Abdominal MRI: Techniques Optimization – 20 Min. Exam

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Abdominal MRI: Techniques Optimization


Gadolinium-Enhanced Imaging of Liver Tumors and Manifestations of Hepatitis: Pharmacodynamic and technical considerations. *TMRI 2009;20;71-78*

Pillars of Success…

Image Quality

Comprehensive

Reproducibility

Efficiency
Overview

- Building Blocks of Body MRI
- Routine Protocol
- Advanced Techniques
**MRI of Liver Diseases**

- Detection (Sensitivity)
  = Can you see the lesion/abnormality?

- and Characterization (Specificity)
  = Can you tell what it (the abnormality) is?

*Highly achievable by consider the following:*

- T1 and T2-weighted imaging
- Sequence Optimization
- Gadolinium dynamic multiple-phase acquisitions
History of Ordering Studies…

Body region → Indication → MR Protocol

- Kidney w/wo
- Liver w/wo
- Liver w/wo
- Pancreas w/wo
- Urogram
- MRCP
- Adrenals

The Result: Too many Protocols!
- Confusion for MR techs
- Possible inconsistencies for Radiologists
Optimal Objective

- One protocol for:
  - All patients
  - All organ systems
  - All diseases
Sequence Optimization – Pre-Contrast

VIBE/LAVA/Thrive  HASTE/ssfse/sSh TSE  In phase

HASTE  TFISP/FIESTA/BFFE  Opposed phase

HASTE-SPAIR  HASTE-LongT2 SLAB
Sequence Optimization – Post-Contrast

PRE-VIBE/LAVA/Thrive  Arterial (Triggered)

Venous (70s)  Delayed (180s)

Delayed (300s)
Each Sequence has a role and is complimentary…

<table>
<thead>
<tr>
<th>USER</th>
<th>Abdomen</th>
<th>Liver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Breath hold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>localizer—sh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>t2_corr</td>
<td></td>
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<tr>
<td></td>
<td>t2_tra</td>
<td></td>
</tr>
<tr>
<td></td>
<td>t2_spair</td>
<td></td>
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<tr>
<td></td>
<td>trufi_ax</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in_crp_ax</td>
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<td>vliec ore pre</td>
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<tr>
<td></td>
<td>vliec ax pre</td>
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</tr>
<tr>
<td></td>
<td>Contrast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Care Bolus 7sec delay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vleic ax 20s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vleic ax 70s</td>
<td></td>
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<tr>
<td></td>
<td>MRCP_cor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MRCP_ax_thin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vleic ax 3min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vleic cor delayed</td>
<td></td>
</tr>
</tbody>
</table>

<T2 single-shot
- inflammation, fluid abscesses
- iron

<T2 single shot Fat Sat
- fat-fluid conspicuity
- bowel

<T1 opposed-phase
- fatty infiltration
- iron deposition

3D T1 pre-contrast
- T1 contrast between tissues

3D T1 dynamic
- vessels
- perfusion, neoplasm
- delayed enhancement

Trufisp (T2/T1)
- vessels, susceptibility

MRCP (high T2)
- biliary disease

< 20 minute exam
Room time!
2-Monitor Layout: Generalized
2-Monitor Layout: Bowel

- CorT2
- CorT2FS
- AxT2
- AxT2FS
- SagT2
- HiResT2
- Cor 3D gre
- Pre
- Arterial
- Venous
- Delayed
- Cor-Del
T2W Imaging – Single shot

65F “drain abscess”
Internally Herniated Cecum
Bolus Timing – Tumor Perfusion

TMRI 2009:20;71-78
JMRI 33:110, 2011
Arterial Phase Optimization – Internal Checks
Bolus Timing - ABLE

8 s delay
And breath hold instructions given

Arterial

venous and delayed
Table 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Tumors (n=35)</th>
<th>Tumors &lt; 2cm (n=23)</th>
<th>Tumors ≥ 2 cm (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity*</td>
<td>97.1 [34/35]</td>
<td>82.6 [19/23]</td>
<td>100 [23/23]</td>
</tr>
<tr>
<td></td>
<td>[83.4-99.0]</td>
<td>[66.5-94.3]</td>
<td>[82.2-100]</td>
</tr>
<tr>
<td>Specificity*</td>
<td>100 [66/66]</td>
<td>100 [78/78]</td>
<td>100 [78/78]</td>
</tr>
<tr>
<td></td>
<td>[93.1-100]</td>
<td>[94.2-100]</td>
<td>[94.2-100]</td>
</tr>
<tr>
<td>Positive Predictive Value*</td>
<td>100 [87.4-100]</td>
<td>100 [79.1-100]</td>
<td>100 [82.2-100]</td>
</tr>
<tr>
<td>Negative Predictive Value*</td>
<td>98.5 [90.9-99.9]</td>
<td>95.1 [87.3-98.4]</td>
<td>100 [94.2-100]</td>
</tr>
<tr>
<td>Accuracy*</td>
<td>98.1 [93.8-99.9]</td>
<td>96.0 [89.5-98.7]</td>
<td>100 [95.4-100]</td>
</tr>
</tbody>
</table>

*Data are percentages. Numbers in parentheses are raw data; numbers in brackets are 95% confidence intervals.

<table>
<thead>
<tr>
<th>3D GRE optimization*</th>
<th>2004-2006</th>
<th>2008-2010</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation RF Pulse</td>
<td>Fixed</td>
<td>Wider with slice oversampling</td>
<td>Better homogeneity and contrast in outer slices</td>
</tr>
<tr>
<td>Gradient spoiling</td>
<td>Fixed</td>
<td>Minimized for abdomen</td>
<td>Better efficiency</td>
</tr>
<tr>
<td>Echo asymmetry</td>
<td>None</td>
<td>Reversed (TE closer to opposed-phase)</td>
<td>Fat is suppressed more uniformly</td>
</tr>
<tr>
<td>Linear ascending</td>
<td>None</td>
<td>Extended range</td>
<td>Less edge ringing in the partition direction</td>
</tr>
<tr>
<td>Partition reordering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast administration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agent</td>
<td>Gadodiamide/ Gadobenate</td>
<td>Gadobenate</td>
<td>Reduced risk of NSF (15)</td>
</tr>
<tr>
<td>Dose</td>
<td>0.1 mmol/kg</td>
<td>0.05 mmol/kg</td>
<td>Uniform use of semi-automated, real-time bolus tracking methods</td>
</tr>
<tr>
<td>Bolus timing</td>
<td>Heterogenous: combination of fixed time delay and bolus tracking methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D T2 optimization</td>
<td>Fat suppression</td>
<td>Non-selective IR*</td>
<td>SPAIR*</td>
</tr>
<tr>
<td>Echo-train</td>
<td>Standard single shot with partial-Fourier transform</td>
<td>Echo train shortened with parallel processing</td>
<td>Improved image sharpness</td>
</tr>
</tbody>
</table>

*See Figure 2

IR: Inversion Recovery

*SPAIR: Spectral Adiabatic Inversion Recovery (14)
Challenge for Your Practice of MRI

- Simplify to one root Body MRI protocol
- Monitor room turn-around times
- Work with MRI techs – education, observation
- Target <20 min. room turnaround
  - Uniform high quality studies