GE Healthcare
Integrating MR into Radiation Therapy
Dennis V Savitskij,
Product Manager MR in Radiation Oncology
Aug 1st, 2016

PubMed search of: ‘MRI radiation therapy’

Diagnostic vs. Radiation Planning MRI

Diagnostic MRI:
• What is the problem?
• High conspicuity
• Dedicated/customized RF coils
• Multiple sequences:
  - Varying contrast
  - Functional information
  - Often qualitative

Radiation Planning MRI:
• What is the spatial extent of the problem?
• Where are the adjacent radiosensitive organs?
• High resolution 3D
• Image in treatment position
• Non ideal (surface coils)
• Relatively limited imaging sequences
• Requires large FOV data

Dr. Kiaran McGee, PhD - Mayo Clinic, Rochester MN
MR Advantages in Oncology

Excellent soft tissue contrast helps provide confidence in tumor delineation
Multi-parametric imaging, anatomical, functional, metabolic, dynamic
Vascular imaging with and without contrast media
No ionizing radiation

Prostate, G1, Head/Neck, Spine, Liver, Ovaries and Breast

Outline

High Quality image generation
RT Applications
MRI patient positioning devices
RT software

Spatial Accuracy

Ideal (linear) gradient field
Actual (non-linear) gradient field

http://mri-q.com/gradient-linearity.html
High Spatial Integrity

Mean abs error ≤ 0.1 cm at 43.0 cm diameter
Max abs error ≤ 1.6% at 43.0 cm diameter

- High magnet homogeneity
- Excellent gradient linearity over a LFOV
- 3D gradient distortion correction software reduces distortion in the MR image

Measurements based on NEMA NU-12 “Quantification and Mapping of Geometric Distortion for Special Applications”, using a large field of view phantom with a 3D FGRE acquisition

Field of View for Radiation Treatment Planning

- Exceptional magnet homogeneity and Field of View
  - 50x50x50 FOV
  - 45 cm DSV @<0.7 ppm typical
Navigator... Motion Insensitive Body Imaging

Body Navigators

Navigator... Motion Insensitive Body Imaging

Fast Brachytherapy Protocol

Susceptibility Weighted 3D Imaging - SWAN

Pencil beam navigator tracks diaphragm motion...acquires data when diaphragm is in an acceptable range.

Image Courtesy: UW Madison, USA & Seirei Hamamatsu, Japan

LAVA Navigator

SUSCEPTIBILITY WEIGHTED 3D IMAGING - SWAN

• SWAN is a multi-echo 3D T2* susceptibility weighted imaging technique
• SWAN provides a magnitude image and phase map
• Phase map allows visualization of diamagnetic and paramagnetic properties.

Image Courtesy: Dr. Cornelis from CHU Bordeaux, France – MR750w

SWAN for Prostate Brachytherapy Imaging

• eSSFE for Lymph Node assessment
• CUBE 2D version
• CUBE volumetric T2
• SWAN High Res.

Image Courtesy: Dr. Cornelis from CHU Bordeaux, France – MR750w
DISCO: 4D time resolved Imaging

- High spatial and temporal resolution
  - By treating DCE as a 4D data vs series of 3D sets
- Flexible matrix size & FOV
  - By using Cartesian k-space sampling
- Maximizes contrast uptake
  - By always sampling full central region
- Reduces blurring/motion artifacts
  - By “random iterative” subsample of outer k-space

Image contrast comes from k-space center
Edge definition is obtained from the edges of k-space
K-space sampling w. different Phases


Imaging Around Metal Implants - MAVRIC

MAVRIC - Volume imaging at multi-frequency offsets to reduce distortions

- Composite image created from spectral offset images
- PD, STIR and T1 contrast is possible

MAVRIC SL

Designed for imaging soft tissue and bone near MR Conditional metal implants
Voxels of the Right Size and Shape

3D Cube
Scan once and reformat the sub-mm isotropic dataset into any plane
T1, T2, FLAIR, DIR, and PD contrasts

Pre-Loaded Radiation Oncology Protocols

High resolution
Thin-slice, zero skip
High contrast
Brain, Head & Neck, Pelvis

LAVA Flex

- Volumetric T1 sequence for DCEMRI
- Four image contrasts in one scan with perfect registration: Segmentation
- Excellent fat suppression
- High SNR allows high-resolution images

Courtesy: Hull University, UK, and Sharp and Children’s, USA
For Prostate Treatments
GEM AA & PA Coils with CIVCO Positioning Devices

High quality images in the treatment position.

Pelvic positioning Setup

GEM posterior Array

Anterior Array Supports

For Head & Neck Treatments
GEM RT Open Head & Neck Suite

Open Design. Patient Comfort.

Combined with 16 ch GEM Large Flex coil and 6 ch Neuro Flex coil to obtain high quality H&N images in the treatment position.
For Head & Neck Treatments
RT Open Head & Neck Suite

RT Open Array + 6 Channel Flex coil + Large Flex coil with coil supports
• Excellent image quality
• High resolution, full FOV images in the treatment position

For Brain Treatments
6 Channel Flex Coil + RT Open Array

High quality images in the treatment position. 10 channels of imaging.
Laser Marking

Laser bridge system specifically designed for radiation therapy laser marking in MR.

MR Compatible Positioning Devices
A Comprehensive Set of Options

- Designed to properly position the patient.
- MR compatible positioning packages, developed in collaboration with CIVCO, provide reassurance.

Integrated Registration – MR to MR and Multi-Modality Fusion.
MR pelvic Organ Segmentation
Advantage Sim9

- Semi-automatic segmentation
- Registered to CT
- Designed to support:
  - Prostate
  - Heads
  - Bladder
  - Rectum
  - Femoral
- Designed to help speed up time consuming manual contouring of Organs-at-Risk on MR images
- Designed to improve consistency of inter-operator contouring

- Average time savings of 19% for prostate, bladder & femoral head segmentation
- Decreases inter-observer variability by an average of 14% for prostate, bladder and femoral head contouring

Designed to help speed up time consuming manual contouring of Organs-at-Risk on MR images
Designed to improve consistency of inter-operator contouring

Easy Integration into RTx Workflow

GE Oncology Workstation (AW) / MD Connect (AW Server)

Easy Integration into RTx Workflow

Planning RT with MR images only Workflow

Dose calculation for prostate RT
Treatment Monitoring... OncoQuant

- OncoQuant AR application is designed to help organize and display multi-modality multi-time point oncology data to facilitate quick review.

Highlights:
- Automatic multi-modality image registration at loading for two or more exams.¹
- Adaptable workflow supports standard criteria such as RECIST² and WHO.³
- Dedicated automatic review protocols to identify and load like series.
- Single-click display up to four dates including Baseline, Nadir, Prior, and Current exams.

¹ Integrated Registration Multi-Modality option required.

Case study by Dr. Boulay

ASSESSING DRUG RESPONSE WITH MULTIPLE MODALITIES USING ONCOQUANT

Takeaways

- GE has a solution for MR in RT
- RT needs a definition of MR Sim analogous to AAPM TG 66
- Have a great AAPM 2016
- Visit the GE booth if you have any questions

Thank you!

GE Healthcare