3T MRI of the CNS

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3T MRI for Brain Imaging
Parallel Imaging & Propeller

T2 FSE
FLAIR
3T MRI for Brain Imaging

T1 FLAIR

High Resolution Imaging

MRA
3T MRI for Brain Imaging

Signal Overload

GRE

DWI
3T MRI for Brain Imaging
Too Much Susceptibility
3T for MR Applications

Advantages

- Increased signal-to-noise
- Better fat suppression
- Increased enhancement with gadolinium
- Definite measurable benefits for fMRI, MRS, MRA, Diffusion tensor, & brain imaging
3T for MR Applications

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
Who decided that 3T should become the new standard?

- Vendors who want to sell new expensive magnets?
- Academic radiologists who want to publish?
- Private radiologists who want to market their imaging centers?
- MR physicists?
- Engineers who want to ensure their employment for life to solve the problems with 3T imaging?
# 3T Imaging of the Brain

## Problem

<table>
<thead>
<tr>
<th>Increased SAR</th>
<th>Solutions</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Parallel imaging</td>
<td>None, ↓ scan time</td>
</tr>
<tr>
<td></td>
<td>2. Shaped RF waveforms</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>3. ↓ Flip angle for acquisition rf pulses</td>
<td>Minimal</td>
</tr>
<tr>
<td></td>
<td>4. ↓ ETL, ↑ TR</td>
<td>↑ Scan time</td>
</tr>
<tr>
<td></td>
<td>5. 3D acquisition</td>
<td>↑ Scan time but ↑ SNR</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Increased chemical shift</th>
<th>Solutions</th>
<th>Trade-offs</th>
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<tbody>
<tr>
<td></td>
<td>1. ↑ Bandwidth</td>
<td>↓ SNR but ↓ min TE</td>
</tr>
<tr>
<td></td>
<td>2. ↓ FOV, ↑ Matrix</td>
<td>↓ SNR but ↑ resolution</td>
</tr>
<tr>
<td></td>
<td>3. Fat saturation</td>
<td>↑ SAR &amp; may ↑ scan time</td>
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</table>
# 3T Imaging of the Brain

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<tr>
<td>Gray CSF on T1 images</td>
<td>1. Reduce flip angle</td>
<td>– Minimal</td>
</tr>
<tr>
<td></td>
<td>2. T1 FLAIR</td>
<td>– Minimal</td>
</tr>
<tr>
<td>Increased Susceptibility</td>
<td>1. ↑ Bandwidth</td>
<td>– ↓ SNR but ↓ min TE</td>
</tr>
<tr>
<td></td>
<td>2. ↑ Matrix &amp; ↓ FOV &amp; ↓ slice thickness</td>
<td>– ↓ SNR but ↑ resolution</td>
</tr>
<tr>
<td></td>
<td>3. Parallel imaging</td>
<td>– None, ↓ scan time</td>
</tr>
<tr>
<td></td>
<td>4. ↓ TE for T1WIs</td>
<td>– Better, ↑ SNR</td>
</tr>
<tr>
<td>Dielectric effects</td>
<td>1. 8-channel head coil</td>
<td>– Better, ↑ SNR &amp; ↓ scan time</td>
</tr>
<tr>
<td></td>
<td>2. High electric permittivity pads</td>
<td>– Cumbersome</td>
</tr>
<tr>
<td></td>
<td>3. Multi-transmit RF</td>
<td>– None</td>
</tr>
</tbody>
</table>
# 3T for Spine Imaging

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solutions</th>
<th>Trade-offs</th>
</tr>
</thead>
<tbody>
<tr>
<td>More flow Artifacts</td>
<td>1. Sat pulses</td>
<td>– (\uparrow) SAR &amp; may (\uparrow) scan time</td>
</tr>
<tr>
<td></td>
<td>2. Change phase direction</td>
<td>– May (\uparrow) scan time</td>
</tr>
<tr>
<td></td>
<td>3. Use gradient-echo</td>
<td>– (\downarrow) SNR</td>
</tr>
<tr>
<td>Increased gradient noise</td>
<td>1. Better ear plugs</td>
<td>– Cost</td>
</tr>
<tr>
<td></td>
<td>2. Acoustically shielded bore liners</td>
<td>– Cost</td>
</tr>
<tr>
<td>Increased cost of magnet &amp; maintenance</td>
<td>1. Hire the Terminator as your negotiator</td>
<td>– ???</td>
</tr>
</tbody>
</table>
3T for MR Applications

Other Annoying Factors

- 3T systems marketed and sold before fully developed.
  - 1.5 T coils simply re-tuned for 3T – not ideal.
- What works at lower field doesn’t always work at higher field.
- Vendor applications personnel of limited help.
- Limited & inaccurate technical information on PACS.
  - AGFA: Get TR, TE, ETL, FOV, slice info & flip angle
  - Do not get matrix, NEX, phase, bandwidth or scan time
- Vendor specific nomenclature & defaults.
Parallel Imaging
Decreases SAR, Susceptibility, Distortion

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

- 8 channel ASSET Brain
- 8 channel ASSET NeuroVas
- 8 channel CTL Spine coil
- 16 channel ASSET Head-Neck-Spine Array (29 e)

• All manufacturers have 8 channel systems, moving toward 16 & 32
DBI Protocol

3D Volume Imaging

Hi-res 2mm images

Fast SPGR

Cube FLAIR
Alzheimer’s Disease

ADNI Study – Courtesy James Brewer, UCSD
Anaplastic Oligo (1p/19q deletion)

Radiation
Temodar
Avastin
D-methasone
Sept 2010

Recurrent Oligodendroglioma

Choline maps
Post Treatment MRS Protocol
Multivoxel (TE 144): Coronal and Axial Planes
3T Spine Imaging
Cervical Axial Sequences

GRE - MERGE

T2 3D FRFSE
3T Spine Imaging
Sagittal T2 & T1 FSE
3T Spine Imaging

Axial Lumbar Sequences

T2 FSE

T1 FSE