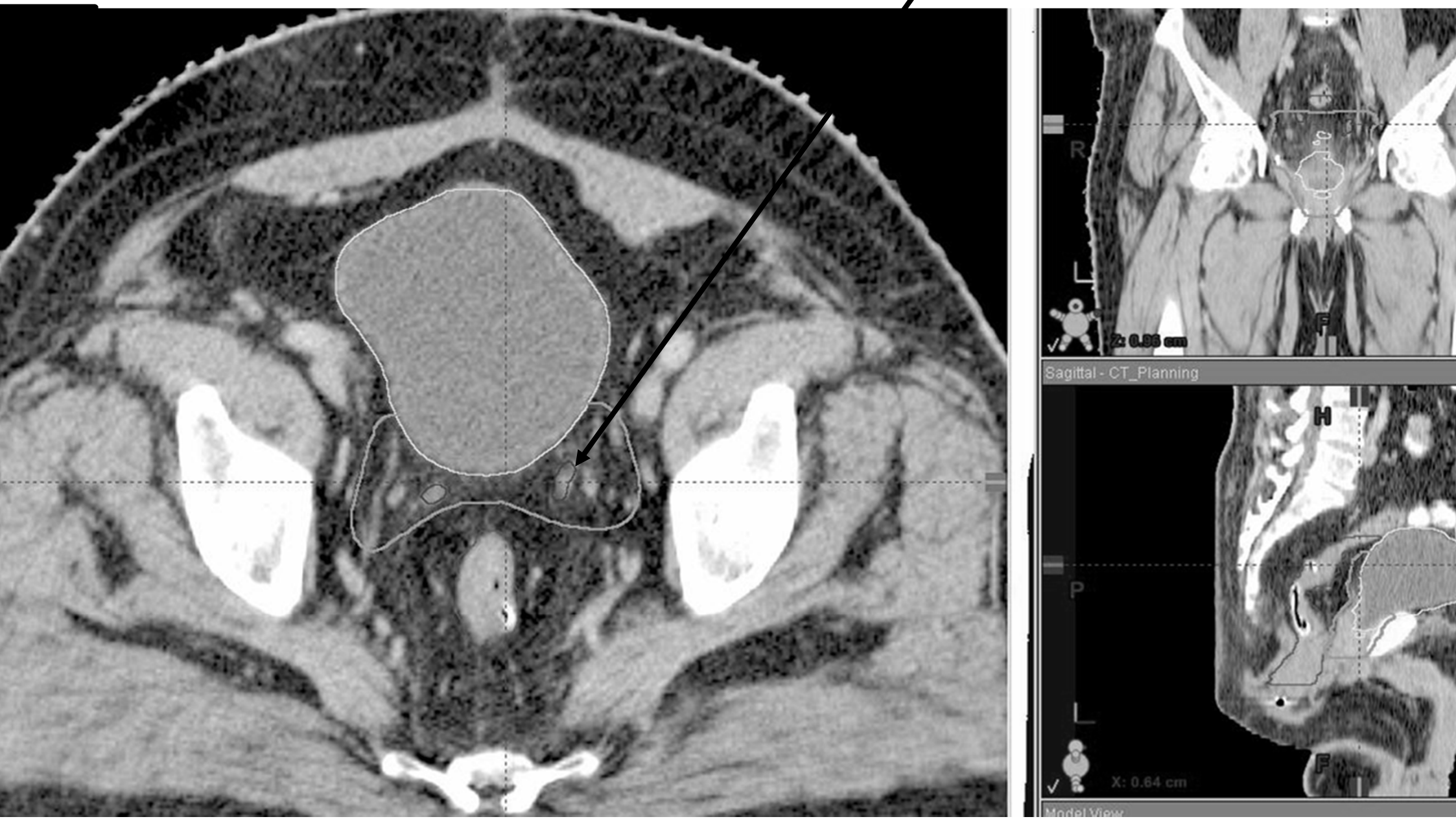

Levator Ani
Pay attention to this groove
R
L
Sagittal - CT_Planning
H
P
L
F
X: 0.28 cm
Model View

