Contouring Guidelines for Prostate Cancers

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RADIOTHERAPY & ONCOLOGY

Three-dimensional treatment planning and conformal radiation therapy: preliminary evaluation ☆

Carlos A. Perez*, James A. Purdy, William Harms, Russell Gerber, Mary V. Graham, John W. Matthews, Walter Bosch, Robert Drzymala, Bahman Emami, Seymour Fox, Eric Klein, Henry K. Lee, Jeff M. Michalski, Joseph R. Simpson

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Abstract

Preliminary clinical results are presented for 209 patients with cancer who had treatment planned on our three-dimensional radiation treatment planning (3-D RTP) system and were treated with external beam conformal radiation therapy. Average times (min) for CT volumetric simulation were: 74 without or 84 with contrast material; 36 for contouring of tumor/target volume and 44 for normal anatomy; 78 for treatment planning; 53 for plan evaluation/optimization; and 58 for verification simulation. Average time of daily treatment sessions with 3-D conformal therapy or standard techniques was comparable for brain, head and neck, thoracic, and hepatobiliary tumors (11.8–14 min and 11.5–12.1, respectively). For prostate cancer patients treated with 3-D conformal technique and Cerrobend blocks, mean treatment time was 19 min; with multileaf collimation it was 14 min and with bilateral arc rotation, 9.8 min. Acute toxicity was comparable to or lower than with standard techniques. Sophisticated 3-D RTP and conformal irradiation can be performed in a significant number of patients at a reasonable cost. Further efforts, including dose-escalation studies, are necessary to develop more versatile and efficient 3-D RTP systems and to enhance the cost benefit of this technology in treatment of patients with cancer.

Keywords: 3-D treatment planning; 3-D CT simulation; Radiation therapy planning; Conformal irradiation

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● *Technical Innovation and Notes*

VOLUMETRIC VISUALIZATION OF ANATOMY FOR TREATMENT PLANNING

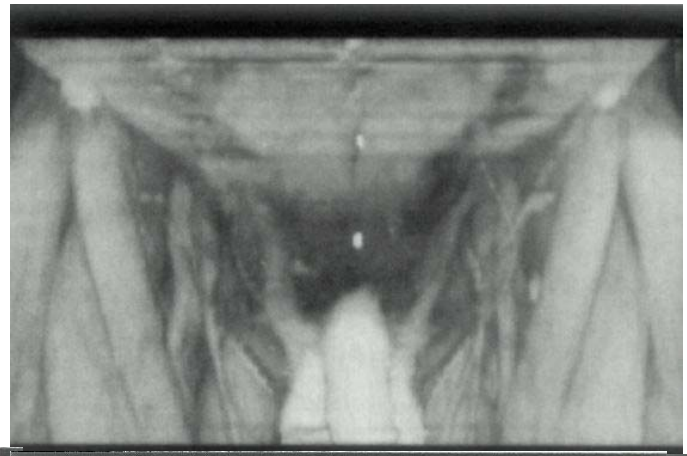
CHARLES A. PELIZZARI, PH.D.,* ROBERT GRZESZCZUK, PH.D.,† GEORGE T. Y. CHEN, PH.D.,*
RUTH HEIMANN, M.D.,* DANIEL J. HARAF, M.D.,* SRINIVASAN VIJAYAKUMAR, M.D.*

Dreblin 1988:

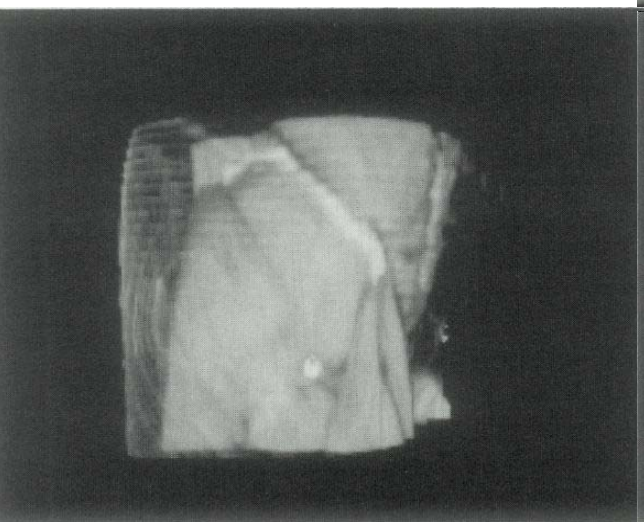
Volume rendering CT

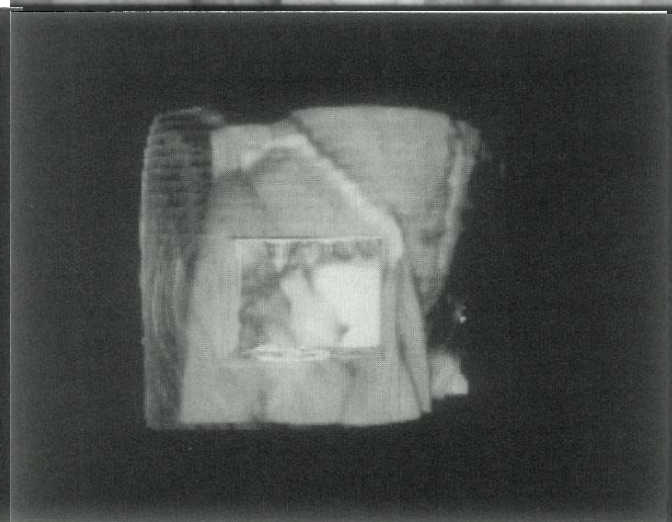
Levoy 1988:

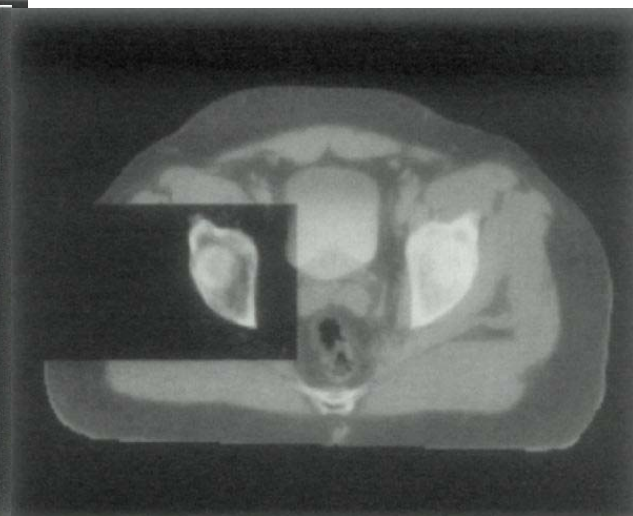
Surface volume data



- **3D CRT**
- **DVH**
- **TCP**
- **NTCP**







PROSTATE

- **Prostate cancer :**

  - Localised Disease : Risk grouping

  - Locally Advance Disease (T3+ / N+)

  - Metastatic Disease

- **Metastatic Disease : HT + RT + Bisphosphonates**
- **Locally Advance Disease : HT + RT (Prostate +Nodes)**
- **Localised Disease : Risk Grouping and Treatment**

Surgery
bDFS 5 year: 80-95%,
10 Year: 75-85%
Incontinence: 10-15%
Impotence: 80-90%

Low risk disease:
(T1, T2a, Gleason 6, PSA ≤ 10)

Surveillence
Willing for close FU
Life expectancy <10 years
Non anxious
<50% of cores involved
Willing for curative Rx on progression

NAAD + External Radiotherapy
bDFS 5 year: 80-90%, 10 Year: 70-80%
Incontinence: 2-5%,
Impotence: 40-60%
Bladder: 5 % (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)

