Clinical Applications of MRI

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Outline

• What has limited MRI from wide applications?
• Applications in MR-based treatment planning
  • Current: CT-based planning with Image fusion
  • Future: MRI-based planning is almost ready
    – Two approaches: Synthetic CT and MRCAT
• Applications in MR-guided treatment delivery
  • MRI-guided radiotherapy (and brachytherapy)
Gaps to wide MRI Applications

- Some gaps have been/will be filled with recent efforts
  - Lack of MRI expertise knowledge
  - Lack of quantitative measures of geometric distortion and correction methods
  - Other lacks...
    - Lack of billing code for clinical service reimbursement
    - Lack of dedicated MRI scanner for radiotherapy department
    - Lack of established MRI clinical workflow for simulation

- These suggest opportunities for improvement
  - More vendors have participated clinical implementations ...

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MRI Scanner QA

- Gradient-nonlinearity distortion & correction

![Raw, 2D correct, 3D correct images](Image)

Siemens 3T scanner, Courtesy of Dr. Eric Paulson, Med Phys, 42 28, (2015)

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MRI QA Phantoms

- Correction of MRI field gradient inhomogeneity

![Philips Φ = 40cm QA phantom, Quasar Φ = 40cm QA phantom with surface markers](Image)

Patient Simulation

- Couch top: from curved to flat for simulation
- Anterior coil setting for planning simulation
  \[ \Phi = 70\text{cm} \]

Patient Immobilization

- HN immobilization device setting

Head and Neck

- Using a MRI-compatible immobilization device
  - Less tissue deformation and better target delineation
PET/CT with MRI

- Multimodal images for better target delineation

Lung MR Simulation

- Alpha cradle extending from the shoulder to the pelvis on a lung board with table index.
- Mold is modified to include ear plugs and head phones
- Arms up and knee support
- Use a MRI-compatible Bellows
- Anterior coil is placed on a bridge

Lung and Upper Abdomen

- 4DMRI for motion assessment
Pelvis MR Simulation

- MR coil can be placed on top of the mask

Prostate MR example

- MR to CT image registration for treatment planning
  - Metal artifacts are shown due to femur metal implants

Paraspinal Simulation

- Better cord delineation for paraspinal SBRT/SRS
- Use anterior/posterior coils
- Clinical MR/CT image fusion
MRCAT for Prostate

• MRI-only treatment planning workflow

• MRCAT is a FDA-approved product to convert MRI image to CT image for pelvis/abdomen

Synthetic CT for HN

MRgRT from ViewRay

• ViewRay patient setup

Sagittal cine MR
Summary

- Wide clinical MRI applications require efforts from ALL parties involved in Radiotherapy

- Majority of current clinical MR applications are image-fusion based

- Methods and workflow of MRI-based planning have been studied and ready for applications