Cover Retro pubic space and all surgical clips

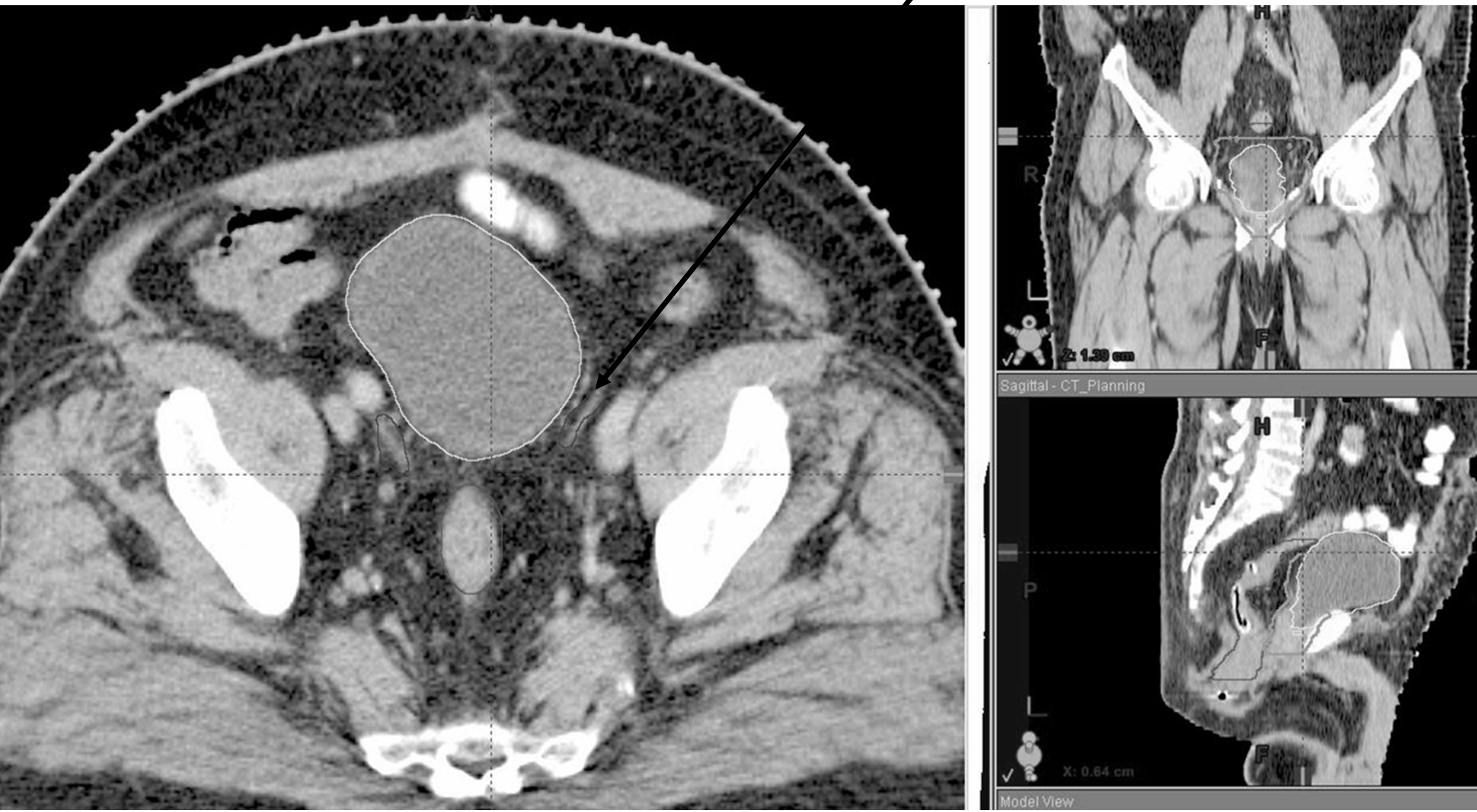
Cover 1.5 cm of bladder and all surgical clips