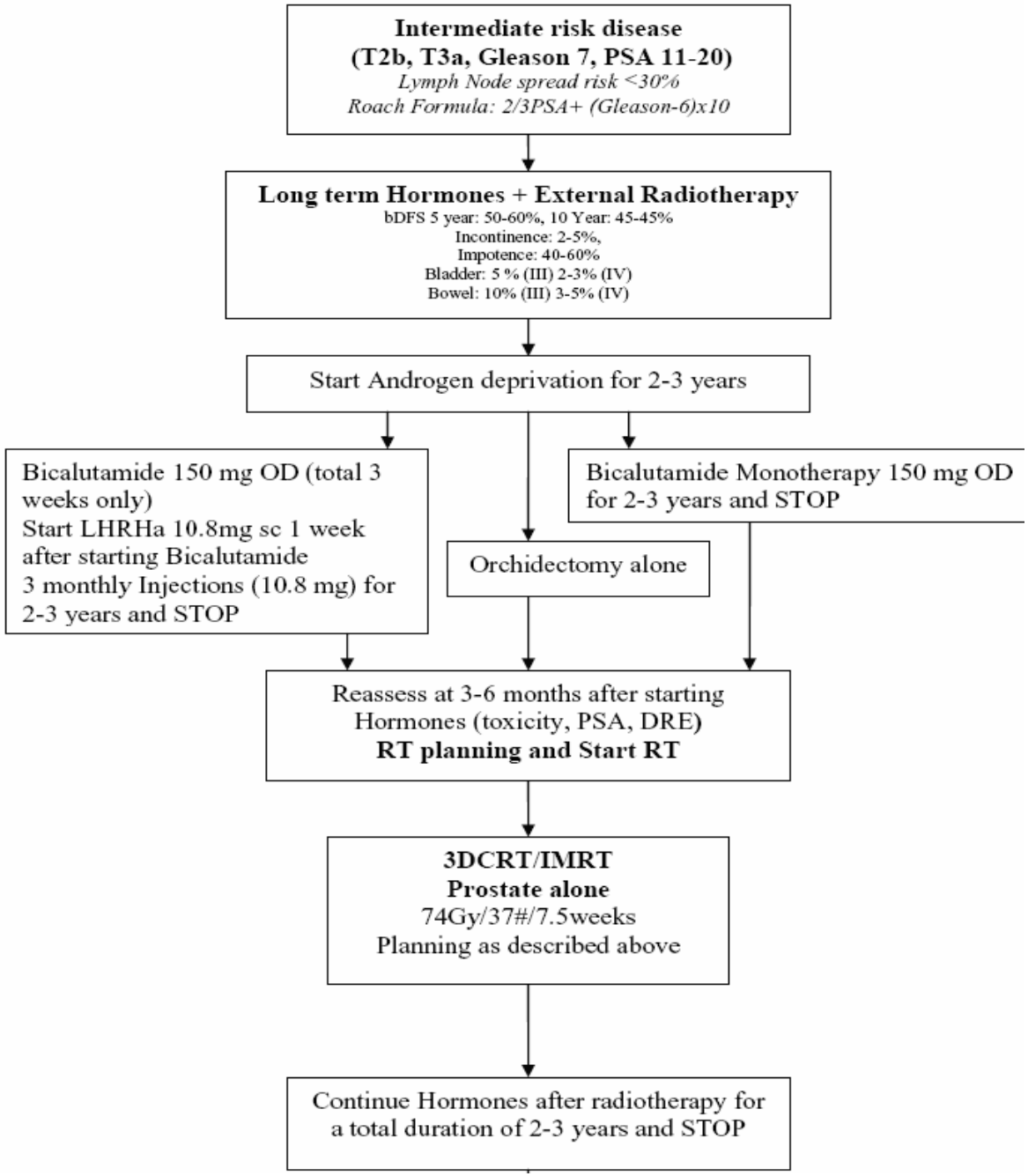
Bicalutamide 150 mg OD (total 3 weeks only)
Start LHRHa 3.6 mg sc 1 week after starting Bicalutamide.
Then monthly Injections (3.6mg x 6 & STOP)

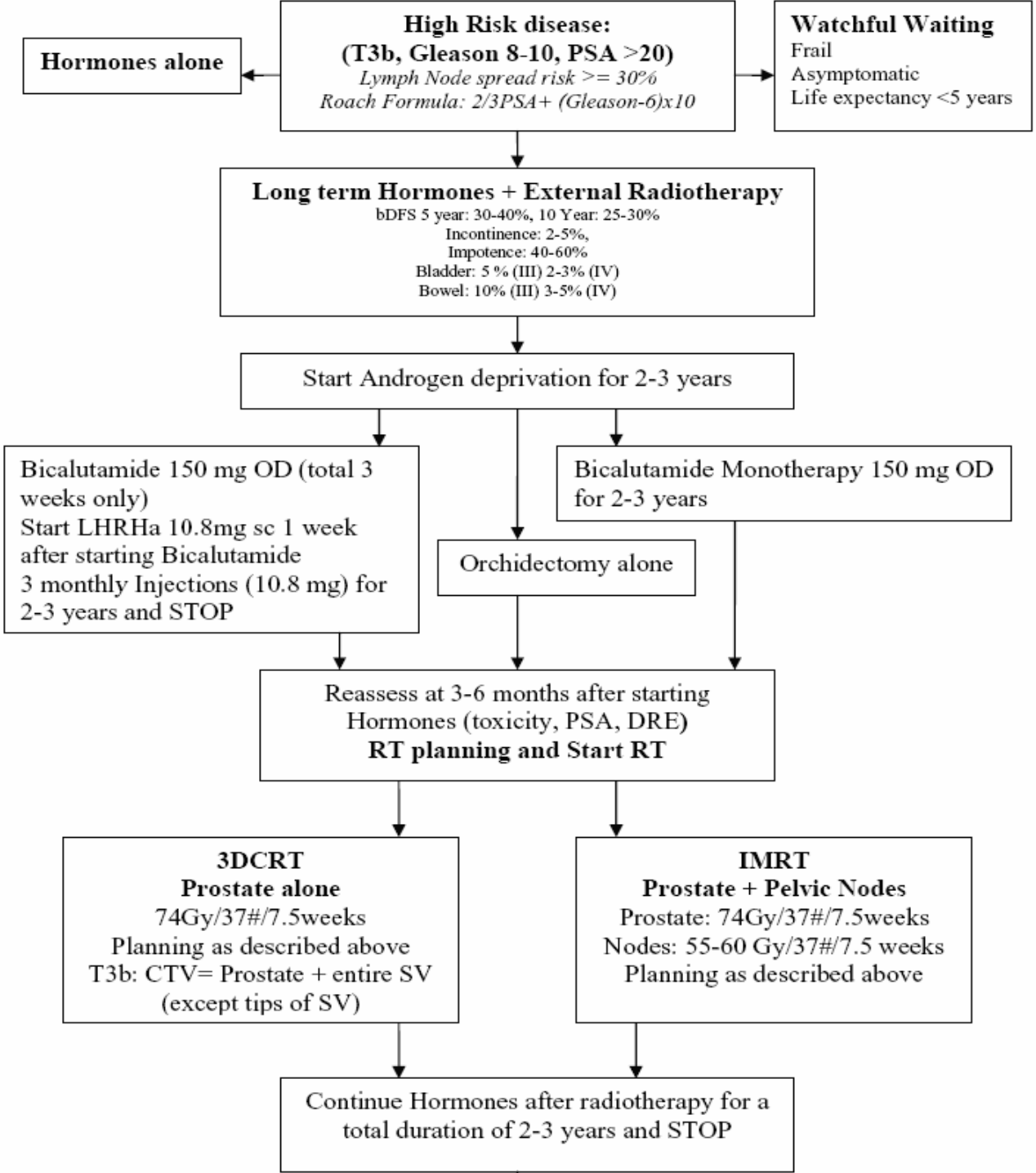
Bicalutamide Monotherapy 150 mg OD for 6 months and STOP

Orchidectomy NOT recommended

Radiotherapy Planning/Treatment
(6-8 weeks after NAAD starts)
3DCRT/ IMRT
Prostate alone

Instructions: 2 Tbsp Milk of Mag. HS before CT Simulator x 2 days
Void Urine then drink 500 ml Water starting 45 min before the Planning scan
Tattoo: Suprapubis + 2 laterals
CT Simulator : Supine, Hands on Chest, No Orfit, Knee rest
3mm slice thickness, from L4-5 to 3 cm below ischial tuberosity
CTV: Prostate + Base (Medial 0.5 cm, postreiorly) of SV
PTV: 0.8-1 cm all around
Dose 74Gy/37#/7.5 weeks
Portal Imaging/IGRT: Day 1, 2, 3, correct as required then weekly once


