

Patient Safety Focused QA

LDR Brachytherapy
Vrinda Narayana

LDR Brachytherapy?

- $\dot{D} < 2 \text{ Gy/h}$
 - Old
 - Ra-226; Cs-137; Ir-192
 - Gynecological; interstitial
 - New
 - Pd-103; I-125; Cs-131
 - Prostate implants
 - Carotid plaques
 - Brain tumors

Prostate Brachytherapy

**Pre-implant
planning**

0-3 weeks

Implant

0-4 weeks

Post Evaluation

Volume Study

Pre-implant
planning

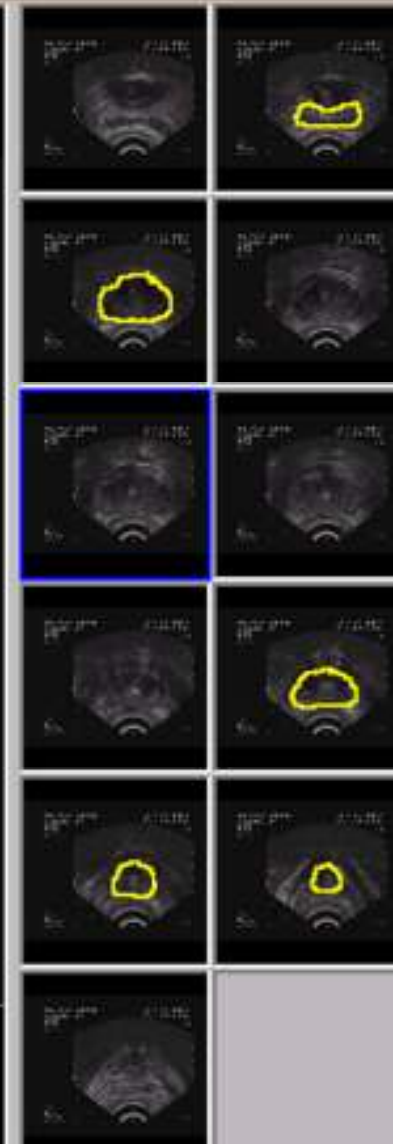
↓
US

Image # 5
Position: 2.00 cm

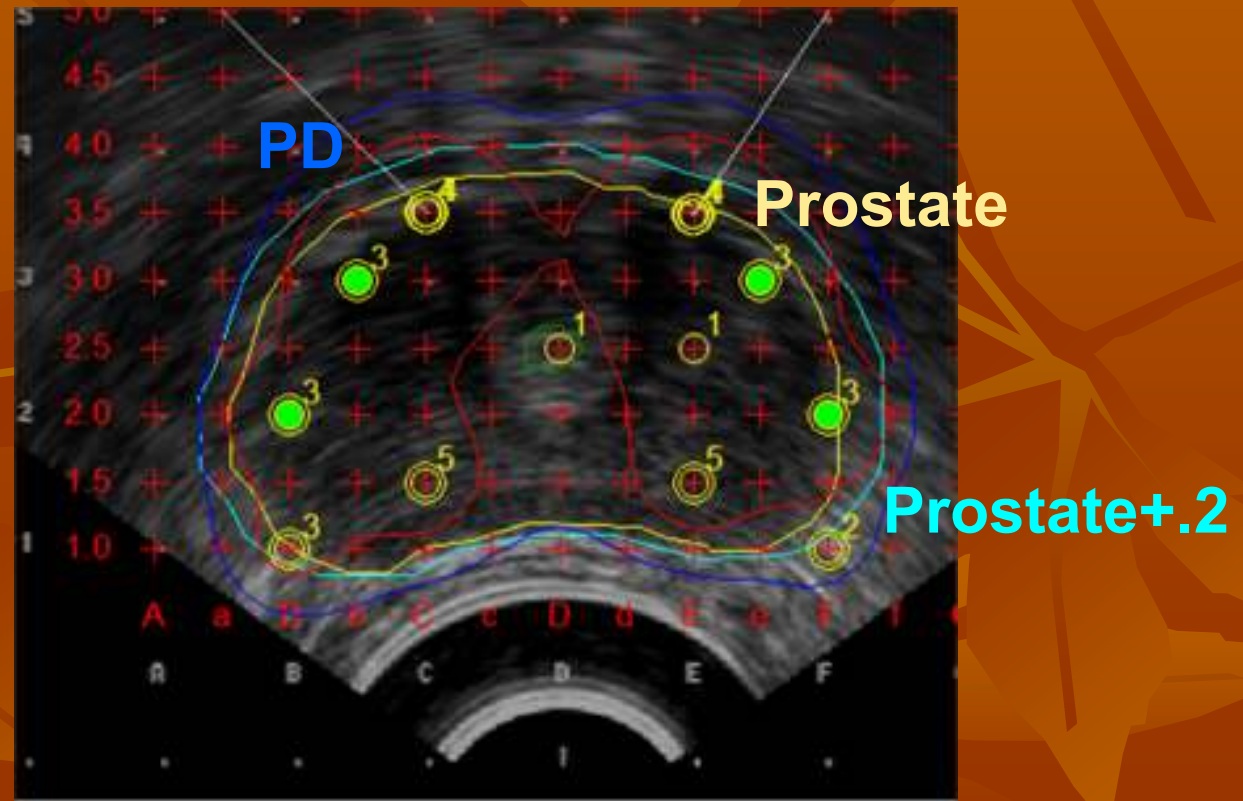
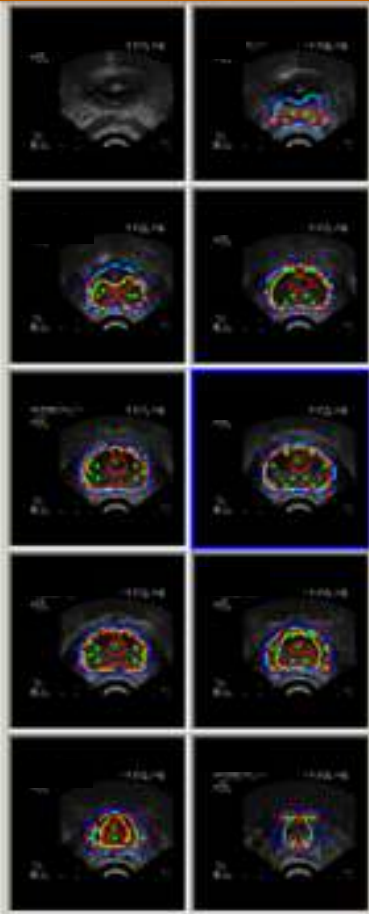
PROVIDENCE HOSPITAL
1
G: 000
FR: 24
MI: 0.7

