ADNI-3 MRI Protocol

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Introduction
Brief History of ADNI:
The Alzheimer’s Disease Neuroimaging Initiative (ADNI) is a longitudinal natural history study. Data from ADNI is publicly available (http://adni.loni.usc.edu). The third phase of ADNI (ADNI-3) began in late 2015, with subject imaging beginning in earnest in mid-2017.

MRI developments for ADNI-1 (2007-2009) focused on consistent longitudinal structural imaging on 1.5T scanners using T1- and T2-weighted sequences. One fourth of ADNI-1 subjects were also scanned using essentially the same protocol on 3T scanners. In ADNI-2 (2010-2016) imaging was performed at 3T with T1-weighted imaging parameter similar to ADNI-1 in place of the T2-weighted image from ADNI-1. 2D-FLAIR and T2*-weighted imaging was added at all sites. Fully sampled and accelerated T1-weighted images were acquired from all ADNI sites. Higher resolution is often required depending on scanner manufacturer - diffusion imaging on GE scanners, real time functional MRI on Philips scanners and arterial spin labeling on Siemens scanners.

ADNI-3 imaging is being done exclusively on 3T scanners. Nearly all of the imaging sequences from ADNI-2 have been updated for inclusion in ADNI-3. Each of the ADNI-2 “advanced” imaging sequences is now included in the ADNI-3 Basic and Advanced protocols; the ADNI-3 advanced sequences are largely based on anticipated hardware improvements for ADNI-3.

ADNI-3 Imaging is being carried out at 57 imaging centers on subjects enrolled at 59 clinical sites. Two of the imaging centers each serve two enrolling sites. Scanners from the three largest MRI vendors (GE, Philips and Siemens) are supported across nearly all of the current software and hardware developments; however, Siemens scanners are only a small part of the network at each imaging center so ADNI has no control over scanner system upgrades.

ADNI-3 Basic and Advanced
There is a broad gulf between older MRI systems and the state of the art production systems within each vendor’s product line. The range of scanners being qualified for state of the art production systems within each vendor’s product line is necessary to restrict the sequences employed to those commercially available on scanners.

Rationale:
ADNI is funded through a public/private partnership in order to establish multi-site imaging methods suitable for inclusion in drug studies as well to investigate Alzheimer’s disease progression. In order to create imaging protocols that can be used to support drug studies it is necessary to restrict the sequences employed to those commercially available on scanners.

Scanner Table
<table>
<thead>
<tr>
<th>Scanning Site</th>
<th>MRI Make</th>
<th>Model</th>
<th>120s</th>
<th>180s</th>
<th>240s</th>
<th>300s</th>
<th>360s</th>
<th>420s</th>
<th>480s</th>
<th>540s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayo Clinic</td>
<td>Siemens</td>
<td>Prisma</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<td>✗</td>
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<tr>
<td>University of Southern California</td>
<td>Siemens</td>
<td>Prisma</td>
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<tr>
<td>University of Southern California</td>
<td>Philips</td>
<td>Achieva</td>
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<tr>
<td>University of California San Francisco</td>
<td>Siemens</td>
<td>Verio</td>
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</tr>
</tbody>
</table>

ADNI-3 Sequence Parameters
<table>
<thead>
<tr>
<th>Purpose</th>
<th>Levels</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP-RAGE</td>
<td>1.5T</td>
<td>TR=1900 ms, 10=400 ms, TE=230 ms, 180° flip angle, no EPI</td>
</tr>
<tr>
<td>3D FLAIR</td>
<td>3.0T</td>
<td>TR=1100 ms, TE=80 ms, TI=3000 ms, 180° flip angle, no EPI</td>
</tr>
<tr>
<td>3D Turbo FLAIR</td>
<td>3.0T</td>
<td>TR=7000 ms, TE=100 ms, TI=2500 ms, 3D acquisition</td>
</tr>
<tr>
<td>DTI</td>
<td>3.0T</td>
<td>b=500, 1000, 2000 s/mm², 32 directions, 60×60×60 voxel size, diffusion-weighted images interleaved through if possible in DWI scan</td>
</tr>
<tr>
<td>High Res T2</td>
<td>3.0T</td>
<td>TR=11000 ms, TE=240 ms, 128×128×128 voxel size, 3D acquisition</td>
</tr>
<tr>
<td>High Res T1</td>
<td>3.0T</td>
<td>TR=1500 ms, TE=20 ms, 256×256×128 voxel size, 3D acquisition</td>
</tr>
<tr>
<td>ASL</td>
<td>3.0T</td>
<td>TR=11000 ms, TE=120 ms, 2D PASL on Siemens, 3D PASL on Philips</td>
</tr>
<tr>
<td>PET</td>
<td>18F</td>
<td>15-minutes PET imaging, 3D acquisition</td>
</tr>
</tbody>
</table>

Notes:
- The sequences given above are preliminary for ADNI-3.
- Protocols will be updated as scanner hardware and software become available.
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