Intermediate risk disease
(T2b, T3a, Gleason 7, PSA 11-20)
Lymph Node spread risk <30%
Roach Formula: 2/3PSA+ (Gleason-6)x10
Long term Hormones + External Radiotherapy
bDFS 5 year: 50-60%, 10 Year: 45-45%
Incontinence: 2-5%,
Impotence: 40-60%
Bladder: 5 % (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)
Start Androgen deprivation for 2-3 years
Bicalutamide 150 mg OD (total 3 weeks only)
Start LHRHa 10.8mg sc 1 week after starting Bicalutamide
3 monthly Injections (10.8 mg) for 2-3 years and STOP
Orchidectomy alone
Bicalutamide Monotherapy 150 mg OD for 2-3 years and STOP
Reassess at 3-6 months after starting Hormones (toxicity, PSA, DRE)
RT planning and Start RT
3DCRT/IMRT
Prostate alone
74Gy/37#/7.5weeks
Planning as described above
Continue Hormones after radiotherapy for a total duration of 2-3 years and STOP

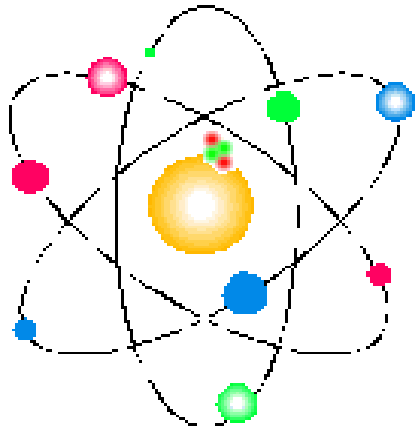

High Risk disease:
(T3b, Gleason 8-10, PSA >20)
Lymph Node spread risk >= 30%
Roach Formula: 2/3PSA+ (Gleason-6)x10
Hormones alone
Watchful Waiting
Frail
Asymptomatic
Life expectancy <5 years
Long term Hormones + External Radiotherapy
bDFS 5 year: 30-40%, 10 Year: 25-30%
Incontinence: 2-5%,
Impotence: 40-60%
Bladder: 5 % (III) 2-3% (IV)
Bowel: 10% (III) 3-5% (IV)
Start Androgen deprivation for 2-3 years
Bicalutamide 150 mg OD (total 3 weeks only)
Start LHRHa 10.8mg sc 1 week after starting Bicalutamide
3 monthly Injections (10.8 mg) for 2-3 years and STOP
Orchidectomy alone
Bicalutamide Monotherapy 150 mg OD for 2-3 years
Reassess at 3-6 months after starting Hormones (toxicity, PSA, DRE)
RT planning and Start RT
3DCRT
Prostate alone
74Gy/37#/7.5weeks
Planning as described above
T3b: CTV= Prostate + entire SV (except tips of SV)
IMRT
Prostate + Pelvic Nodes
Prostate: 74Gy/37#/7.5weeks
Nodes: 55-60 Gy/37#/7.5 weeks
Planning as described above
Continue Hormones after radiotherapy for a total duration of 2-3 years and STOP

Contouring in Prostate Cancers

- **Volumes in defining prostate cancer**

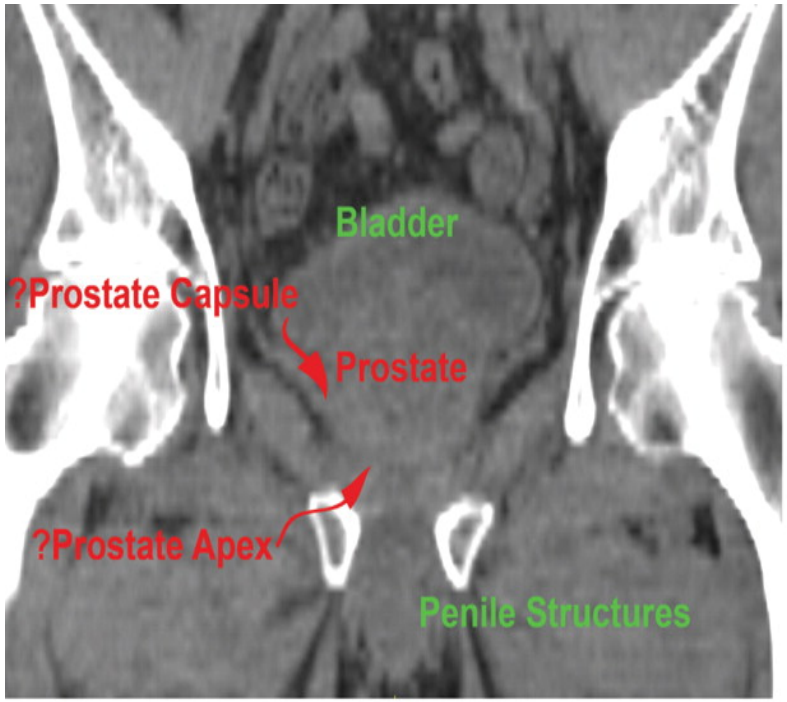
  1. Primary tumor & CTV

  2. Pelvic Lymph Nodes

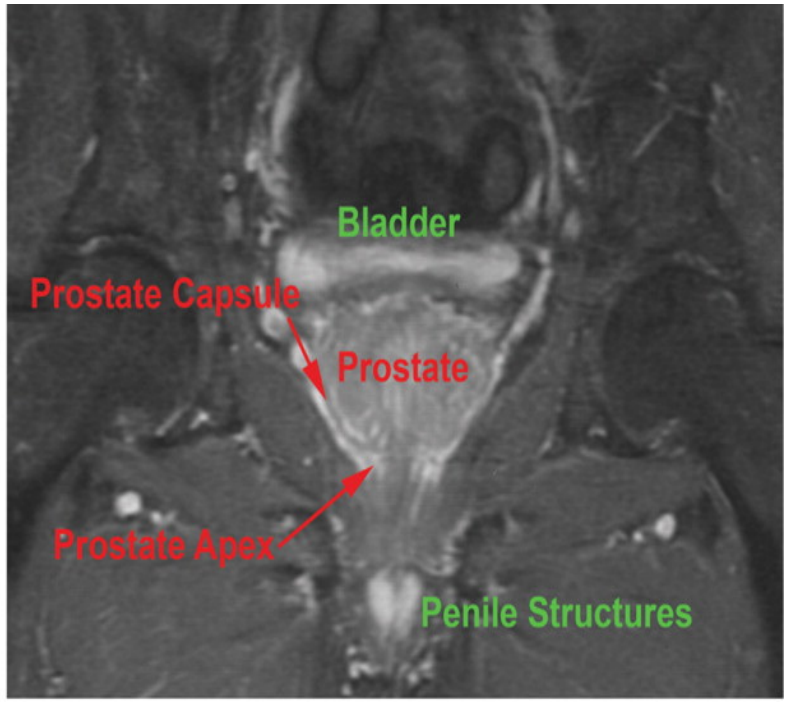


- **GTV contoured only if newer imaging like MR, MRS, etc done**
- **CTV depends on risk stratification**
- **PTV depends on immobilisation accuracy and machine parameters**

CT v/s MR imaging: Differences



(a)



(b)

- **Comparison of coronal views of the pelvis for prostate radiotherapy with (a) CT reconstructed from 2.5 mm slices and (b) MR image obtained in-plane in the same patient.**
- **Definition of the prostate gland boundaries and the adjacent structures is better visualized on MRI than with CT.**

TARGET DELINEATION

No definite consensus guidelines

- $GTV_{prostate}$: Gross tumor (delineated with newer Imaging)
- $CTV_{prostate}$: GTV + Prostate only (low risk)

  : GTV + Prostate + SV (Intermediate / High)
- CTV_{nodes} : $CTV_{Vessels}$ + 7 mm margin
- CTV_{pelvis} : $CTV_{prostate}$ + CTV_{nodes}
- PTV : CTV + Margins

  (Depending on Immobilization Accuracy)

