4D MRI for Radiation Therapy of Moving Tumors

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Learning Objectives

► To discuss the need of 4D-MRI technique for improving patient care in radiation therapy
► To present the latest development of 4D-MRI imaging techniques and their differences
► To discuss the application of 4D-MRI in tumor motion management and treatment planning in radiation therapy

Management of Moving Targets

Available Imaging Techniques

MRI, CT, PET-CT, Ultrasound, X-Ray, SPECT, Hyperpolarized gas, MRA, …
Challenge of Motion Management

- **Inter-subject Variation**
- **Intra-subject Variation**

- **Inadequate coverage**: Geographic miss of radiation dose
- **Excessive coverage**: Unnecessary radiation dose to surrounding normal tissue

Limitations of 4D CT

- 4D-CT has been widely used in radiation therapy for imaging moving tumors.
- 4D-CT Limitations:
  - Increased radiation dose (~10 times more data)
  - Low soft-tissue contrast
  - Requires external surrogate system
  - Questionable correlation with internal motion
  - Increased complexity of procedure

Emergence of 4D MRI

- Overcome limitations of 4DCT
- Multiple respiratory cycles
- Imaging in any selected plane
- No radiation to patient
- Good soft-tissue contrast

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Development of 4D MRI

- Imaging technique
  - External and internal surrogate
  - Reconstruction

- Planning method
  - Dose calculation
  - Fusion/Deformation

- QA of 4D MRI
  - Machine specific QA
  - Patient specific QA