02-11-02 8558/T
9:19:53 AM 6.5MHz

7.1



■ Variseed - plan



Implant

Pre-implant
planning

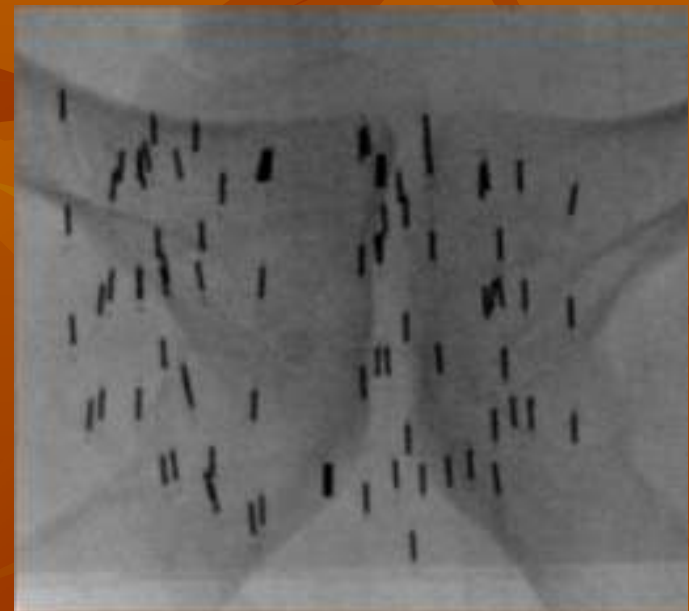
US

0-3 weeks

Implant

US

Fluoro



Post evaluation

Pre-implant
planning

US

0-3 weeks

Implant

US

Fluoro

0-4 weeks

Post Evaluation

US

CT

MR

High quality implant

Patient Safety focus

AAPM Task groups

- TG 56 - 1997
 - Code of practice for brachytherapy
- TG 64 – 1999
 - Permanent prostate seed implant brachytherapy
- TG 128 – 2008
 - QA for prostate brachytherapy US systems
- TG 137 – 2009
 - Dose Prescription and Reporting

High Quality Post Evaluation

- Volume; Time
- Source Strength
- Prostate
 - V_{200} , V_{150} , V_{100} , V_{90}
 - D_{100} , D_{90} , D_{80}
 - $D_{90} \geq PD$?
- Rectal wall
 - D_{2cc}
- Urethra
 - D_{10}

Stock, et. al. 1998

Potters et. al. 2001

VA incident

- 2002 - 2009
 - 92 medical events
 - 57 patients: prostate < 80% of PD
 - 35 patients: rectum >100 Gy (misplaced seeds)
 - No post-implant dosimetry
 - Inadequate supervision of AU
 - No corrective action on poor quality implants

Medical Event

- Wrong dose
 - Prescribed dose difference 20% or greater
 - Dose > 0.05 Sv
 - Dose to tissue > 0.5 Sv to organ, tissue, skin
- Wrong individual
- Wrong isotope
- Leaking source
- Migrated source

Medical events FY 2010

- Implant 2005; reported 2010
 - Seeds too deep in sigmoid colon
 - Underdose prostate
 - Inadequate prostate visualization
 - 7 additional violations on inspection
- Implant (5)
 - 100 % of seeds outside prostate
 - Inadequate visualization of prostate

Medical events FY 2010

- Implant 2005-2007
 - High dose to urethra

Quality Management and Radiation Safety

Imaging QA

Tx Planning system

Checklists

Seed Assay

Tx Plan check

Implant QA

Radiation Survey

**Post-implant
evaluation**

Imaging QA

- US – TG128
 - Precise Volume and Area
 - Needle-Grid Alignment
- C-arm
- CT
- MR

Treatment planning

- Acceptance and Commissioning
- Repeat at upgrades

Treatment Planning checks

- Prescription Dose
- Source strength
- Target expansions
- Needle positions
- Seed positions
- IDL
- Dose Parameters

Seed Assay

- NIST traceable Well Chamber
- 10 % seed assay
 - Within $\pm 3\%$
 - $> \pm 5\%$ contact manufacturer
- Autoradiograph

Checklists

- Wrong individual
 - ID by 2 means
 - Time out
- Wrong Isotope
 - One isotope
 - One source strength (mCi vs U)
- Wrong prescription
 - Primary
 - Boost

- Wrong source strength
- Leaking source
 - Wipe test
 - Gentle handling (Mick applicator jams)

Wrong Dose - Complex

- High gradients

— PD
— 1.2 PD
— 0.8 PD



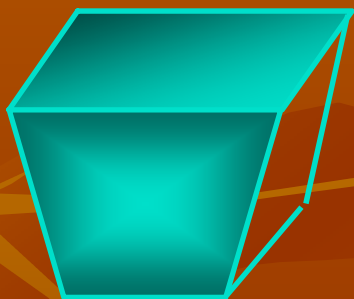
Case Study

- Prescription
 - I 125
 - 100 Gy to the prostate
- CT
 - day of implant
- D90 – 79 Gy
- Is this a Medical Event??

Swelling

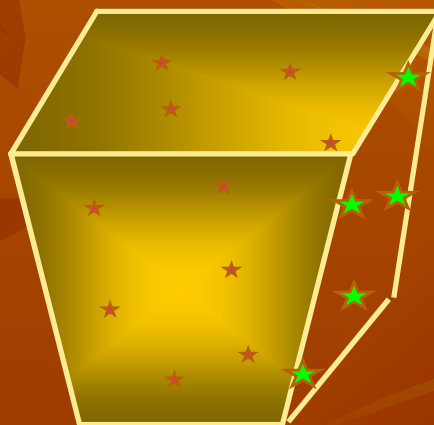
- 1997 Narayana et. Al.
- 1.5 swelling

1



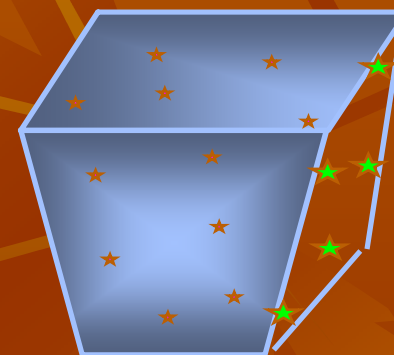
Before implant
CT

1.5



< 24 h CT

1.2



> 1 m CT

Timing of evaluation

- Optimal time
 - 10 ± 2 d Cs-131
 - 16 ± 2 d Pd-103
 - 42 ± 2 d I-125
- Recommended time
 - 10 ± 2 d Cs-131
 - 16 ± 2 d Pd-103
 - 1 month $\pm$ 1 week I-125

Case Study

- Prescription
 - I 125
 - 100 Gy to the prostate
- CT
 - 1 month
- D100 – 121Gy
- Is this a Medical Event??