Literature for Prostate Volumes

Summary of target definitions and dose prescriptions for prostate IMRT

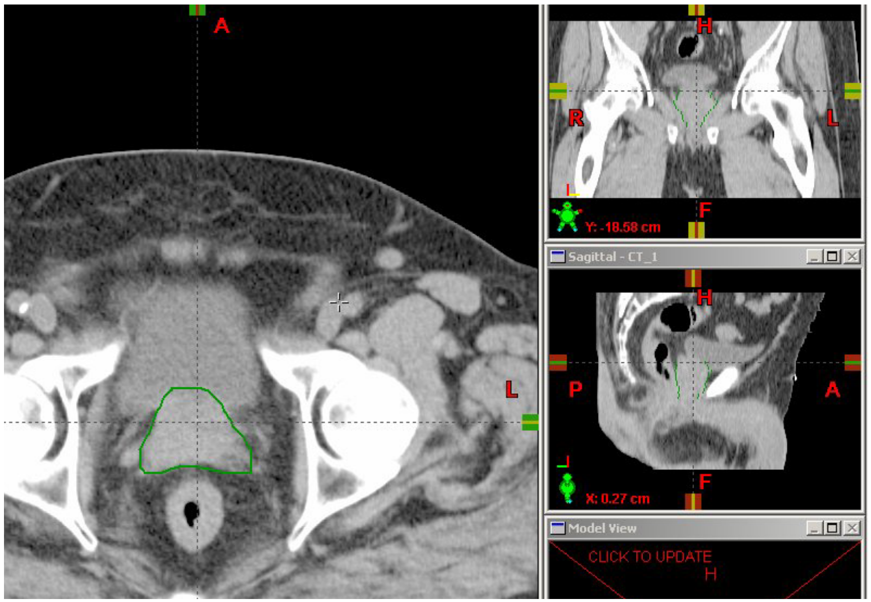
Study	GTV	CTV	PTV	Prescription (TD/FS) in Gy
Zelefsky et al[11]				
81-Gy plan	NS	P + SV	CTV + 1.0 cm UE (0.6 cm posterior)	PTV: 81/1.8 ≥ 90% to receive ≥ 70
86.4-Gy plan	NS	P + SV	CTV + 1.0 cm UE (0.6 cm posterior)	PTV: 86.4/1.8 ≥ 85% to receive ≥ 86.4
Ezzell et al[18]	NS	P + SV	CTV + 1.0 cm UE	75.6/1.8 to ≥ 95% CTV
Jani et al[12]				
Phase I	P + SV	CTV1 = GTV1	PTV1 = CTV1 + 1.0 cm UE	PTV1: 50/2
Phase II	P	CTV2 = GTV2	PTV2 = CTV2 + 1.0 cm UE (0.6 cm posterior)	PTV2: 24/2
Sethi et al[19]	NS	NS	PTV1 = (P + SV) + 1.0 cm UE PTV2 = (P) + 1.0 cm UE	PTV1: 55.8/1.8 PTV2: 18/1.8, 25.2/1.8, or 34.2/1.8*
Teh et al[20] †	NS	Prostatic fossa and periprostatic tissues	CTV + 0.5 cm UE	PTV: 60-66/2 to 86% line

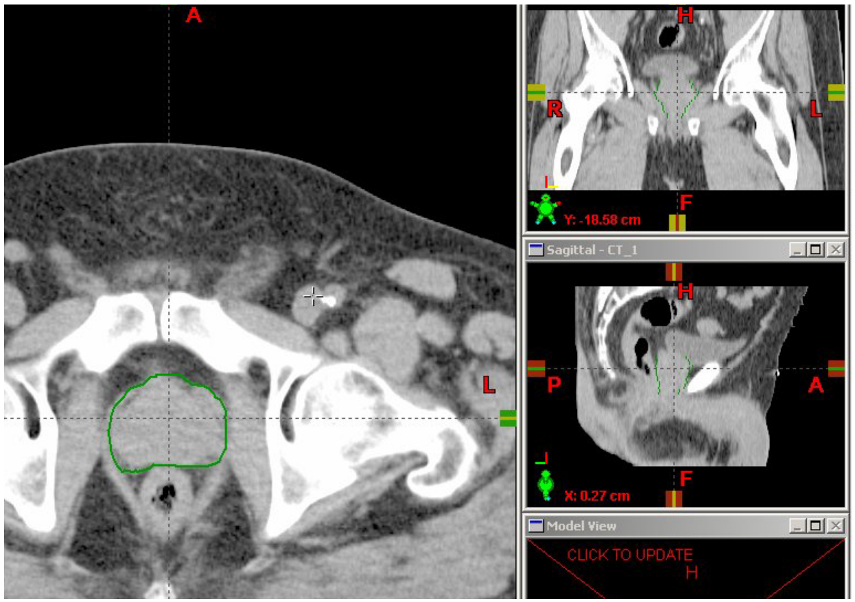
CTV = clinical tumor volume; FS = fraction size; GTV = gross tumor volume; NS = not specified; P = prostate; PTV = planned treatment volume; SV = seminal vesicles; TD = total dose; UE = uniform expansion

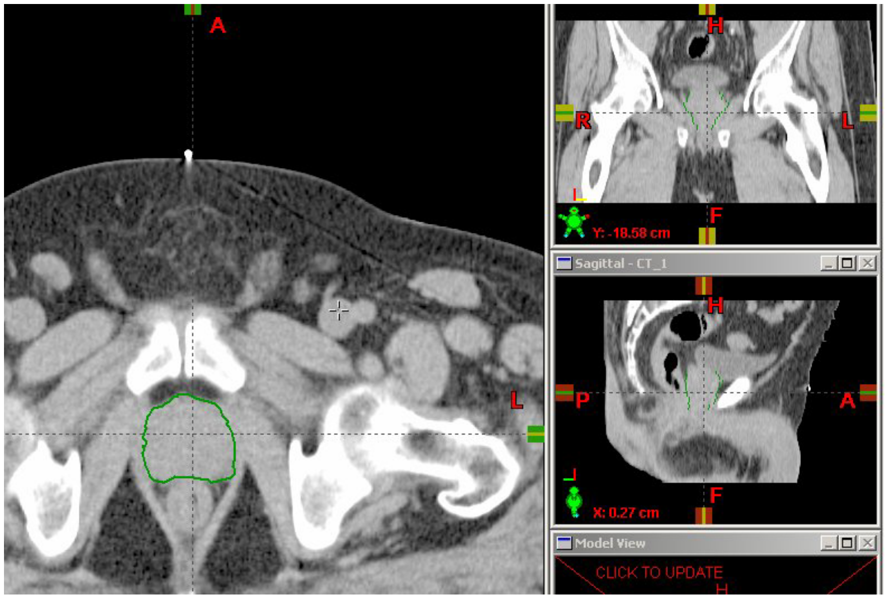
*Dose escalation (total dose, 73.8, 81, or 90 Gy)

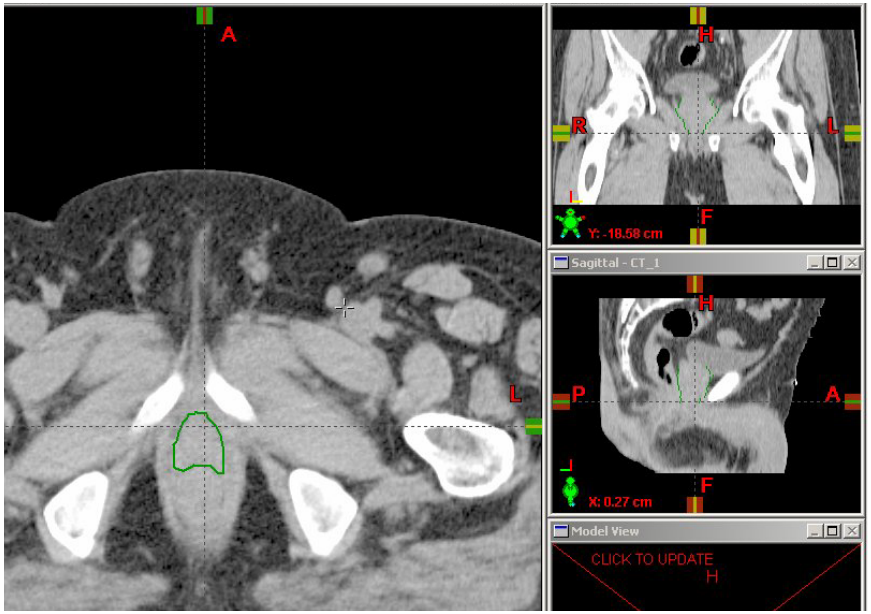
† Subjects were studied postprostatectomy.

