High Field Spine Imaging

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3T for MR Applications

Advantages

- Increased signal-to-noise
- Better fat suppression
- Increased enhancement with gadolinium
- Definite measurable benefits for MRS, MRA, & Diffusion tensor imaging

3T for Spine Imaging

Problems

1. Increased SAR (Large FOV met surveys with FSE)
2. Increased chemical shift
3. Decreased T1 contrast
4. Increased susceptibility
5. Dielectric effects
6. More flow artifacts
7. Increased gradient noise (130 dB)
8. Increased cost of purchase & maintenance

3T for Spine Imaging

Problem | Solutions | Trade-offs
--- | --- | ---
Increased SAR | 1. Parallel imaging 2. Shaped RF waveforms 3. Flip angle for acquisition of pulses 4. ETL, TR 5. 3D acquisition | None, ↓ scan time
Increased chemical shift | 1. Bandwidth 2. FOV, Matrix 3. Fat saturation | SNR but ↓ min TE

3T for Spine Imaging

Problem | Solutions | Trade-offs
--- | --- | ---
More flow Artifacts | 1. Sat pulses 2. Change phase direction 3. Use gradient echo | ↓ SAR & may ↓ scan time
Increased gradient noise | 1. Better ear plugs 2. Acoustically shielded bore liners | Cost
Increased cost of magnet & maintenance | 1. Hire the Terminator as your negotiator | ??
Parallel Imaging
Decreases SAR, Susceptibility, Distortion

- Siemens TIM Trio
  - 32 channels
  - 102 coil elements

8 channel SENSE™ Head coil
16 channel SENSE™ NeuroVas
12 element CTL Spine coil
6 channel SENSE™ Torso coil

- All manufacturers have 8 channel systems, moving toward 16 & 32

3T Spine Imaging
C-Spine Sequences

- T2 FSE
- T1 FSE
- T1 FLAIR

3T Spine Imaging
Cervical Axial Sequences

- T2 FSE
- T2 3D FSE

3T Spine Imaging
Cervical Axial Sequences

- T2 GRE
- T2 FSE
- GRE-MERGE

3T Spine Imaging
Cervical Axial Sequences

- COSMIC
- FIESTA/3D CISS

3T Spine Imaging
Post Gd Sequences

- T1 with Gad & FS

3T Spine Imaging
Disk Extrusion

3T Spine Imaging
Demyelinating Disease

3T Spine Imaging
Susceptibility Artifact – Hardware

Increase Bandwidth, Frequency SI / RL, Avoid GRE & Fat Suppression

3T Spine Imaging
Post-op Cervical Spine

IDEAL Contrast: Iterative Decomposition of Water and Fat With Echo Asymmetry and Least-Squares Estimation

Acquired Data

Water Only
Fat Only
In-phase
Out-of-phase


Cervical Spine: Neurofibromatosis

T1W Fat Sat FSE
T1W IDEAL-FSE

Courtesy Scott Reeder
UW-Madison

### 3T Spine Protocols

**Cervical Spine**

<table>
<thead>
<tr>
<th>Sequence</th>
<th>TR/TE/ET/NEX</th>
<th>FOV</th>
<th>Slice</th>
<th>Matrix</th>
<th>Phase</th>
<th>Bandwidth</th>
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</thead>
<tbody>
<tr>
<td>Sagittal T2 FSE</td>
<td>4000/110/24/4</td>
<td>22</td>
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<td>SI</td>
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<td>AP</td>
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<td>2.50</td>
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<tr>
<td>Sag T1 FSE Gd</td>
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<td>3/1</td>
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<tr>
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<td>3/1</td>
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<td>AP</td>
<td>31.2</td>
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</tbody>
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### 3T Spine Imaging

**Thoracic Spine**

- T2 FSE
- T1 FSE
- T1 FLAIR

**Sagittal T2 & T1 FSE**

- T2 FSE
- T1 FSE

**Sagittal Lumbar Spine**

- T2 FSE
- T1 FSE
- T1 FLAIR

"Metastases T1 FLAIR at 3 T"

Courtesy: Meng Law, Mount Sinai, NY

3T Spine Imaging
Phase-artifacts & Chemical Shift

3T Spine Imaging
Phase – Frequency Direction

3T Spine Imaging
Sagittal T2 FSE

3T Spine Imaging
Effect of Vacation

3T Spine Imaging
3T MR-Cat Scan Fusion

3T Spine Imaging
Axial Lumbar Sequences
3T Spine Imaging
Phase-artifact Reduction

Crossed SAT Bands (Vision)

3T Spine Imaging
Lumbar Disk Protrusion

3T Spine Imaging
Proton-Density Axial

3T Spine Imaging
No Coil – No Signal

3T Spine Imaging
Post-Gd T1 with FS

1.5T Spine Imaging
Post-op Lumbar Spine

Dx: Spinal stenosis

History: 32 y/o male with back & leg pain
History: 43 y/o man with back pain for several months

Dx: Hemangioblastoma

History: 36 y/o man with a chronic C6-8 radiculopathy

Dx:
### 3T Spine Protocols

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<td>3.5/0.5</td>
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<td>AP-RL</td>
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**History:** 95 y/o woman with acute bilateral upper extremity weakness

**Dx:** Acute cord infarction

**History:** 48 y/o women with pain down both legs

**Dx:** Spinal epidermoid

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**Dx:** Acute cord infarction

**History:** 48 y/o women with pain down both legs

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