Axial CT
without Contour



Axial CT
with Contour

Axial MRI
without Contour



Axial MRI
with Contour

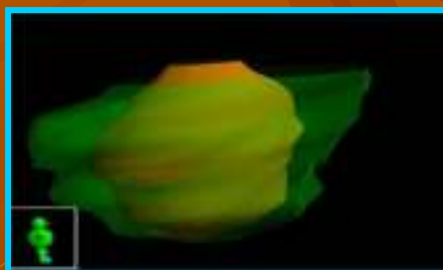
Narayana et. al 2005

- 6 prostate implant cases
- Contouring workshop
 - 6 expert Radiation Oncologists
- Contouring stations
 - 59 participants – all claimed to contour prostate at their institutions
 - Physicians
 - Dosimetrists (few)
 - Physicist (few)

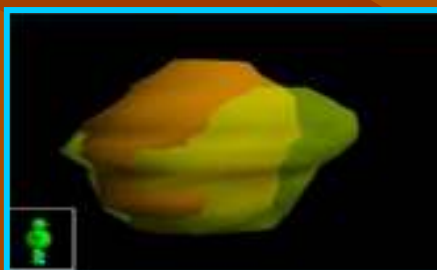
Contouring errors

- D90
- V100

Physician 1



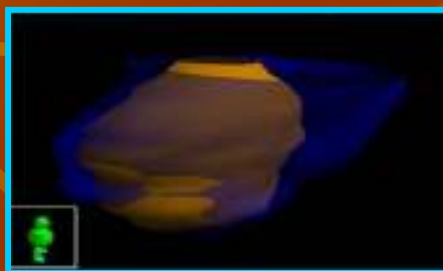
Physician 2



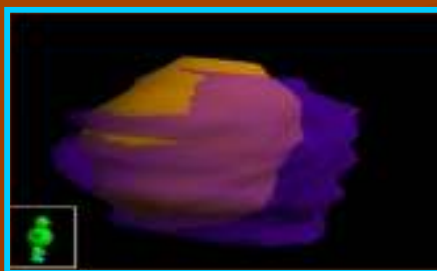
Physician 3



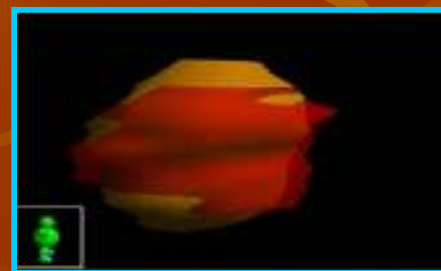