CTV_LOW RISK (Prostate ONLY)



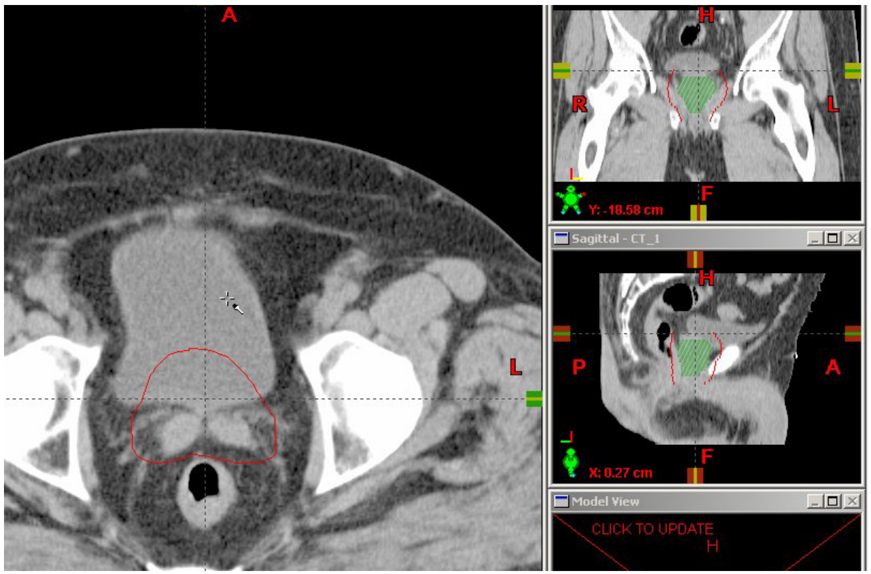


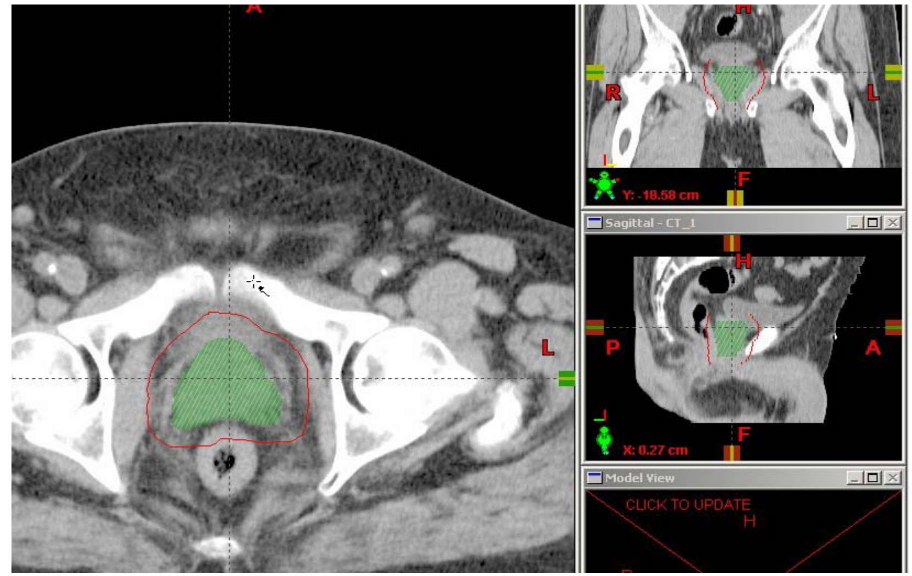


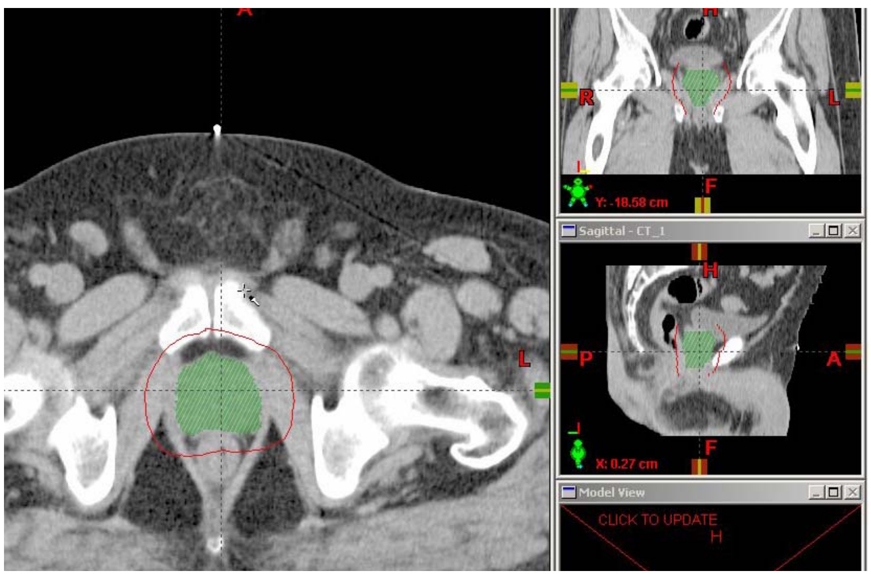


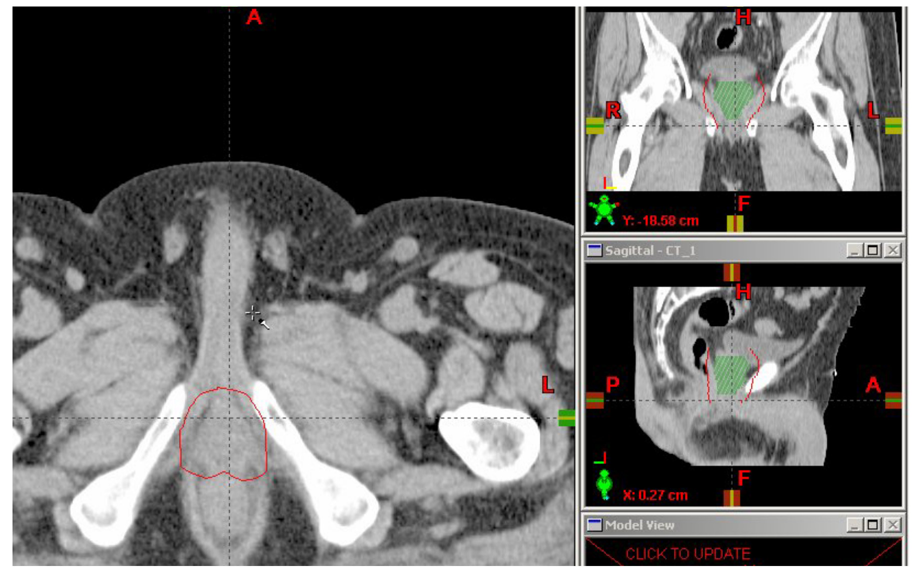
PTV_LOW RISK

CTV +1cm (0.7 cm posterior)





