UPDATES MR IMAGING

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INTRODUCTION:

- Volumetric acquisition
- Angiography
- Artifacts
  - Magnetic subsceptibility effects
  - Chemical shift artifacts
- Fusion
- Therapeutics
The problem with MRI DETAILS vs TIME

• High spatial resolution
  – Slower
  – Better resolution
  – Needed in: Neuroimaging, all other imaging

• High temporal resolution
  – Faster
  – Loss of resolution
  – Needed in: Cardiac imaging, EPI (functional/tractography), abdominal imaging due to bowel and breathing movements
**HIGH SPATIAL RESOLUTION-Cube**

- Volumetric Fast Spin Echo acquisition for T2, T2 FLAIR and PD tissue contrasts
- Scan once and reformat the sub-mm, isotropic dataset into any plane with no loss of resolution and no gaps
- Automated, no-miss sequence, consistent image quality and shorter exam time

Scan once – reformat into any plane with the same high resolution
Reformatted 3D BRAVO datasets: fMRI, pediatric anatomy

Volumetric with functional fusion- BRAVO

- Volumetric FSPGR acquisition for superb T1w brain imaging
- Optimized contrast for brain tissue segmentation
- Reformat the sub-mm, isotropic dataset into any plane with no loss of resolution
- Automated, no-miss sequence, consistent image quality in short scan time

✓ Reformatted 3D BRAVO datasets: fMRI, pediatric anatomy
✓ BRAVO 3D volume rendering

3D isotropic sub-mm– reformat to any plane w. same resolution
DCE T1w imaging

Delivers the ability to capture high-resolution T1w morphology in a short breath-hold

High spatial resolution…
For small detail and enhanced reformats

High temporal resolution…
For short breath-holds and multi-phase imaging

Fat-sat
For enhanced conspicuity

AutoVoice
For consistent patient instructions

Detail & speed in one scan… without compromise
Small bowel imaging

Body array with respiratory and bowels movement

Hi-definition… and hi-speed small bowel imaging

LAVA, 418x288, 3.6mm, 20 sec
Stress Imaging at 1.5 T

Technical excellence for diagnostic confidence

- GE exclusive notched RF pulse creates excellent CNR essential for good time course studies.

Complex exam made simple...powerfully simple
Functional Imaging at 1.5T

FIESTA CINE imaging & Tagging
- Robust steady state free precession (SSFP) imaging
- Volume shimming provides robust image quality without artifacts
- ASSET compatibility reduces breath-hold time
Viability Imaging at 1.5T

2D Myocardial Delayed Enhancement (MDE)
- Adiabatic inversion recovery for homogenous myocardium suppression and improved CNR between infarcted and normal myocardium

Complex exam made simple...powerfully simple
Coronary Artery Imaging at 1.5T

3D Fat Suppressed FIESTA with Navigator Echo

- Free breathing acquisition with improved navigator echo technique
Anatomy at 1.5T

Double Inversion Recovery (DIR) FSE  
Double Inversion Recovery with Fat Sat  
Triple Inversion Recovery (TIR)

Complex exam made simple...powerfully simple
ANGIOGRAPHY

- Limited by slab coverage-slab artifacts and time of examinations.
- Increase SAR.
- Decrease of signal in tortuousity or reversal of flow in terms of directions.
Non-contrast MR Angiography

- Inhance Application Suite
  - Non-contrast MR angiography without compromise
  - The first choice for NSF susceptible population
  - Utilizing inherent contrast characteristics like flow and relaxation times to delineate vascular anatomy
  - Consistency and reliability without contrast injection and reduced cost

No compromise Non-Contrast MR Angiography
3D Velocity

Brain MRA Applications

• Whole brain volumetric 3D acquisition in less than 5 min
• Excellent background suppression for cerebral arteries and veins visualization
• T1 weighted contrast from the same acquisition for accurate correlation between vessels and anatomy

3D rendering with color-coded arterial and venous flow

No Miss NCE MRA – whole brain in 3D in less than 5 min
3D Velocity

Inhance 3D Velocity images capture this dural fistula and the network of typical corkscrew shaped supplying vessels in exquisite detail – in one rapid scan.

Multiphase TRICKS confirms the AVF and provides blood filling.