CTV
R
L
F
Sagittal - CT_Planning
H
P
L
F
X: 0.64 cm

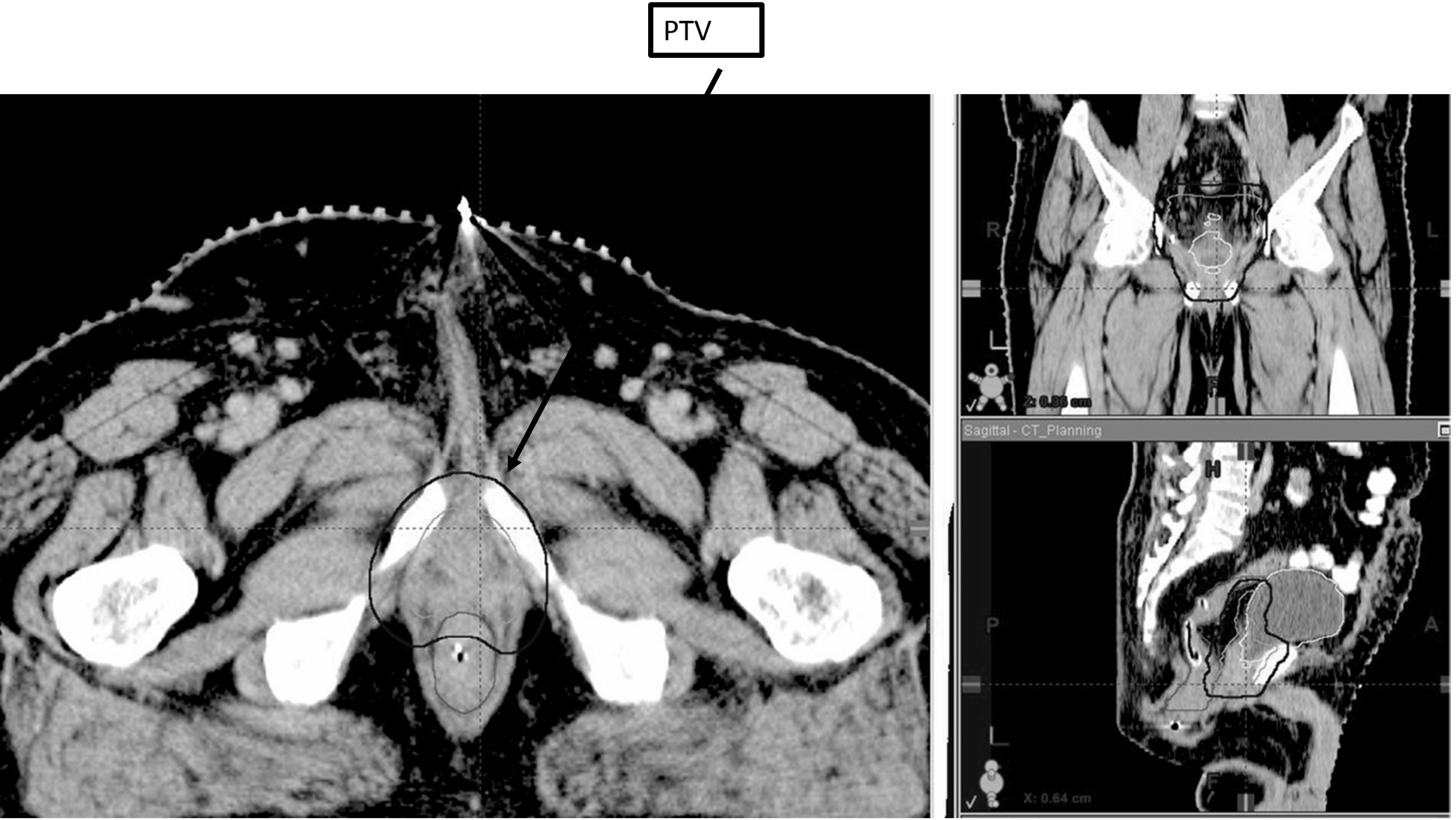
Cranial level at level of Vas Deferens

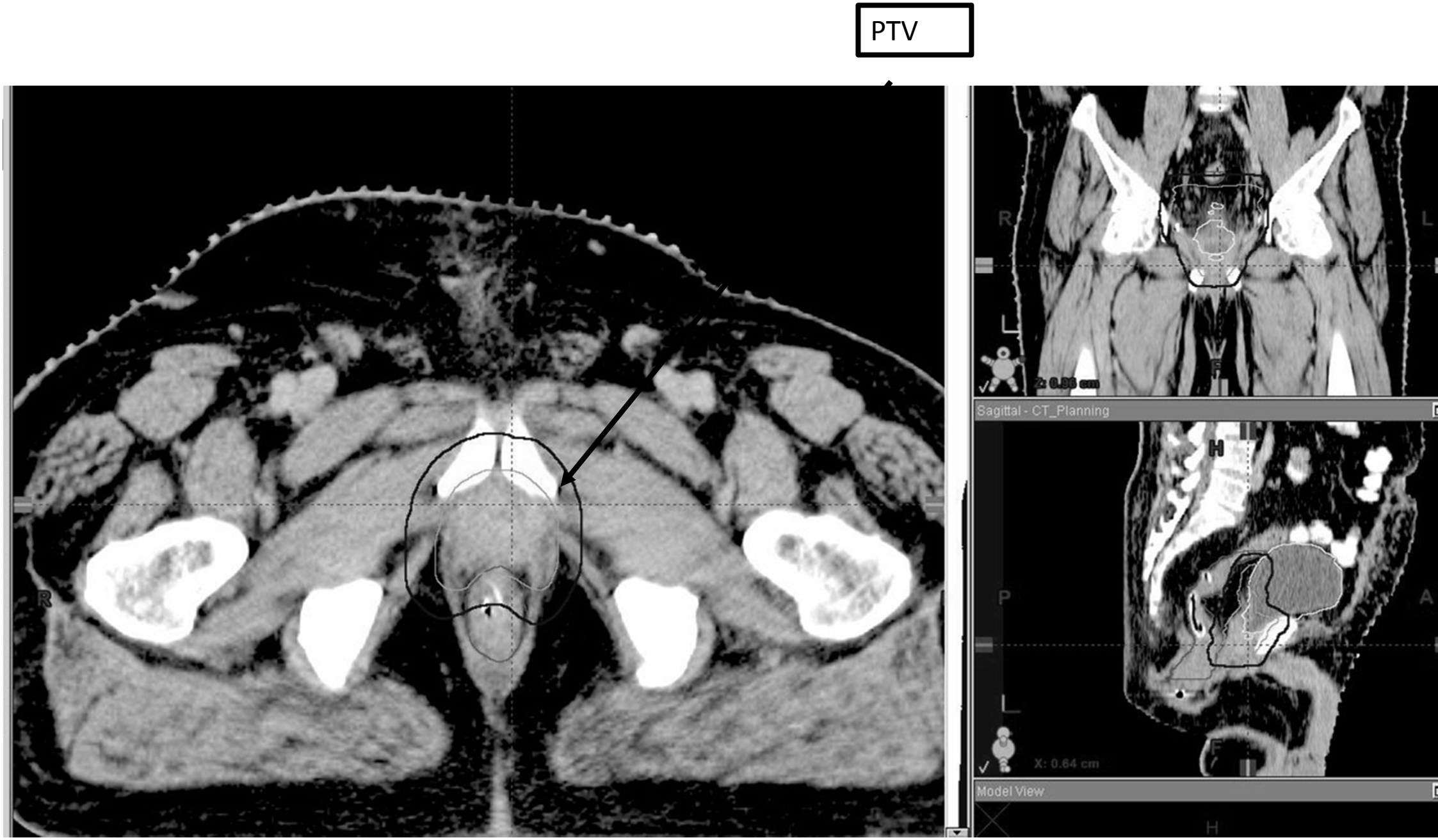


Top level Vas Deferens

