Abdominal MRI: Techniques Optimization

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Abdominal MRI: Techniques Optimization

Approach to abdominal imaging at 1.5 Tesla and optimization at 3 Tesla.

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1.5/3 Tesla Liver Imaging
1.5/3 Tesla Liver Imaging
“Science is but a perversion of itself unless it has as its ultimate goal the betterment of humanity”

—Nikola Tesla (1856 – 1943)
Teslacar
Challenges and Solutions

Sequence Optimization
Challenges and Solutions

- Fundamental liver sequences
  - Single Shot Echo Train (SSET) T2
  - “True” Free Induction Steady-state Precession (TFISP)
  - 2D/3D GRE In/Out of Phase T1
  - 3D GRE T1
# Nomenclature

<table>
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<tr>
<th>Acronym</th>
<th>Philips</th>
<th>GE</th>
<th>Siemens</th>
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<tr>
<td>Fast Spin Echo</td>
<td>TSE</td>
<td>FSE</td>
<td>TSE</td>
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<td>Single Shot Fast Spin Echo</td>
<td>SSh TSE</td>
<td>SSFSE/RARE</td>
<td>HASTE</td>
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<td>Snapshot / Ultrafast Gradient Echo</td>
<td>TFE</td>
<td>Rapid SPGR</td>
<td>TurboFlash MP RAGE</td>
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<td>3D Turbo Field Echo with fat suppression</td>
<td>THRIVE</td>
<td>FAME/LAVA</td>
<td>VIBE</td>
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<td>Fast Field Echo</td>
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<td>FLASH FISP</td>
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<td>Steady State Fast Field Echo</td>
<td>Balanced FFE (bFFE, bTFE)</td>
<td>FIESTA</td>
<td>True FISP</td>
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<td>Saturation Bands</td>
<td>REST</td>
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<td>Spectrally Selective Fat Suppression</td>
<td>SPIR SPAIR</td>
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<td>Water Excitation Fat Suppression</td>
<td>Proset</td>
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<td>QuickFatSat</td>
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Sequence Optimization – Pre-Contrast

VIBE/LAVA/Thrive
HASTE/ssfse/sSh TSE
In phase
Opposed phase
HASTE-SPAIR
TFISP/FIESTA/BFFE
HASTE
HASTE-LongT2 SLAB
Sequence Optimization – Post-Contrast

PRE-VIBE/LAVA/Thrive

Arterial (Triggered)

Venous (70s)

Delayed (180s)

Delayed (300s)
2-Monitor Layout: Generalized

CorT2  AxT2  AxT2FS  AxFISP  AxIN  AxOUT

Ax 3Dgre  Arterial  Venous  Delayed  Cor Del  MRCP
2-Monitor Layout: Bowel
**T2W Imaging**

- Single shot
- Fast ~1s per slice
- Motion resistant
**T2W Imaging**

- **Applications**
  - **Structures**
    - Fluid filled
      - Tubes – localizes pathology (patent vessels)
      - Cysts/cavities
  - Tissue evaluation
    - Edema (fat suppression)
      - Inflammation / Infection / Congestion/Tissue Function
  - Lesion characterization
    - Cyst vs solid
    - Smaller relative role in solid lesion characterization
T1: 2D GRE In/Out of Phase

- Applications
  - Tissue characterization
    - Fat
    - Iron
    - Calcium versus iron deposit or metal
**T1: 3D GRE**

- Higher resolution
- Greater coverage volume
- Faster fat suppression
T1: 3D GRE

Applications

- Structure detail
- Intrinsic T1 contrast and abnormalities related to disease
  - Pancreas: Normally high T1 SI
  - Kidney: Normal corticomedullary differentiation
  - Protein/Blood products: High T1 SI
T1: 3D GRE

- Dynamic enhancement
  - Angiography – Macrovascular
  - Tissue enhancement - Microvascular
    - Tumor characterization
    - Inflammation
    - Fibrosis
**T1: 3D GRE**

- Dynamic enhancement - Tissue
  - Early
    - Represents vascularity
  - Later
    - Represents redistribution between vessel and interstitial spaces (leakage into tissue)
T2W Imaging – Long TE slab
**T2W Imaging - HASTE**

![Imaging Examples]

SPAIR fat suppression

*JMRI 2008;27(6):1448-54.*
T1W – 3D GRE Dynamic

Pre

Arterial

Delayed
T1W – 3D GRE Dynamic

Fibrosis leads to delayed uptake
Types I, II, and III-IV cysts
Normal Cortico-Medullary Differentiation (CMD)
The Contrast Enhanced Exam - Bolus Timing

- Arterial Phase
  - Automated Breath hold Liver Exam (ABLE)
Bolus Timing – Tumor Perfusion
Bolus Timing
Bolus Timing - ABLE

8 s delay
And breath hold
instructions given

Arterial

Venous and Delayed

70s and 180s
Timing
Arterial Phase – Internal Checks
Liver - Tumors

Sequence Optimization
Sequence Optimization

Liver - Tumors

HCC
Liver: Focal Lesions

FNH
Abnormal Liver: Focal Lesions

HCC

T2
Pre
Arterial
Venous
Interstitial- Delayed
MRI Provides Excellent Sensitivity and Specificity

Detection = Sensitivity
Pathological diagnosis = Specificity
Cholangiocarcinoma
Fibrosis - Advanced
Fibrosis Early
Fibrosis
Confluent Bands
Liver Perfusion

**Acute Hepatitis**

*JMRI 20:838-842, 2004.*
Liver Fat / Iron

Double echo gre in/opposed-phase

TE  4.4 ms

2.2 ms
Liver Fat / Iron

TE  80-100 ms  2.2 ms  4.4 ms

T2 SSFSP  T2* Double echo gre
NASH

JMRI 20:838-842, 2004
Whole Body MRI
Whole Body MRI

- Methodological Considerations
Whole Body MRI

- Multi-station scanning
- Speed
  - Acquisitions
  - Image processing
- Automation
- Surface coils
  - Application
  - Matching FOV to coils
Whole-body MR system
MR Protocols – key building blocks for body MRI

- Single Shot T2 (HASTE/SSH/SSFSE)
- 3D GRE T1 (VIBE/THRIVE/LAVA-xv)
MR Protocols

- Head: FLAIR
- Thorax: T2 HASTE
  - w/ wo Fat Sat
- Abdomen: 3D GRE T1
- Pelvis: pre / post gado
- Thigh: (not listed)
Whole Body Scan – Tumor (30min)

*Chest → Abdo → Pelvis (CAP)*

- **Pre-Gd Contrast**
  - Ax SST2 +/- FS
  - Sag Pelvis
  - Ax 3DGRE
    - Ax 2D GRE In/Opposed phase - Abdomen

- **Post-Gd Contrast**
  - A: Ax 3DGRE Arterial + Venous phase
    - Liver, pancreas
  - P: Ax 3DGRE Venous phase
  - CAP: Ax 3DGRE Delayed phase
Post-Processing Stitched Images

Cor HASTE

Cor VIBE
Lung

2D Gradient Echo

3D Gradient Echo

2D Steady State Precession

2D Single Shot Fast Spin Echo
Lung

CT

3D Gradient Echo

AJR 179:1225-1233, 2002
Lung

CT

3D Gradient Echo

AJR 179:1225-1233, 2002
Crohn’s Disease
Crohn’s Disease
Crohn’s Disease
65F “drain abscess”
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