3D TOF fails to depict the whole convoluted vasculature (sensitive to thru-plane flow only) and the pathology is obscured by some background tissue.
Inhance 3D Velocity

Abdominal MRA Applications

- Excellent background suppression with optimized pulse sequence design
- Respiratory Triggering compatible, allowing free breathing renal artery acquisition
Quick Step

Quickest way to do a run off exam with minimum user input

- No Localizers – Landmark once at ankle
- Automatic Skin to Skin coverage
- Just select protocol based on patient size & scan
- Fluoro Trigger contrast detection
- Faster table (30cm/s) to capture arterial phase
- Multi-Phase capability at 3rd station
- Parallel Imaging (2D ARC) compatible

QuickStep 1st Station with TR = 2.2ms
Vascular MR TRICKS at 3T

Combining high spatial with high temporal resolution at 3T

AVM CALF

Bilateral Lower Legs

Whole head coverage

For vessel filling dynamics use TRICKS
Vascular MR TRICKS at 3T

Single phase images from TRICKS-XV acquisitions showing superb spatial resolution

For smallest vessel detail use TRICKS
ARTIFACTS

• Chemical shift artifact
IDEAL

• Break-through water-fat separation technique
• One scan, four contrasts
  - Water Only
  - Fat Only
  - In Phase
  - Out of Phase

✓ Consistent quality and uniformity

No-fail water-fat separation...one scan, four contrasts
LAVA-Flex DCE T1w imaging

Delivers the ability to generate up to 4 contrasts in one scan enabling the ability to characterize tissue with one scan.

1 scan… 4 contrasts…

Tissue Characterization

Water, fat, in-phase, and out-of-phase that enable tissue characterization and problem solving.

Scan ONCE… characterize tissue with multiple contrasts.
LAVA-Flex DCE T1w imaging

1 scan... 4 contrasts... including...

Water-only... no fat
Homogeneous fat suppression that succeeds where traditional fat sat may fail

320x192, 4mm/-2mm, 20 sec
ARTIFACTS

• Susceptibility artifacts
  – Usually occurs near interfaces of substance of different magnetic susceptibility
  – Can be useful clinically and therefore use in gradient echo or sequence with long TE
SUSCEPTIBILITY WEIGHTED IMAGING

- Clearly delineate microbleeds & small veins
- Visualize large vascular structures
- Assess iron and calcium in the tissue

“Good susceptibility weighting without susceptibility artifacts. It’s fast, easy and provides excellent image quality.”

L. Tanenbaum, MD @ Mount Sinai, NY

Developmental venous anomaly (DVM) clearly visible on SWAN (L) but not GRE (R).

Microbleeds show much better on SWAN image (L) compared to GRE (R).

More SNR, More Contrast, Faster Scans
**FUSION:** Fusion of ADC/Diffusion, perfusion, CSI and anatomic map will assist in lesion detection

- eADC
- NEI
- Cr.+Cho: Citrate
- LAVA: 3 sec/phase, 40 time points
- FSE 4:20, 320x256 x 4mm
EchoPlus body diffusion

Extend clinical utility with anatomical and functional imaging
MR-Touch

An extension of the age old technique of diagnosing from touching

Shear waves generated in the tissue by an external acoustic driver
Imaging performed with multi-phase GRE with a modified cyclic Motion- Encoding Gradient (MEG)
MEG gradient is synchronized with the external acoustic driver
Inversion algorithm generates wave images and stiffness map (Elastogram)

Extend clinical utility with a new touch in MR imaging
THERAPEUTICS

• MR guided focused ultrasound
• 4 role of MRI
  – Diagnostic tool
  – Planning tool
  – Monitoring tool
  – Assessment tool
Focused Ultrasound (FUS)

- The ExAblate 2000 system is a device that can target and ablate tissue without requiring surgical incision.
How Focused Ultrasound Works (con’t)

• Similar to how a magnifying glass focuses light energy, ultrasound can be focused on a specific point.
Physiology of Thermal Therapy

- Coagulated regions seen in macro pathology image
- Histology analysis shows a sharp demarcation between treated and non treated regions

MRgFUS treated liver (pig)
Magnetic Resonance Imaging (MRI) is a method used to visualize the inside of living organisms.

MRI uses non-ionizing, radio frequency signals to acquire images. MRI is best suited for soft (non-calcified) tissues.

Medical MRI relies on the relaxation properties of excited hydrogen nuclei in water and fat.
MR Imaging Anatomy

- T1W+C breast MR image
- T2W pelvic MR image
- Breast
- Ribs
- Uterus
- Fibroid
- Nerves
- Bladder
- Pubic bone
- Tumor
MR Guidance

• Visualization of treatment plan before energy is delivered, identifies:
  - Surgical clips
  - Bowel
  - Nerves
  - Scar
MR Thermometry

- Provides real-time feedback during treatment, showing regions that have met thermal dose requirements.

### Temperature graph

- **Sonicating**
- **Cooling**

**Images:**

- **6 sec**
- **12 sec**
- **18 sec**
- **24 sec**

**Legend:**

- **Parallel to beam path**
- **Perpendicular to beam path**
MRgFUS In Treatment Of Uterine Fibroids: Early UMMC Experience

• Introduced MRgFUS in UMMC in Feb. 2009
• Treatment planning is done by radiographers
Results

% of fibroids treated (19)
• Range 22-100%
CONCLUSION

- Recent advance in MRI has improve temporal and spatial resolution.
- In future this will create a TRUE merging of functional and anatomical imaging
- MRI also has an increasing role as a tool in therapeutics.