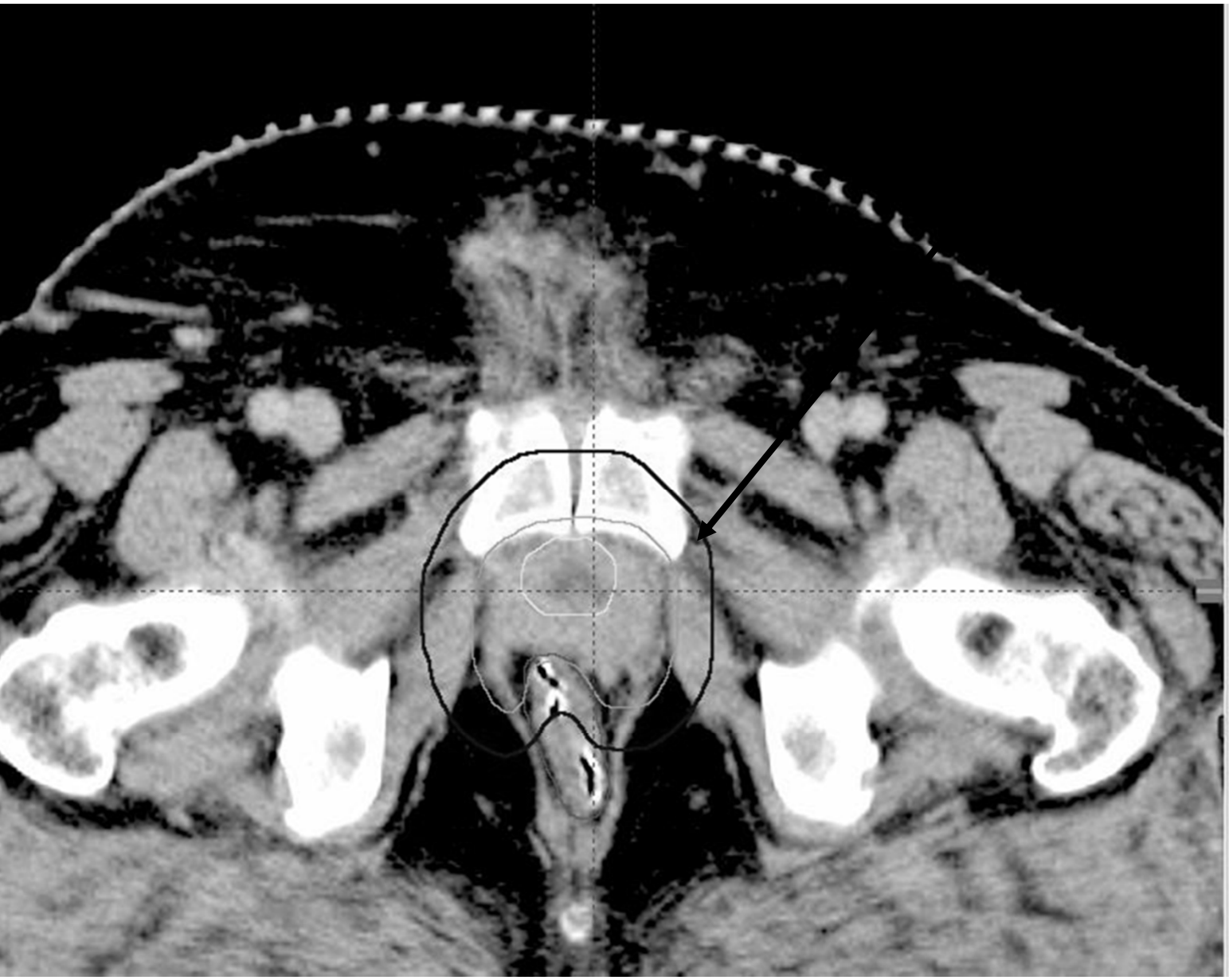


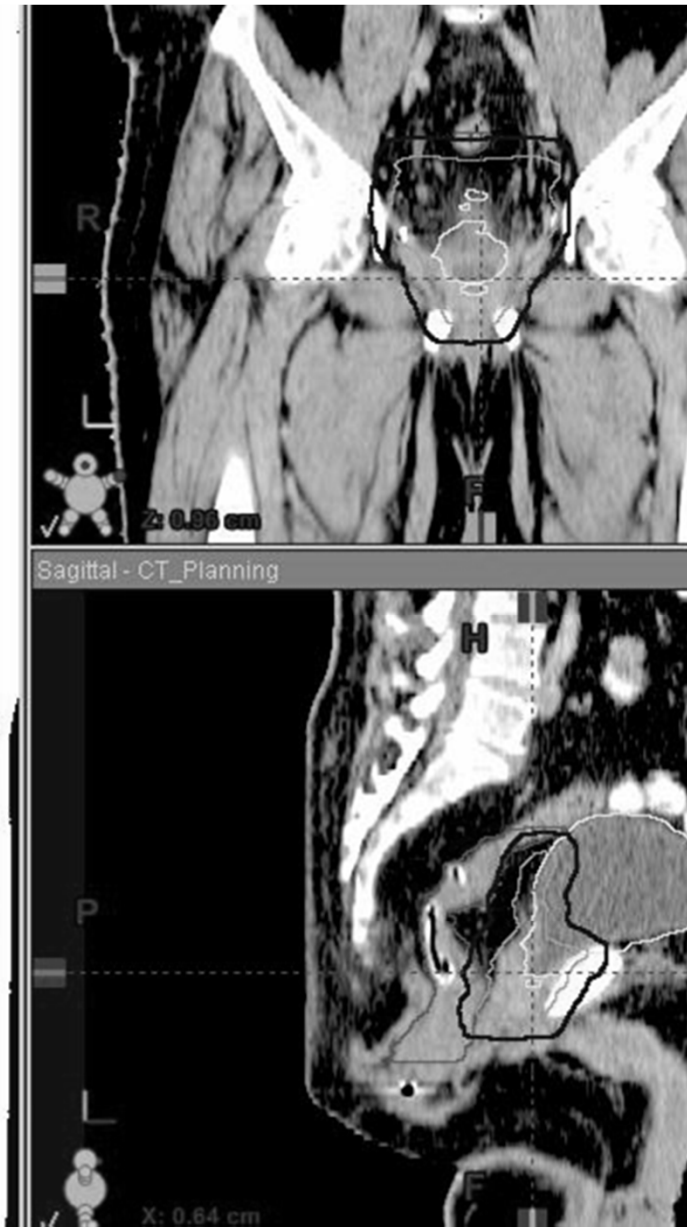
Sagittal View CTV

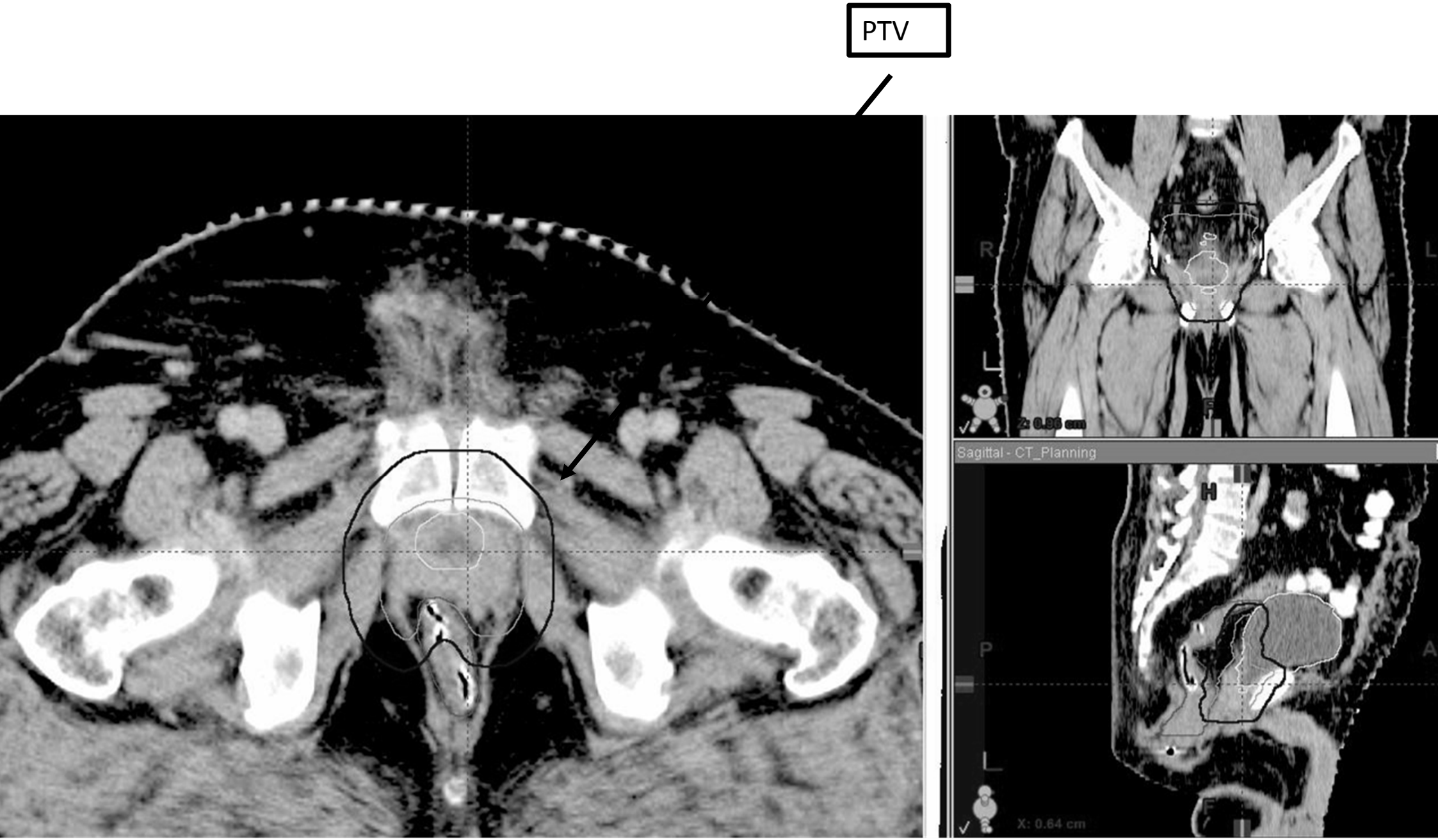

PTV
R
L
F
Sagittal - CT_Planning
H
P
A
L
F
X: 0.64 cm


PTV
R
L
Sagittal - CT_Planning
H
P
A
L
X: 0.64 cm
Model View

PTV






PTV
R
L
Sagittal - CT_Planning
H
P
A
X: 0.64 cm

adiographic and Anatomic basis
r prostate contouring Errors and
ethods to improve accuracy