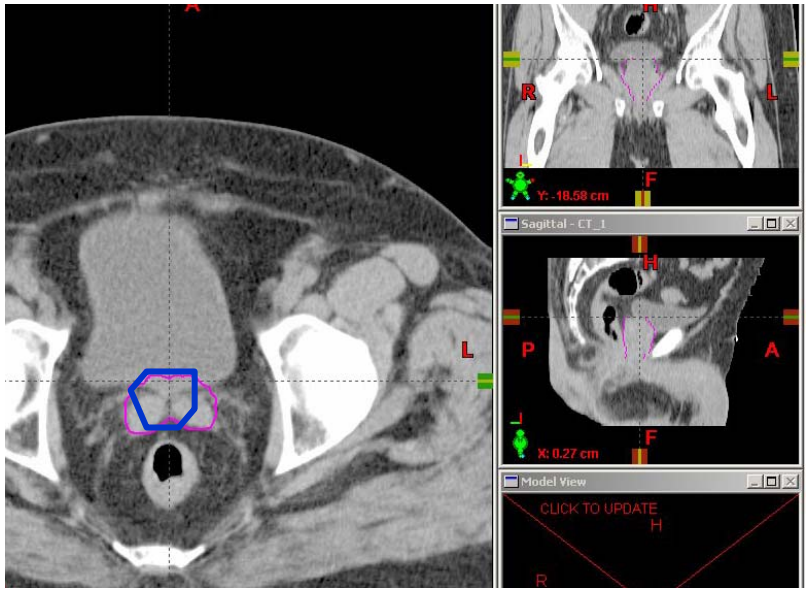


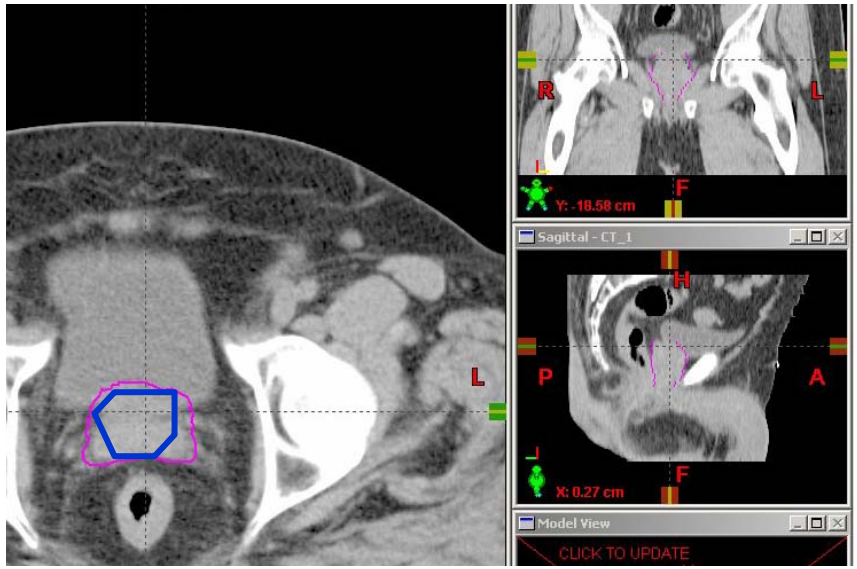


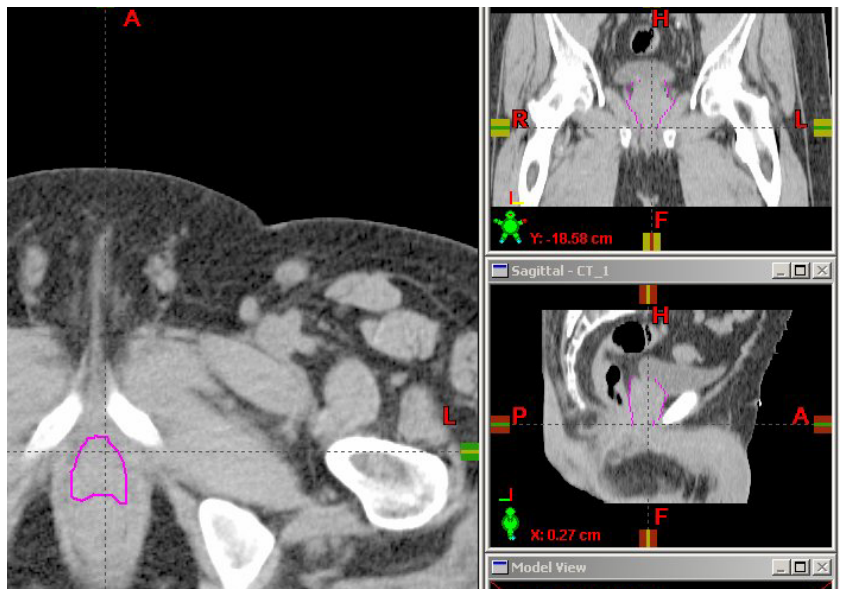
CTV_INTERMEDIATE / HIGH RISK

SV Not involved: Base contoured

SV Involved: Whole SV Contoured

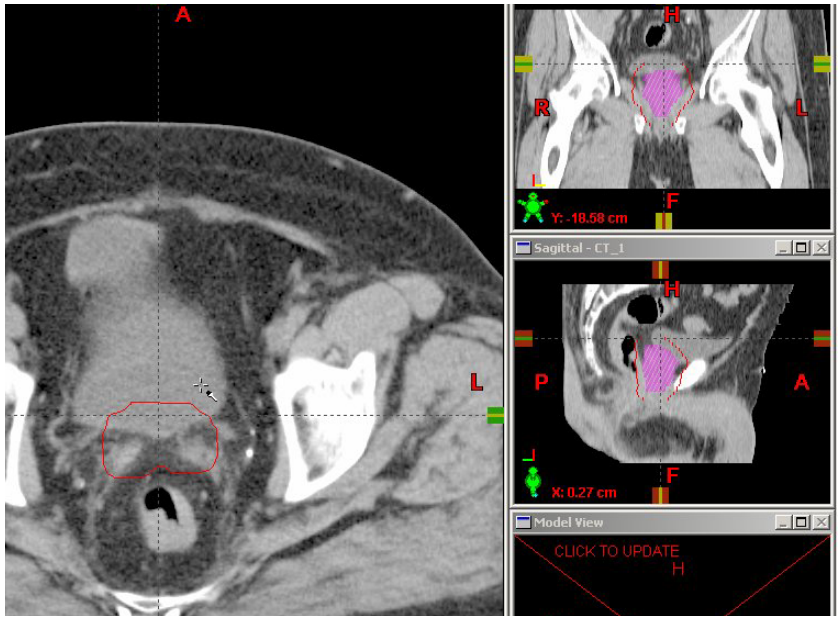


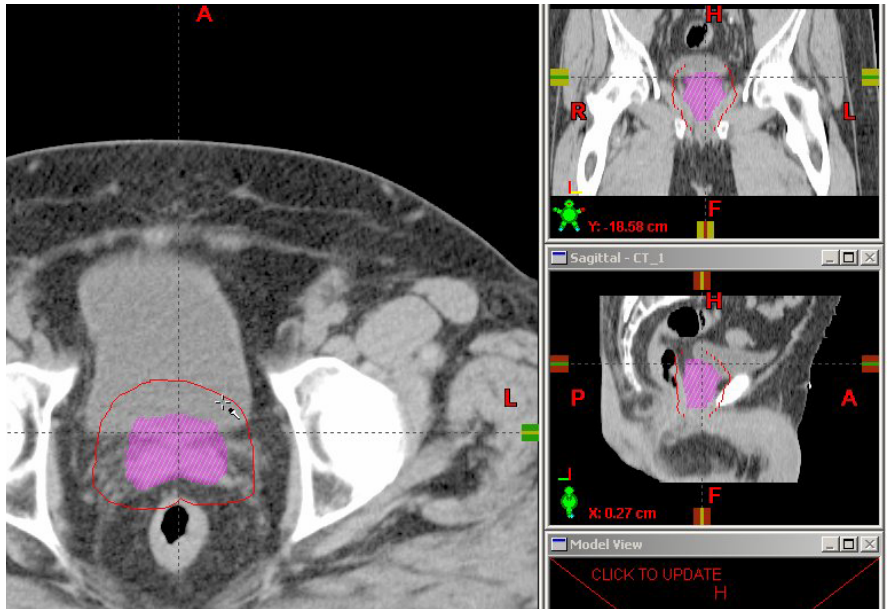


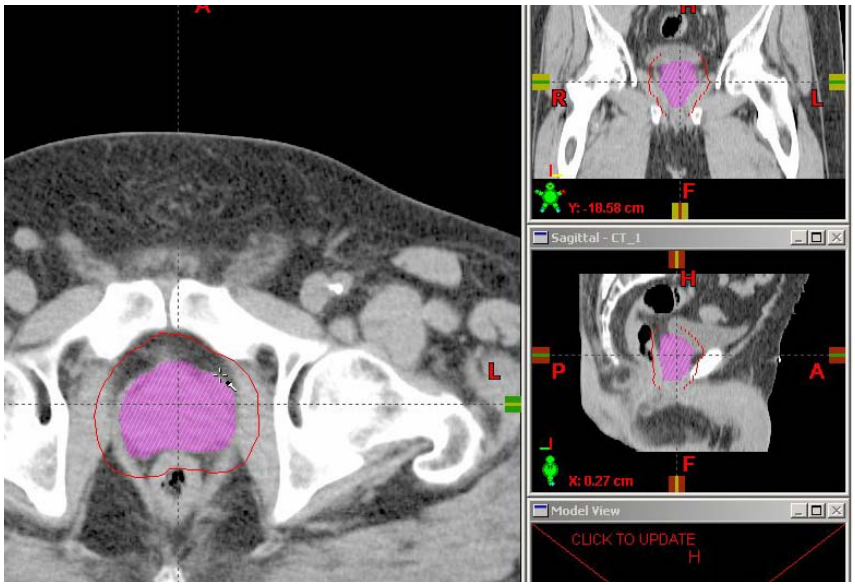


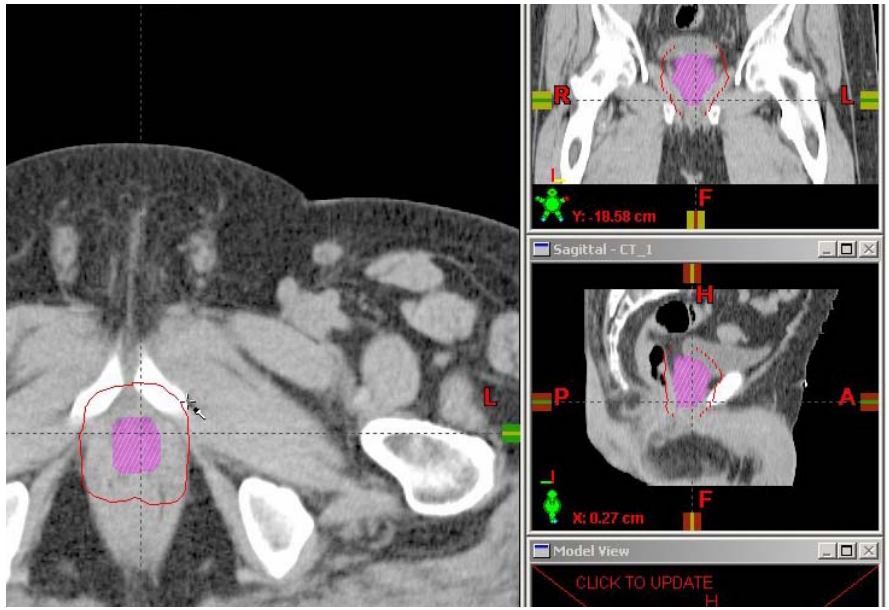
PTV_INTERMEDIATE / HIGH RISK