Physician 4



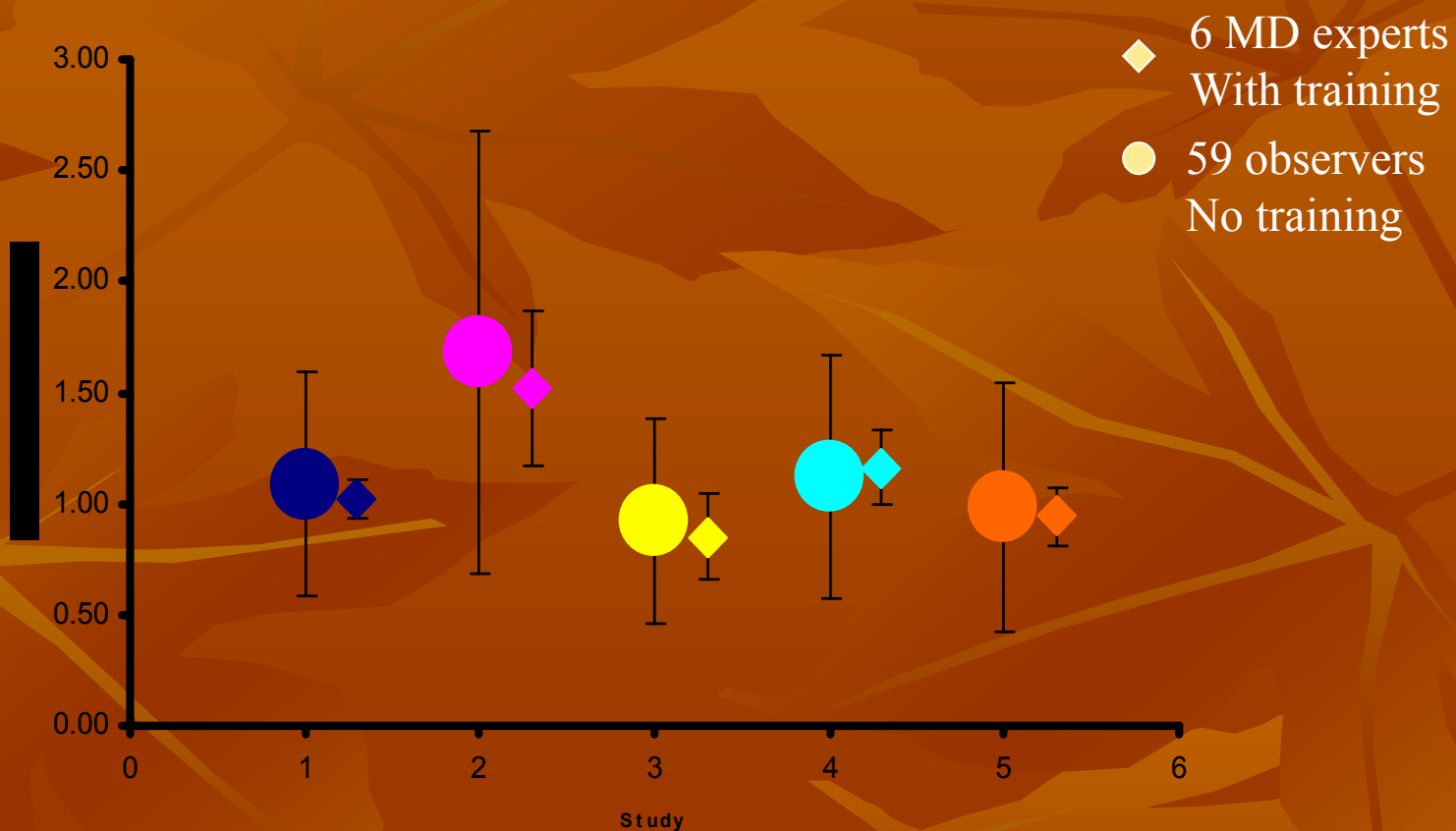
Physician 5



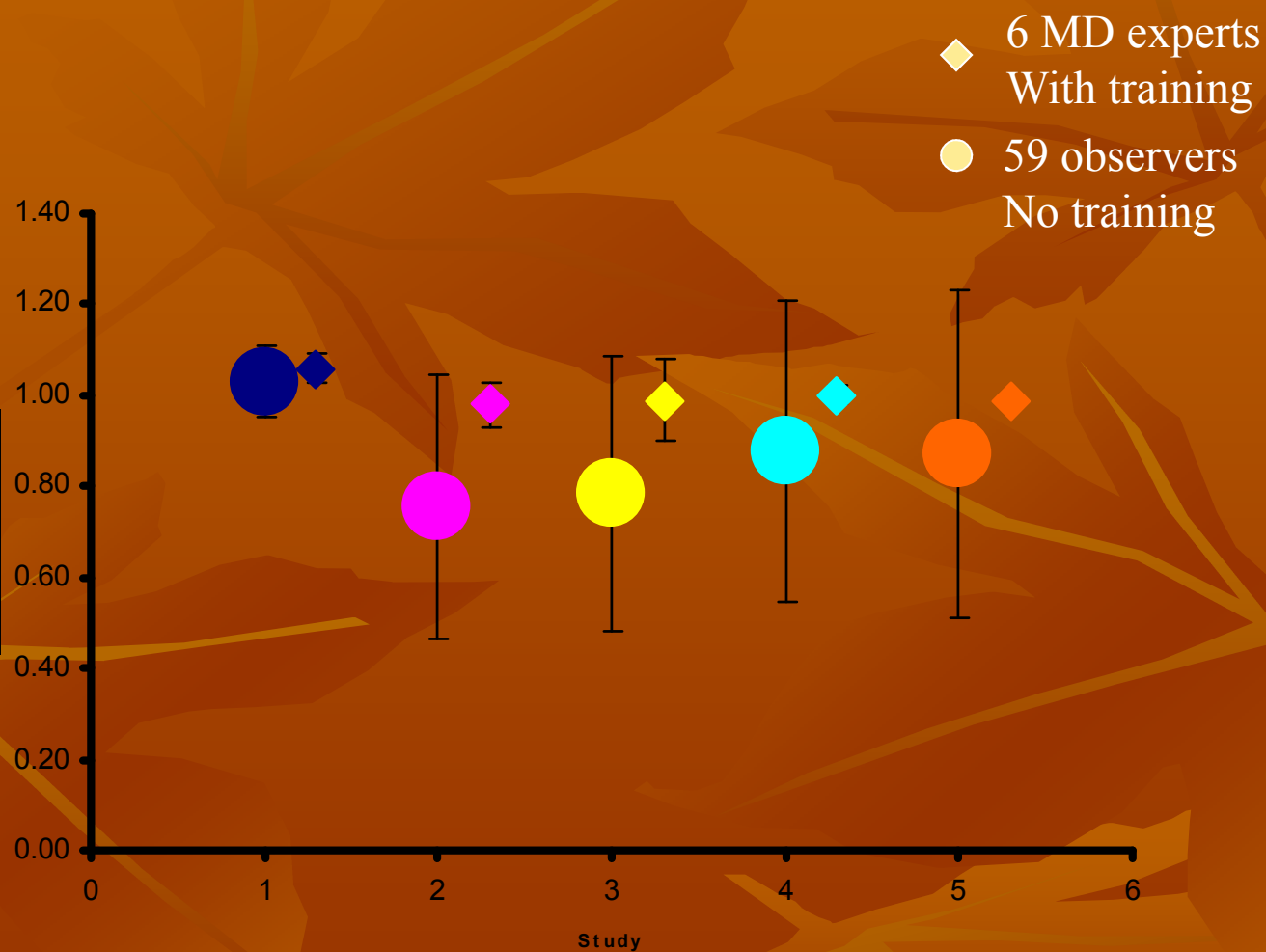
Physician 6



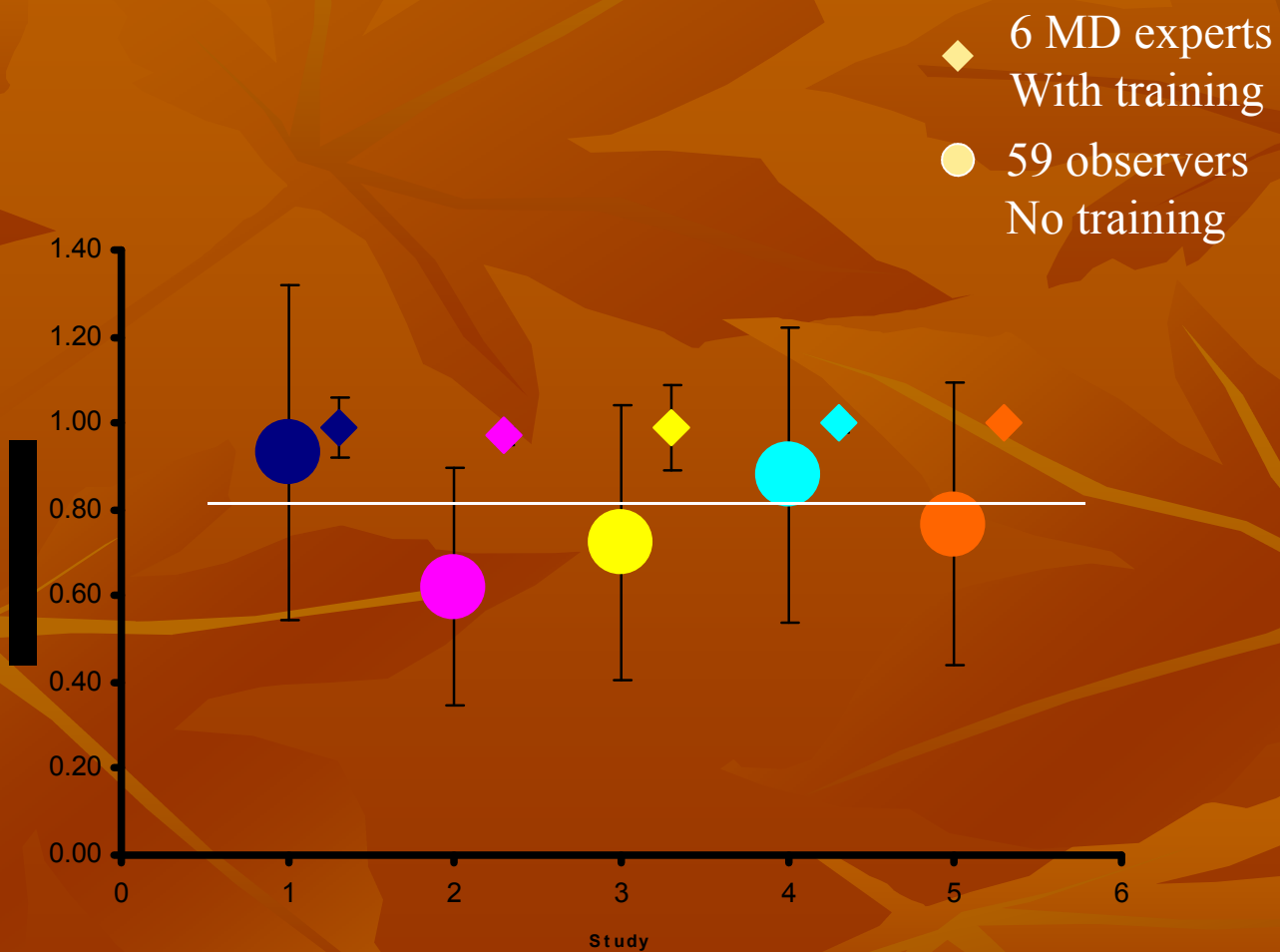
Changes in volume



V100



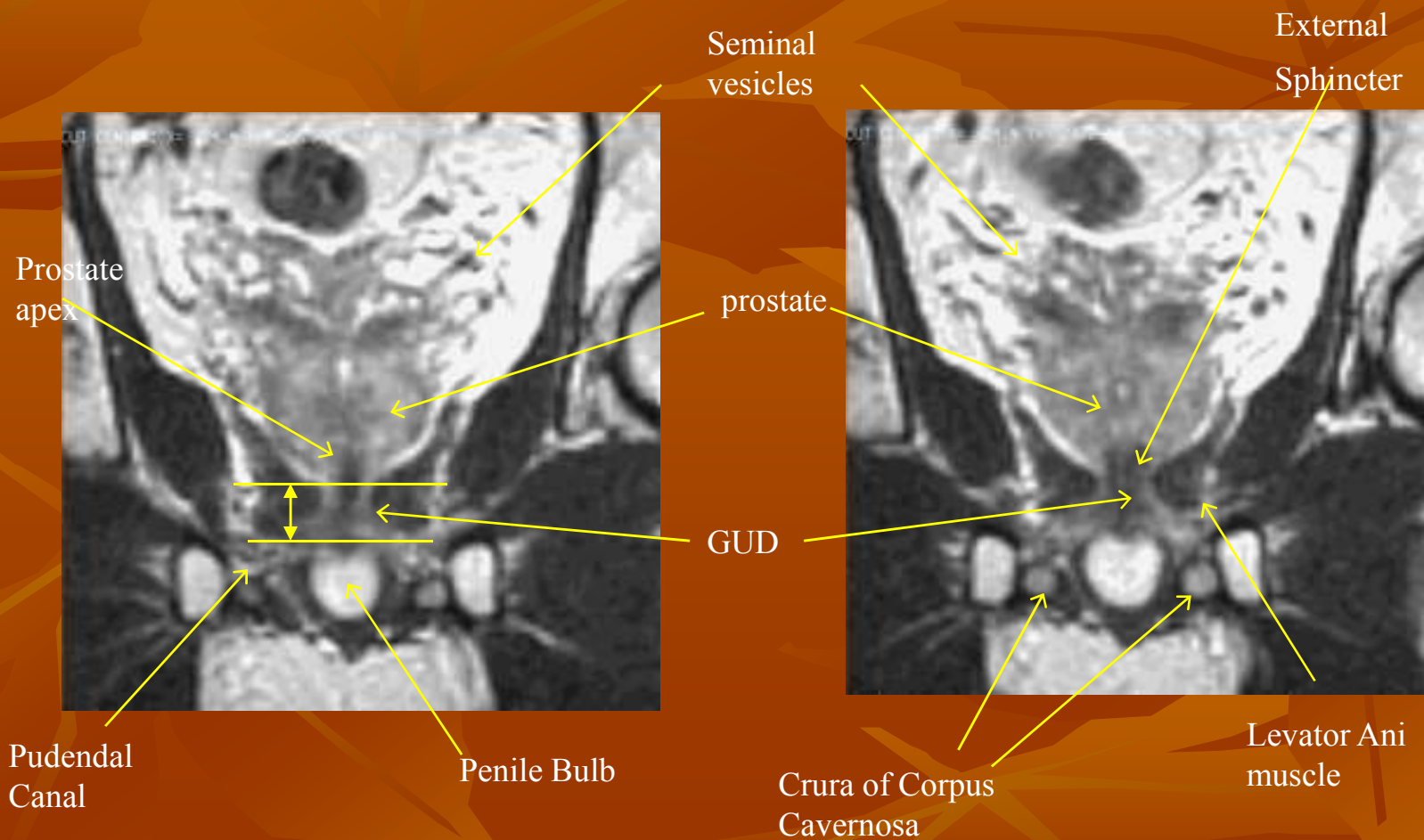
D90

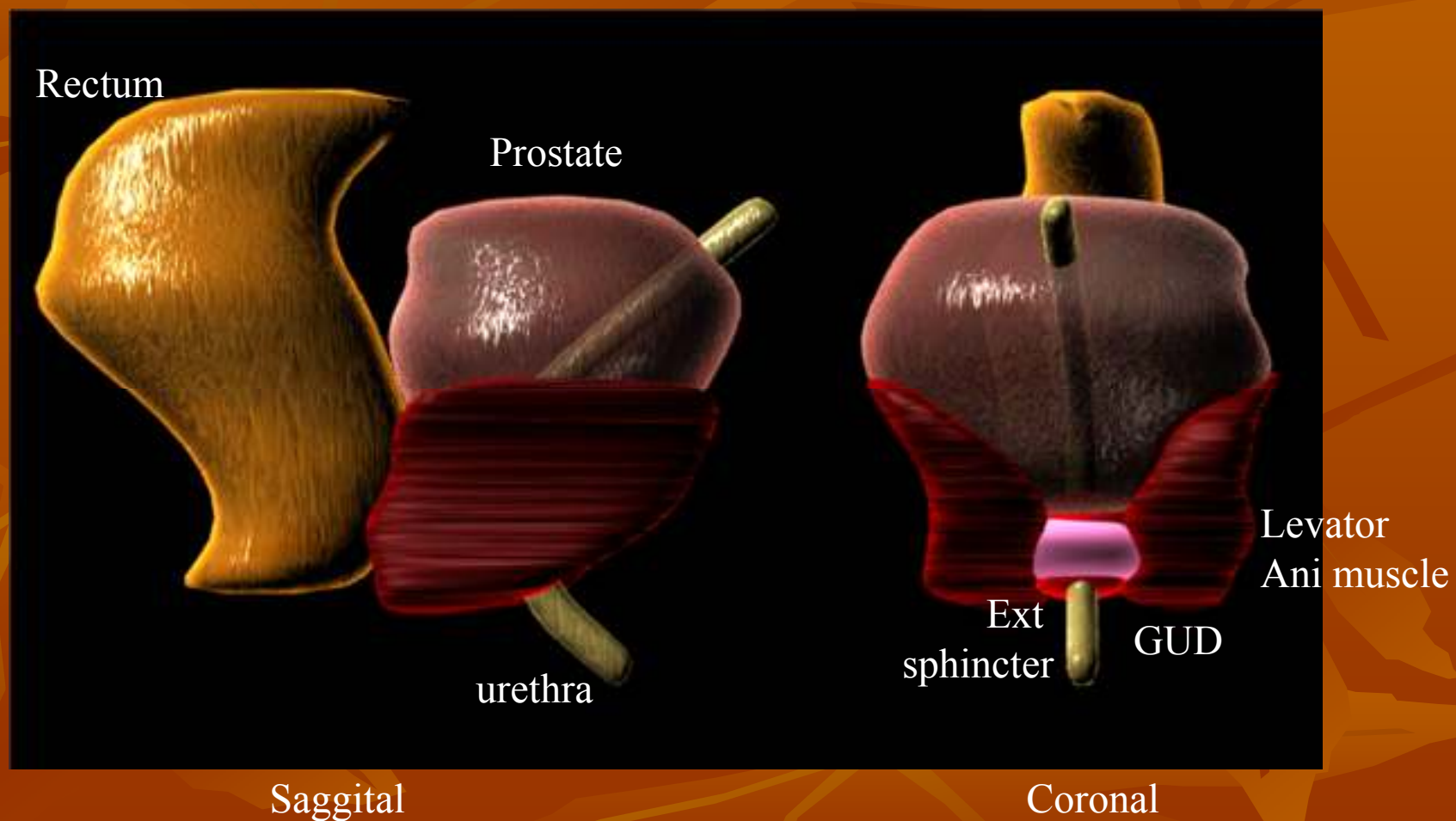


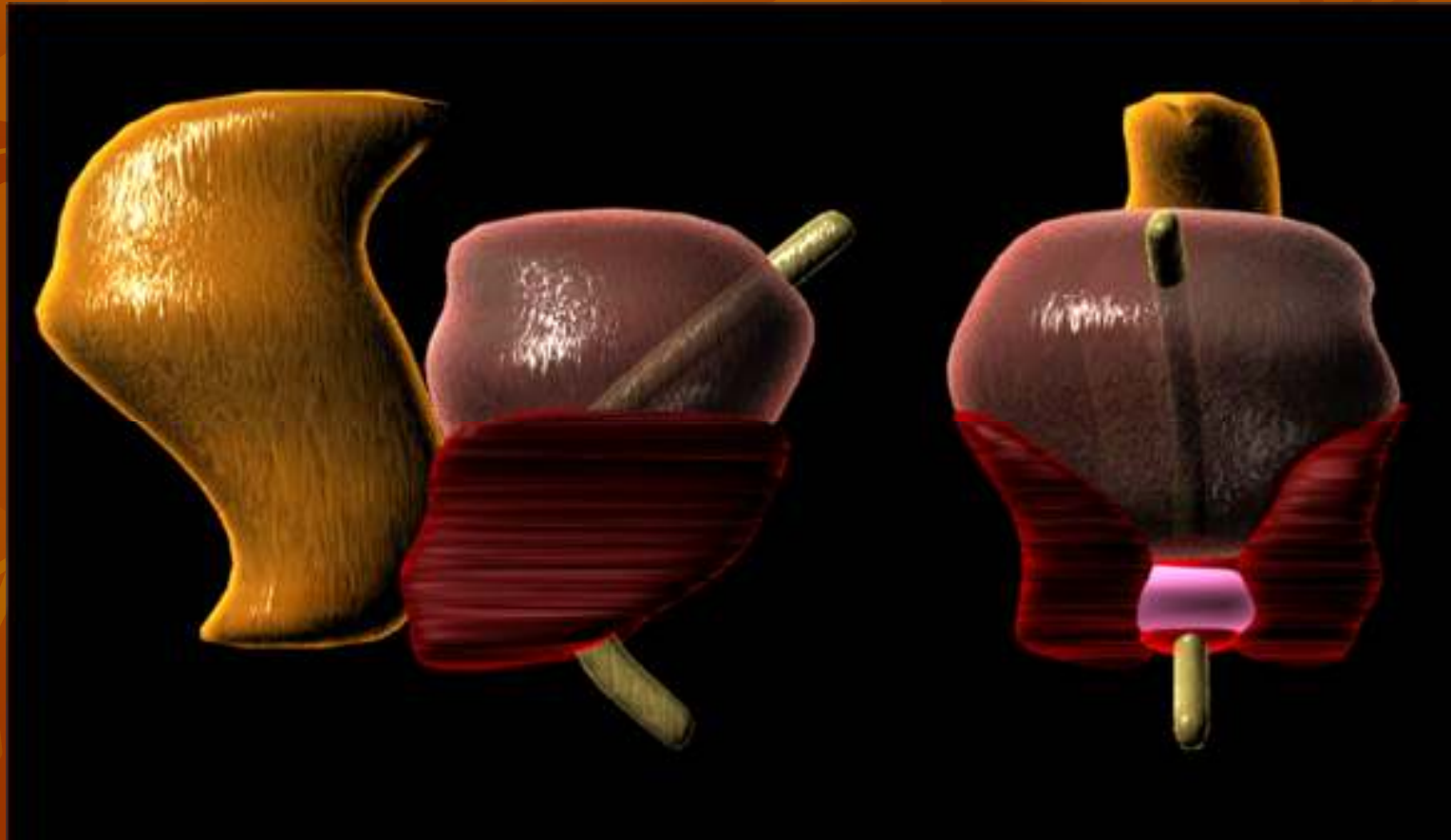