atrick W McLaughlin, Mary
eng et all

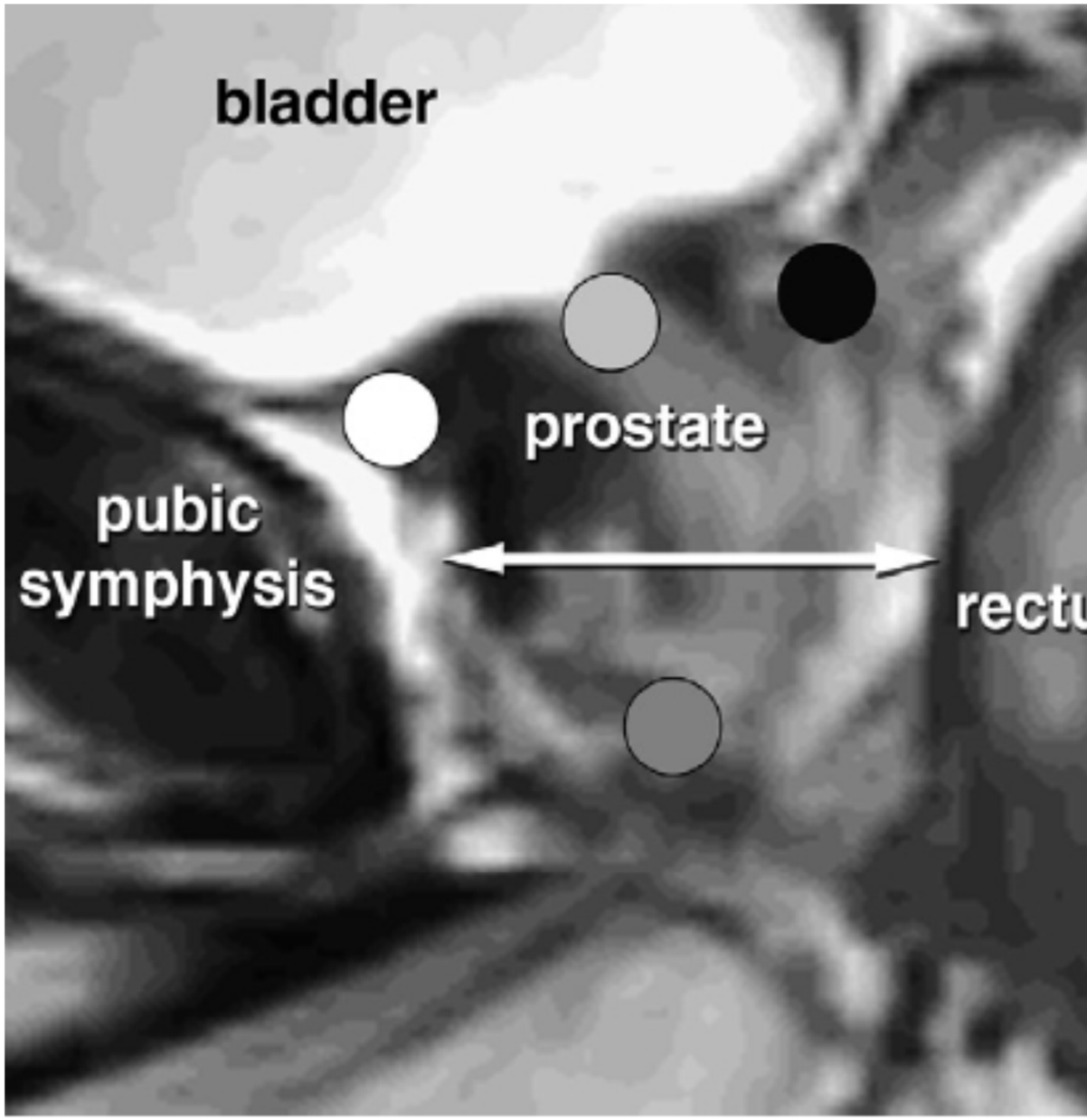


Fig. 1. Regions of contouring errors: white circle = anteric
light gray circle = superior base (bladder neck); black circle
terior base; arrow = mid prostate; dark gray circle = apex.