CTV +1 cm (0.7 cm posterior)









PROSTATE CANCERS AND NODAL DRAINAGE

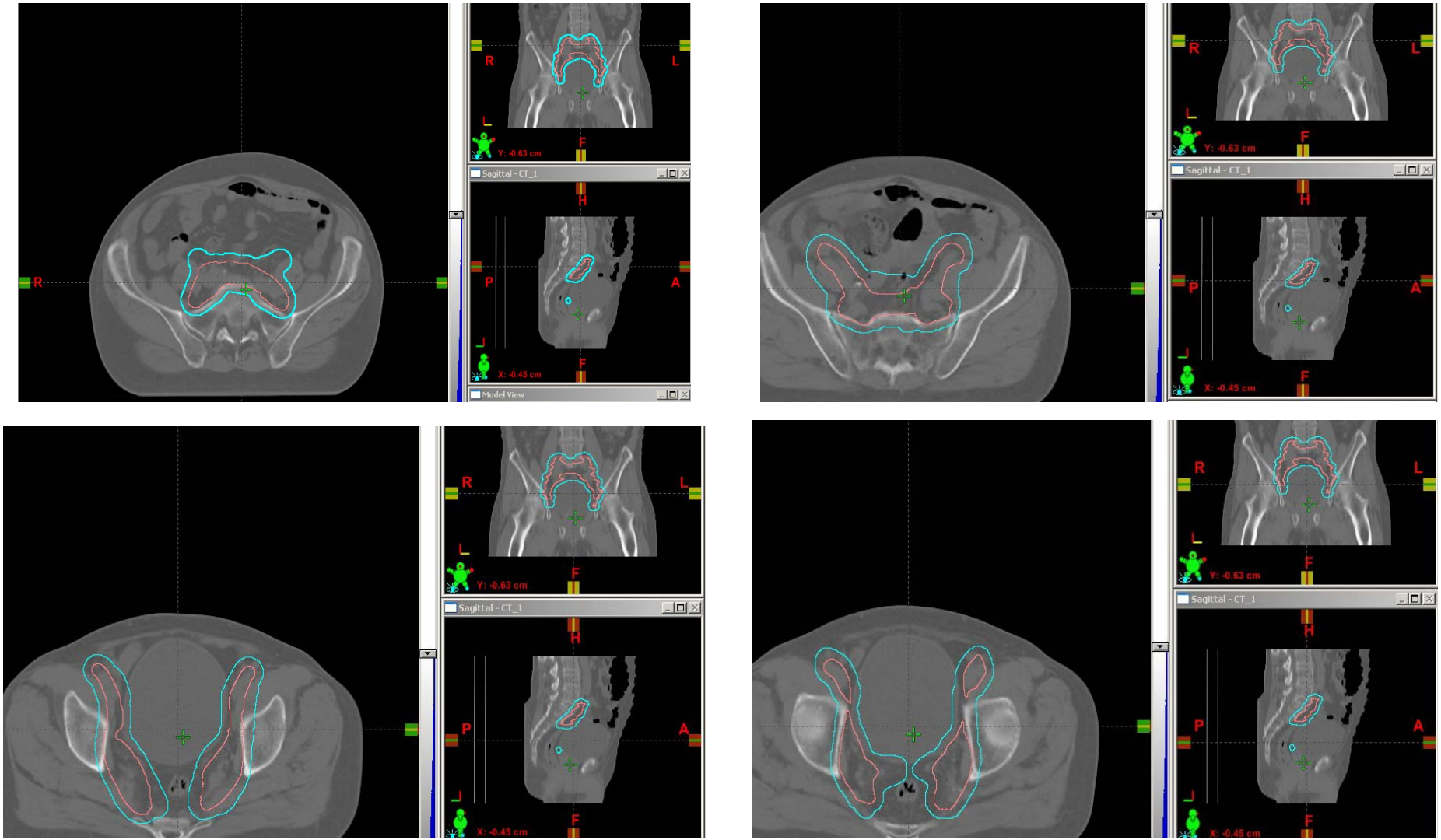
- **Periprostatic and obturator nodes**
- **Internal Iliac**
- **External Iliac**
- **Common Iliac**
- **Presacral**
- **Para-aortic**

Contouring

- **CTV VESSELS**
- **CTV Nodes : CTV Vessels + 7 mm margins**

CTV Nodes: CTV Vessels + 7 mm)

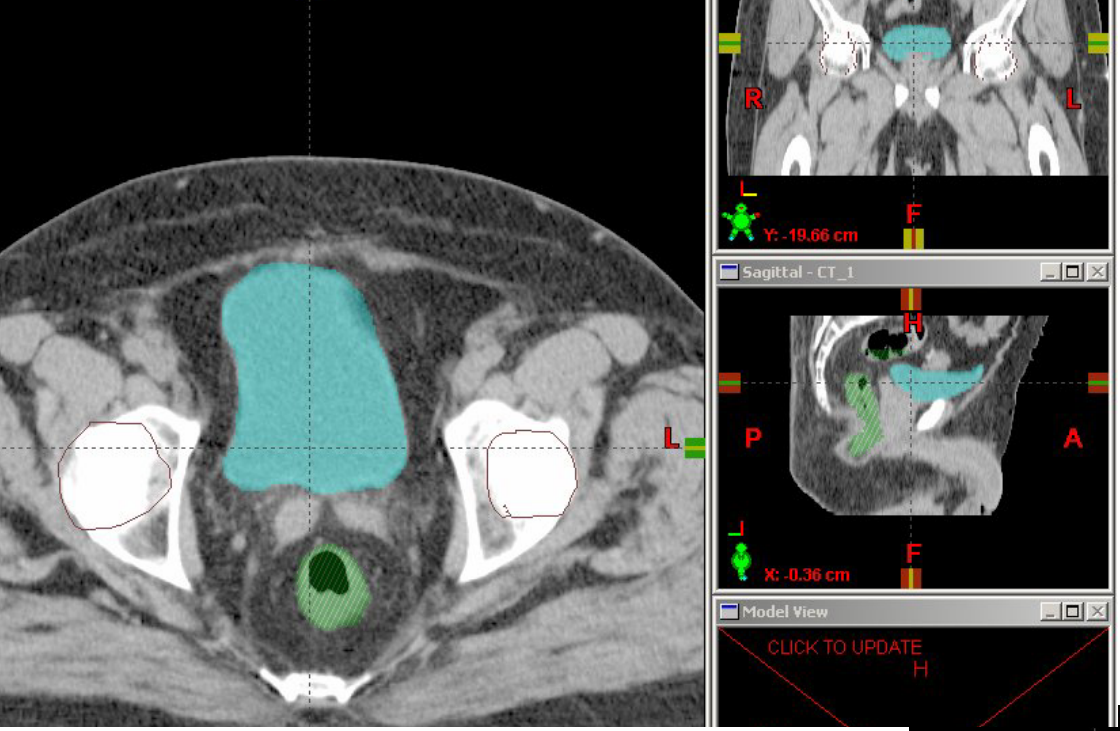
To exclude bones / lateral half of muscles