McLaughlin et. al. 2006

- Day 1 vs Day 14 dosimetry
- MR based
- Rapid strands

MR anatomy













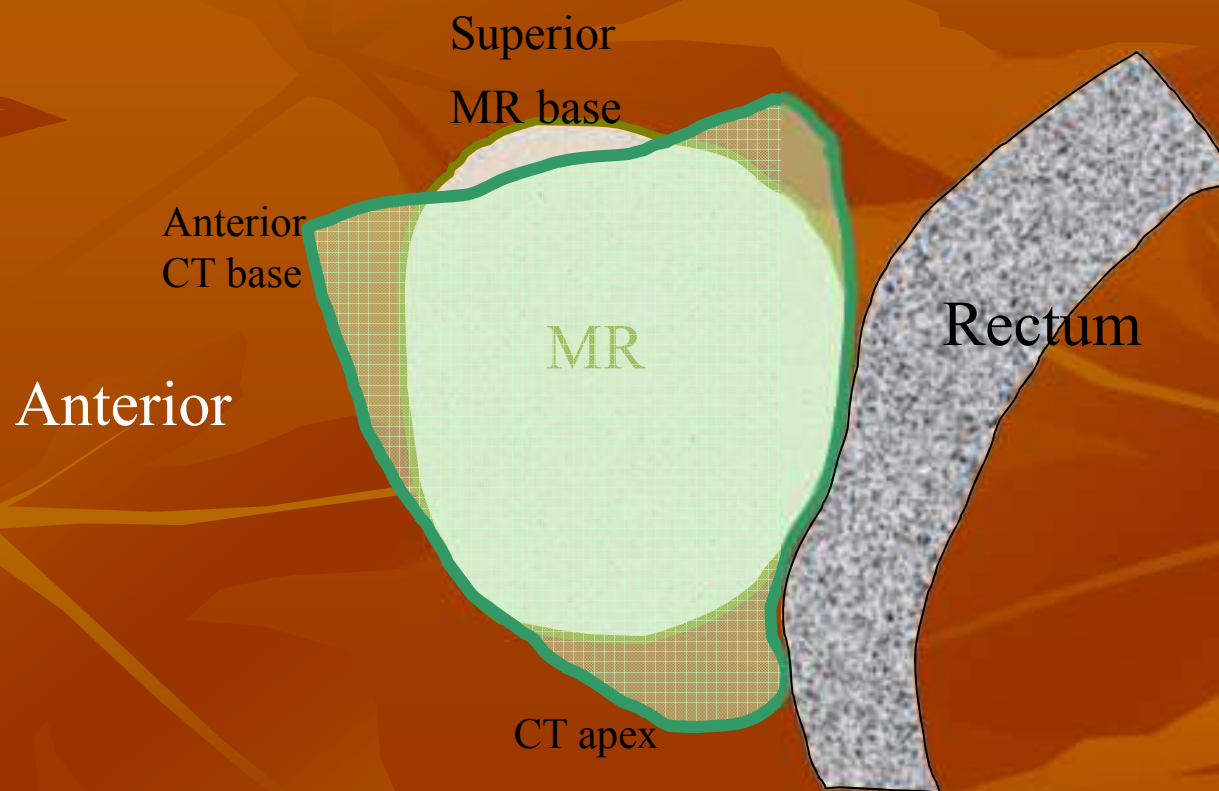
Case Study

- Prescription
 - I 125
 - 100 Gy to the prostate
- MR
 - 3 weeks post
- D90 – 79 Gy
- Is this a Medical Event??

Where is it cold?

- Apex or base?
- Low or high risk?