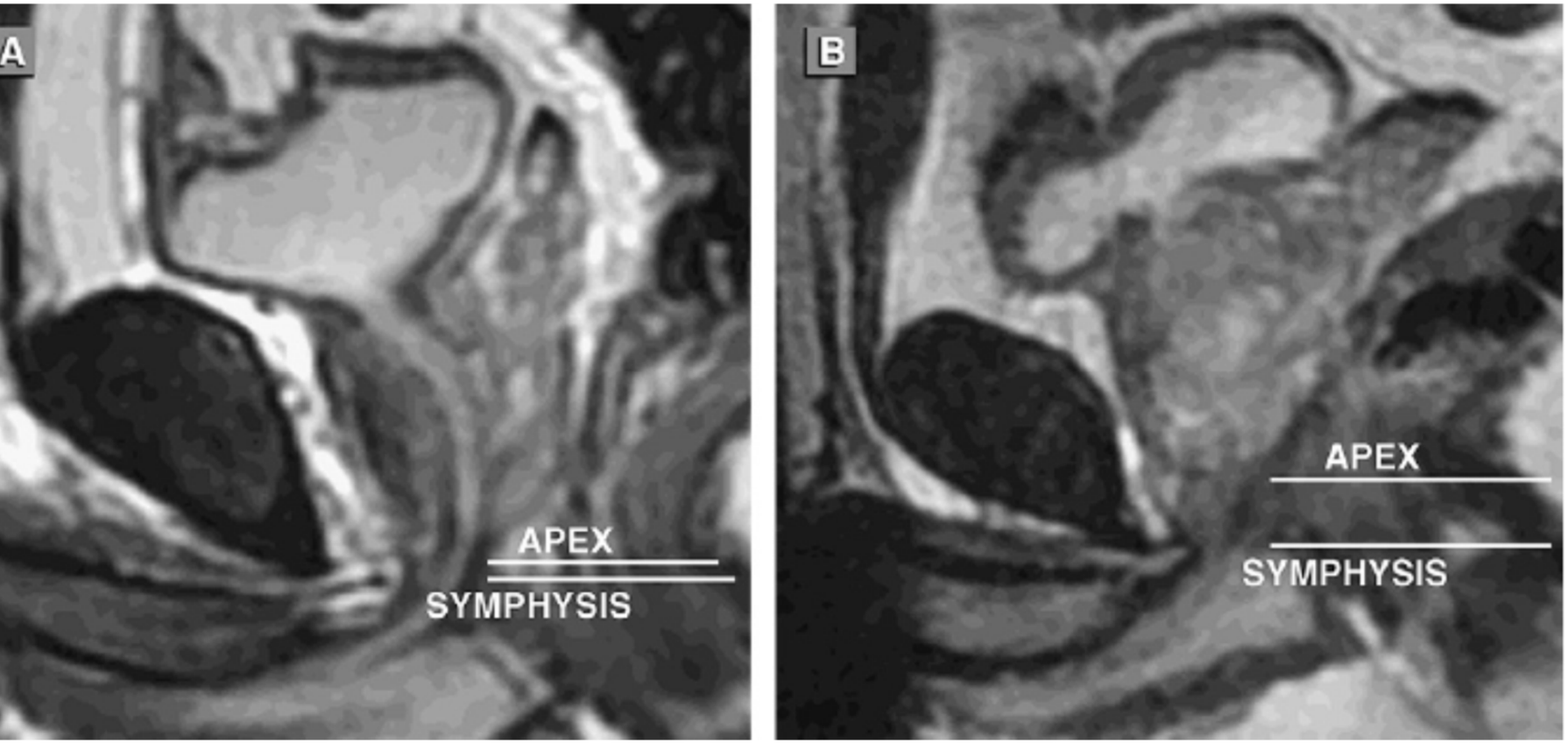
JROBP vol 76 no 2 p369-378, 2010

pex- Overestimation of prostate at apex due to

. Minimal radiographic difference b/w anatomy of prostate and ms on CT

Circular elements within GUD can be mistaken as prostate

variation In anatomy- especially when bony landmarks are used



Suggestions

- Keep an eye on sagittal and coronal view
- Take opinion of other colleague (peer review)
- Take help of a radiology colleague
- Use MRI

OARS

Comparison of different contouring definitions of the rectum as organ at risk (OAR) and dose–volume parameters predicting rectal inflammation in radiotherapy of prostate cancer: which definition to use?

[1,2]MIRKO NITSCHE, MD, [3]WERNER BRANNATH, PhD, [3]MATTHIAS BRÜCKNER, PhD, [1]DIRK WAGNER, [4,5]ALEXANDER KALTENBORN, MD, [1]NILS TEMME, Msc and [1,6]ROBERT M HERMANN, MD

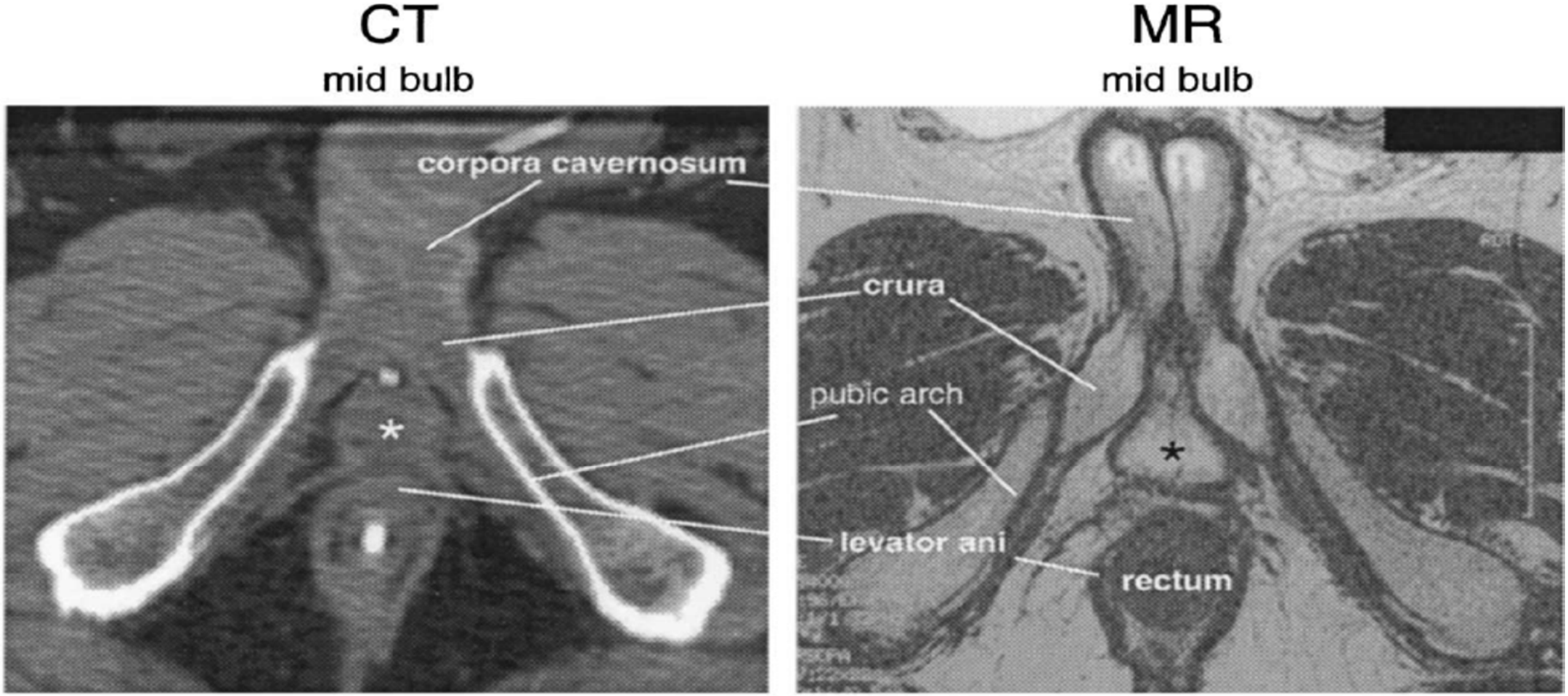
Table 1. The rectum an as organ at risk. 13 different definitions of contouring the rectum were available from the current literature

