Alan Pollack, M.D., Ph.D.
University Of Miami
Sylvester Comprehensive Cancer Center

MR Simulation For Prostate Cancer

The Benefit Of MRI

- Prostate Apex
  - Prostate-rectal interface
- Penile Bulb
- Tumor Location/Extent
- Bladder-Prostate Interface
- Seminal vesicles
- Pelvic vessels
- Lymph nodes

Prostate Anatomy
McLaughlin et al, IJROBP 2005

MR Simulation

- Prostate Anatomy
- MR-CT Fusion
- Functional Imaging
- Therapeutic Implications

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Prostate Anatomy
McLaughlin et al, IJROBP 2005

Case 3 High Risk CT-Sag
Apex Not Well-Visualized

Case 3 High Risk MRI-Sag
Apex Better Visualized

Case 3 High Risk Coronal
CT
Case 3 High Risk Coronal MRI

CT Overestimates Prostate Volume
- Roach et al, IJROBP 1996:
  ◦ “The mean prostate volume was 32% larger...” by CT
- Rasch et al, IJROBP 1999:
  ◦ The “average ratio between the CT and MR volumes was 1.4”
  ◦ “CT-derived prostate volumes are larger than MR derived volumes, especially toward the seminal vesicles and the apex of the prostate.”

Retrograde Urethrogram vs MRI For Defining The Prostate Apex
- Rasch et al, IJROBP 1999

MRI vs CT: GTV Delineation
- Milosevic et al 1998 Radioth Oncol: ∼80% agreement between CT urethrogram and MR.
Case 3 High Risk: Slice 89

Penile Bulb/Cavernosal Bodies

MRI vs. CT: Hip Replacement

MR Simulation
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MR Simulation

- No fiducials or Gold fiducials:
  - CT Sim First
  - Calypso Beacons
  - MR Sim first
  - Fusion based on bone and soft tissue.

1.5 T, 60 cm bore

- Retrograde urethograms are not performed.

MR-CT fusion based on boney anatomy

Mismatch arises from time of scan differences

MR And CT With Gold Fiducials

Note that the prostate is in a different position relative to the femoral heads
CT With Calypso Beacons

Note that the prostate is in a different position relative to the femoral heads.

Don't outline from MR for soft tissue if there is discrepancy in the soft tissue.
- Fusion should be based on both soft tissue and bony anatomy.
- Gold markers on MR and CT can aid in soft tissue fusion.
- Calypso beacons are on CT only and MR should only be used as a reference (all outlining from CT).

MR-CT Fusion

MR Simulation

- Prostate Anatomy
- MR-CT Fusion
- Functional Imaging
- Therapeutic Implications
How Can Bulky-Hypoxic-Microvessel Dense Areas Be Identified And Better Targeted?

- **MR**
  - MRS, Bold, DCE, DW
- **PET**
  - 11C-Choline, 11C-Acetate
- **Spect**
  - PSMA

Testa et al, Radiology 2007

Imaging To Identify Bulky Tumor Regions

- **Pretreatment**
  - Target with EBRT boost, EBRT+Brachy boost, EBRT+Cryosurgery boost, EBRT+FUS boost
  - MR-Guided FUS
  - Reduce incidence of Bx+ at 2-3yr
- **Post-treatment**
  - Biopsy at 2-3 years
    - Decision to Bx based on imaging?
    - Target residual tumor before PSA rise
      - Treatment of residual tumor cells only

Is Failure Related To High Volume Areas?

- TZ: Left: 0/0
- TZ: Right: 0/0

Post-Treatment Biopsy Results

- TZ: Left: 0/0
- TZ: Right: 0/0
9 Patients
- Pre-RT and Post-RT MRI
- Salvage Prostatectomy

Pucar et al, IJROBP 2007

Radiation Oncology

Research:
Simultaneous integrated boost of faRPX, MRI defined prostate seminal vesicle lesions in H group with IMRT: study results of a phase I/II study

Researchers:
Pickett et al, MRSI In Follow-up After EBRT

Pretreatment

Post-treatment

EQD2 = \text{EQD2} = \frac{D((d + (\alpha/\beta))/(2 + (\alpha/\beta))))}{2.0 \text{ Gy}}
Lymphotropic Superparamagnetic Nanoparticle lymph node imaging agents (Combidex)

There are gains in the use of MR imaging in RT planning and delivery, and in follow-up.

Need to test and incorporate better imaging methods for identifying bulky-hypoxic-microvessel dense disease