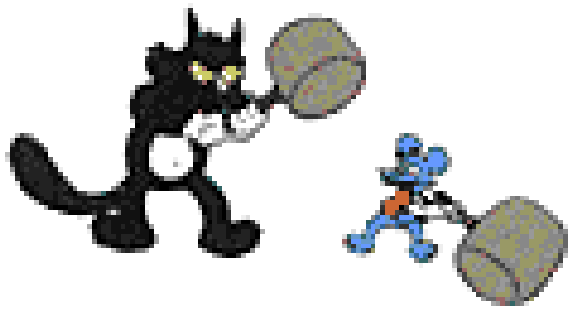


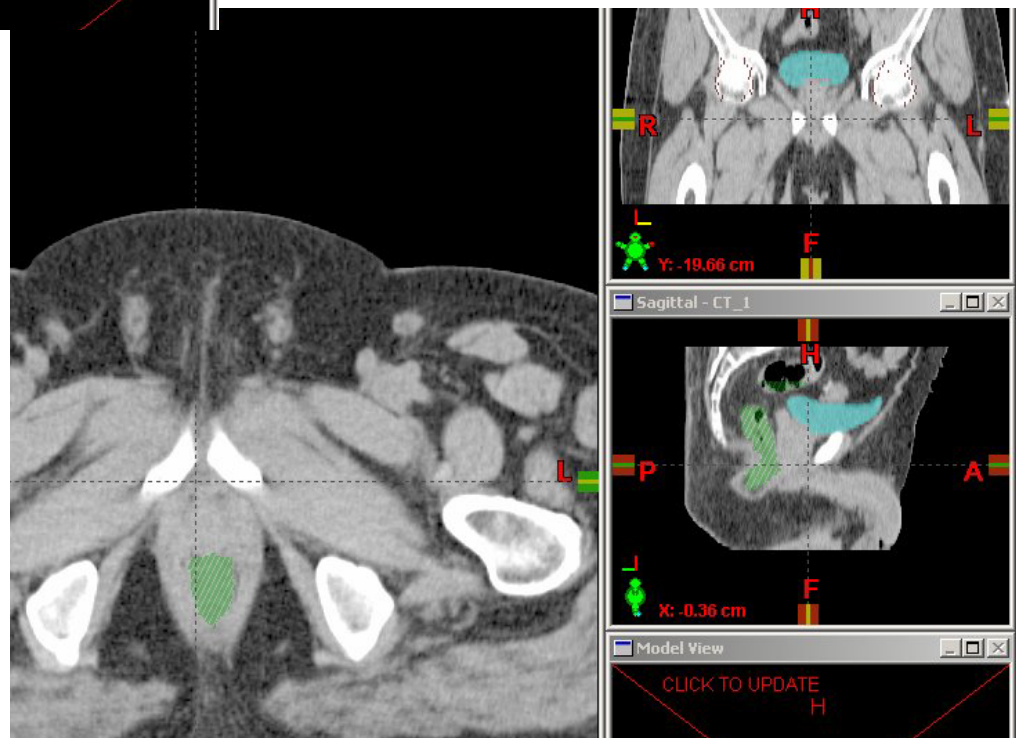
PTV : Margins according to Institutional Protocols (10 + 10 + 7 mm)

OAR

- Rectum
- Bladder
- B/L Femoral heads
- Small Bowel







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CLINICAL INVESTIGATION **Prostate**

VESSEL-SPARING PROSTATE RADIOTHERAPY: DOSE LIMITATION TO CRITICAL ERECTILE VASCULAR STRUCTURES (INTERNAL PUDENDAL ARTERY AND CORPUS CAVERNOSUM) DEFINED BY MRI

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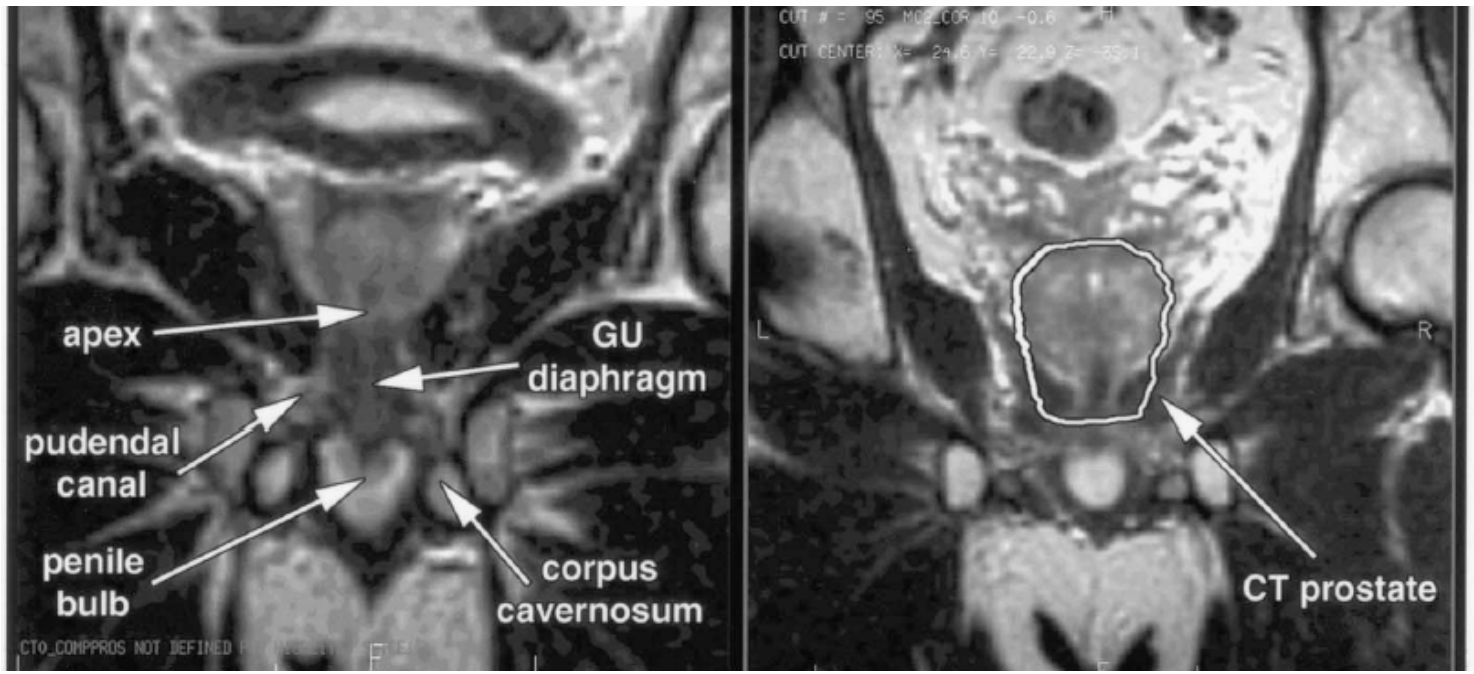

Incorporation of newer imaging can define newer critical structures to reduce morbidity

SUMMARY

- Complete Evaluation, Staging and stratification at Diagnosis: Critical
- Appropriate treatment sequencing and counselling: Essential
- Radiological Anatomy: Mandatory for Radiation Oncologists
- Newer Imaging Modalities: Potential to reduce morbidity of RT
- Various Target volume definition and delineation: Learning Curve
- Consensus guidelines: Not yet established