Definition name	Caudal limit	Cranial limit	Citation
R1	Lowest slice of ischial tuberosity including the anus	One slice below the layer in which the rectum gives up its round shape and the sigmoid anteriorly connects	de Crevoisier et al[13]
R2	Lowest slice of ischial tuberosity	For a length of 15 cm or to the point where the rectosigmoid flexure could be identified	Michalski et al[14]
R3	Lowest slice of ischial tuberosity	Inferior border of the sacroiliac joints or when the rectum anteriorly leaves the sacrum	Rasch et al[15]
R4	Lowest slice of ischial tuberosity	11 cm above	Kuban et al[16]
R5	2 cm below the ischial tuberosity	11 cm above	Huang et al[17]
R6	Anal verge	The slice in which the rectum gives up its round shape and connects to the anterior sigmoid	Cozzarini et al;[1] Thor et al;[18] Fonteyne et al[19]
R7	One slice above the anal verge	The slice in which the rectum gives up its round shape and connects to the anterior sigmoid	Valdagni et al[2]
R8	One slice above the anal verge	One slice below the rectosigmoid flexure	Vavassori et al;[20] Foppiano et al[21]
R9 "RTOG"	Lowest level of ischial tuberosity	Before the rectum loses its round shape (when the rectum leaves the sacrum anteriorly)	Vargas et al;[3] Gay et al[22]
R10 "PTV-based"	Most inferior CT slice of the PTV	Most superior CT slice of the PTV	Onal et al[10]
R11 "PTV-linked"	1 cm below the most inferior CT slice of the PTV	1 cm above the most superior CT slice of the PTV	Guckenberger et al[23]
R12	2 cm below the most inferior CT slice the PTV	2 cm above the most superior CT slice of the PTV	Liu et al[11]
R13	3 cm below the most inferior CT slice the PTV	3 cm above the most superior CT slice of the PTV	In-house definition

Follow one guideline consistently or 1cm
Cranial and caudal to PTV

PENILE BULB IMAGING

KENT E. WALLNER, M.D.,*† GREGORY S. MERRICK, M.D.,‡§ MARK L. BENSON, M.D.,‖
WAYNE M. BUTLER, PH.D.,‡ JEFFREY MAKI, M.D.,¶ AND BRYAN G. TOLLENAAR, M.S.‡



Int. J. Radiation Oncology Biol. Phys., Vol. 53, No. 4, pp. 928–933,

Anatomy-Body of penis consists of paired corpora cavernosa and the middle spongiosum

Followed posteriorly, into perineum, the two corpora cavernosa separate and form crura of penis, attached to inferior pubic ramus

Between the crura, corpora spongiosum enlarges to form bulb of penis, which is attached superiorly to inferior surface of diaphragm

Radiology- Best identified on T2 weighted MR images in axial, sagittal and coronal planes

Top of bulb is typically located 10 mm inferior to apex of prostate

GUD is b/w apex of prostate and top of penile bulb


R
L
F
Sagittal - CT_PLAN
H
P
A
L
F
X: 0.58 cm
Model View

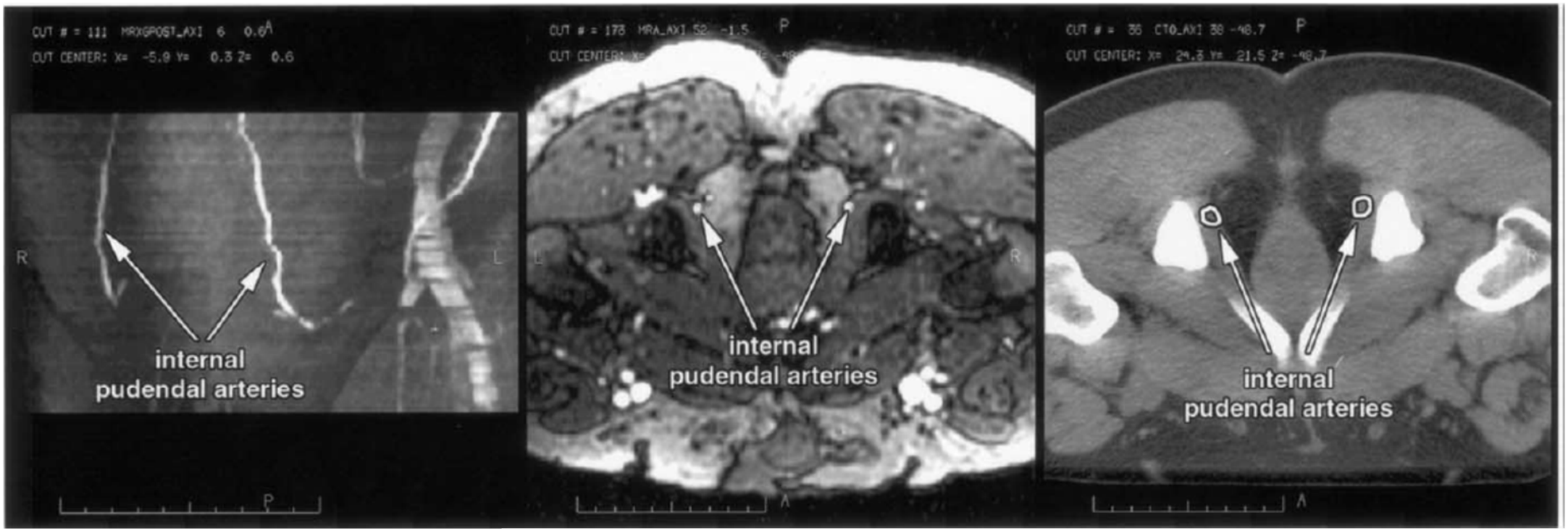

R


R
L
F
Sagittal - CT_PLAN
H
P
L
F
X: 0.58 cm
Model View


R
L
L
F
Sagittal - CT_PLAN
H
P
A
L
F
X: 0.58 cm
Model View
H
R

Vessel sparing RT to decrease ED

- Some evidence that ED after prostate RT has vascular etiology
- Corpora cavernosa (CC) and internal pudendal A (IPA) are critical structures related to ED
- Most accurate on MR Angiogram



Int. J. Radiation Oncology Biol. Phys., Vol. 61, No. 1, pp. 20–31,

THANK YOU

Acknowledgement- Dr Arun Verma