Pitfall of CT contouring



Imaging Modality

- Registration

Full Dataset



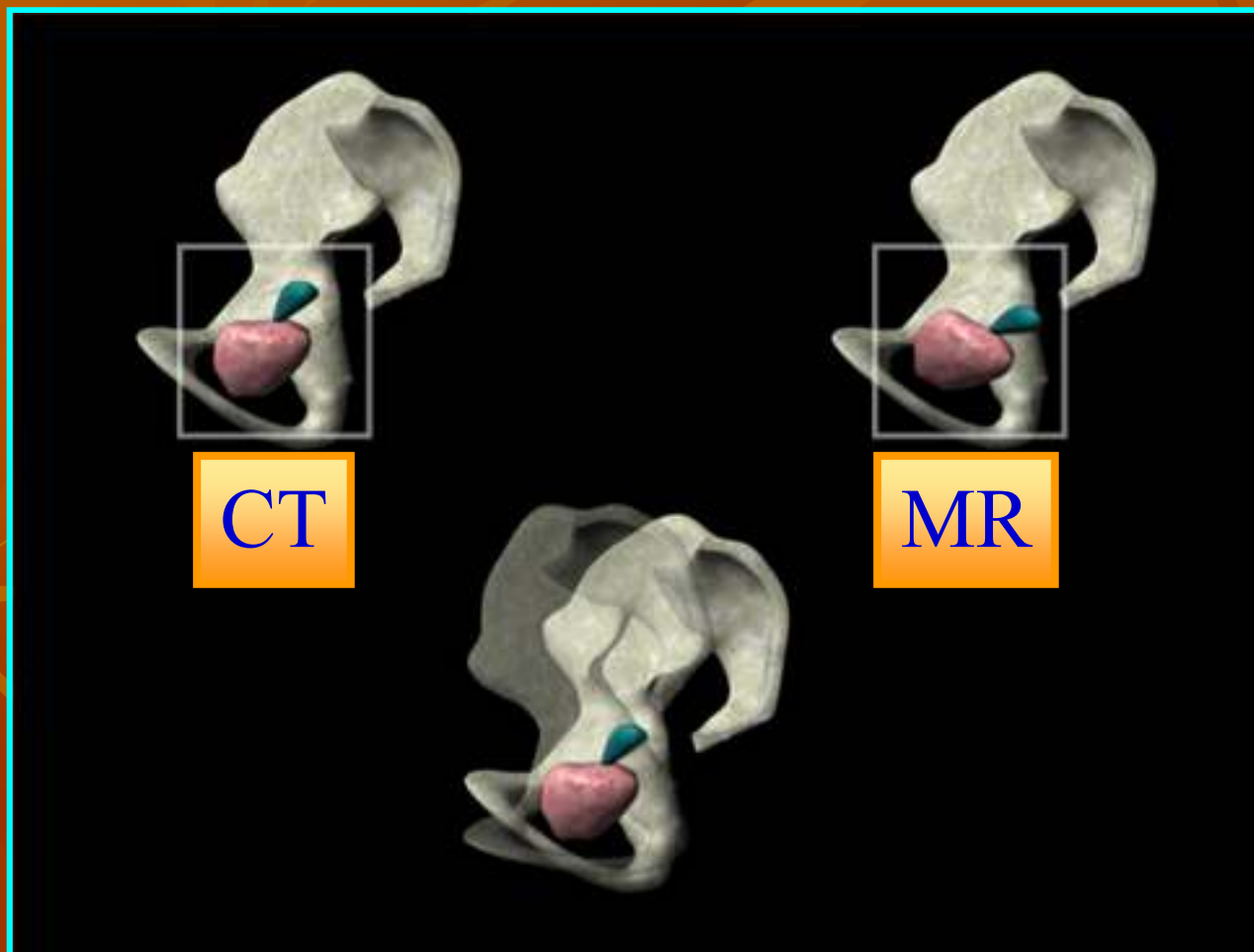
CT



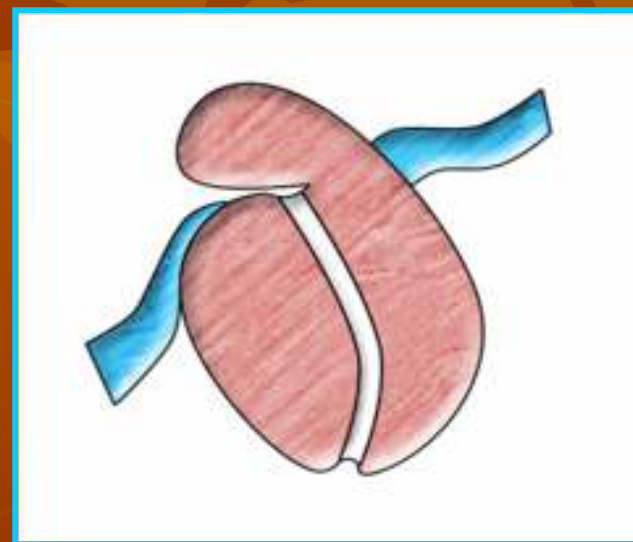
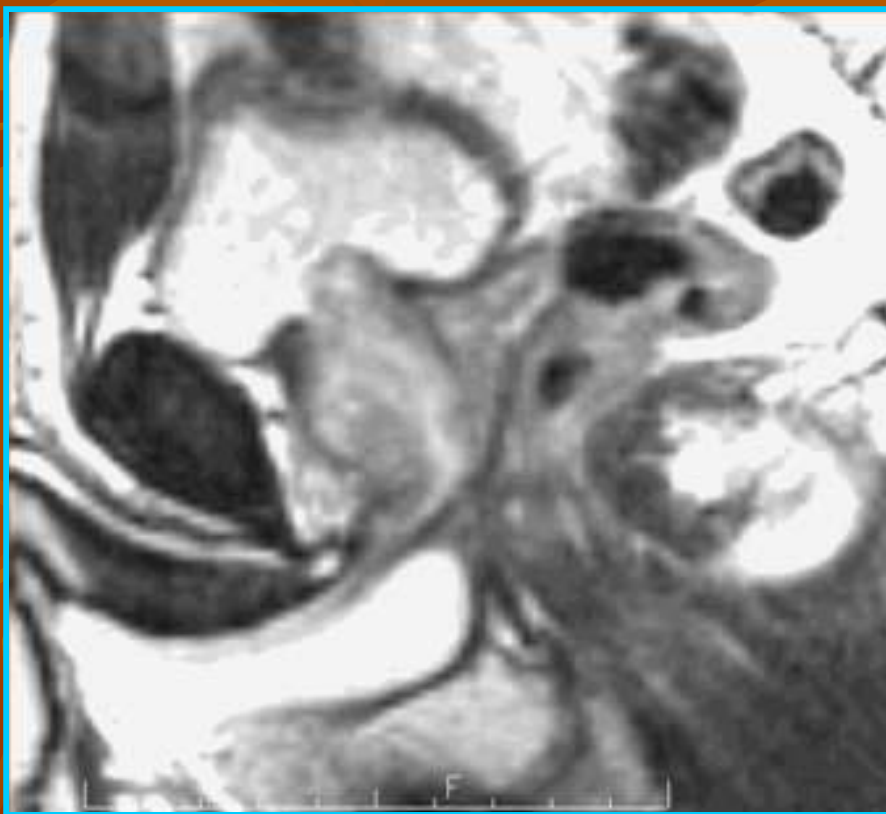
MR



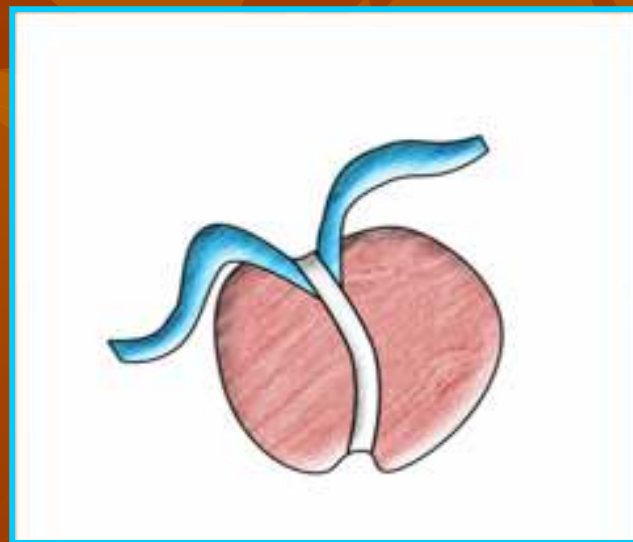
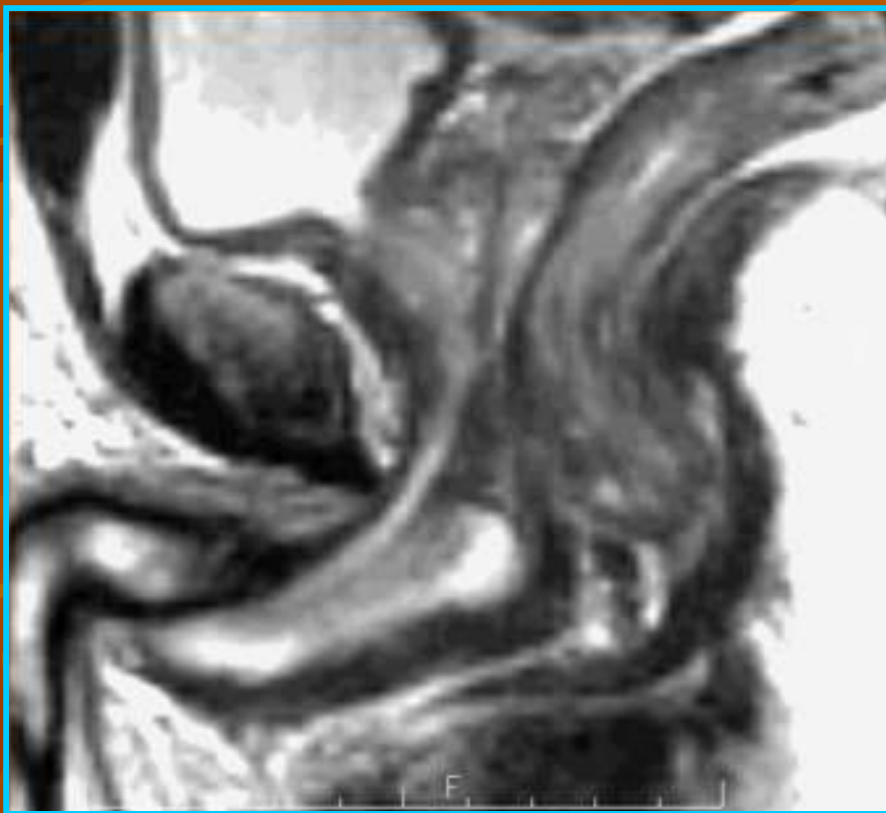
Region of Interest



Prostate inside bladder



Bladder neck inside the prostate



Medical Event ?

- Specific to prostate implants
- Activity vs. Dose based
- U implanted difference $\pm 20\%$ prescription
- U calculation error causing $\pm 20\%$ prescription
- U in a ring 3cm outside target $>20\%$ of total U
- Source $> 3\text{cm}$ from target

Patient Specific QA Prostate implants

- Checklists
- Adequate Training
- Documented Procedures
- Simple Processes