Magnetic Resonance Imaging

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Magnetic Resonance Imaging

- Tube shaped machine
- Uses a magnetic field and radio frequency waves
  - Body chemical composition and tissue structure contribute to form image contrast
  - Computer generated image
- Special terms
  - High signal (white or bright), Low signal (dark grey or dark), Isointense (equal density)
Magnetic Resonance Imaging

Advantages:

- No ionizing radiation (no x-rays)
- Sensitive to slight chemical difference
- Three dimensional study
- Capable of showing fine anatomic structure
- Angiography can be done non-invasively
3-T MRI scanning
MRI with Patient
MRI Principles

- Hydrogen ions in the magnetic field of the MRI machine align with a small net dipole (1).
- Application of a radio frequency causes ions to move to a higher energy state (2-3) (Blue arrow).
MRI Principles

• When the frequency is removed the ions begin to return to prior state releasing energy (4 – 5)

• Resulting radiofrequency is measured and localized to create an image (Changing bl)
MRI Sequences

- **T1-Weighted** - short TR short TE - Fat Bright
- **T2-Weighted** - long TR, long TE - Water Bright
- **Proton Density-Weighted** or balanced imaging - long TR, Short TE
<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1 Weighted Image</th>
<th>Proton Density-Weighted Image</th>
<th>T2 Weighted Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR (msec)</td>
<td>≤500</td>
<td>≥2000</td>
<td>≥ 2000</td>
</tr>
<tr>
<td>TE (msec)</td>
<td>≤25</td>
<td>≤40</td>
<td>≥ 75</td>
</tr>
</tbody>
</table>

TR = Time of repetition of the radio-frequency pulse
TE = Time of echo, the time of collecting the signals
## Signal Intensity of Certain Tissues

<table>
<thead>
<tr>
<th></th>
<th>T1-Weighted</th>
<th>Proton Density-Weighted (balanced)</th>
<th>T2-Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF</td>
<td>Dark gray or Black</td>
<td>Dark gray</td>
<td>“White” or light</td>
</tr>
<tr>
<td>White Matter</td>
<td>“White” or light</td>
<td>Dark gray</td>
<td>Dark gray</td>
</tr>
<tr>
<td>Gray Matter</td>
<td>Gray</td>
<td>Light gray</td>
<td>Dark gray</td>
</tr>
</tbody>
</table>
MRI Normal Brain Midline T1

- Corpus Callosum
- Vermis
- Cerebellum
- Scalp
- CSF
Brain MRI Normal Axial T1

- Ventricle
- White Matter
- Grey Matter
- Scalp fat
Brain MRI Normal Flair

- T-2 Sequence
- Special technique suppresses CSF signal
- Allows better evaluation of areas adjacent to CSF spaces
- Excellent for evaluation of Multiple Sclerosis
Brain MRI Normal T2
Brain Coronal T1
Lumbar Spine MRI

Arrow at disk herniation

T1  Proton Density  T2
MRI Thoracic Spine

- Intramedullary Spinal Cord Lesion
MRI Thorax
Cardiac MRI
MRI Abdomen
MR Angiogram Cerebral
Cardiac Function and Perfusion

- Advanced Cardiac evaluation
  - Perfusion
  - Function
CAD Enhanced Prostate MRI

Courtesy of Dr. Kevin DeMarco
Increased Resolution MRA

1024 MR Angiography Exceeds DSA resolution (no contrast)

8-Channel head coil

Courtesy of Jim Potchen, MD
Nerve Track Imaging

[Diagram of nerve tracks]
Brain Functional Imaging-
Listening to Brahms

Music Therapy Professor
Musically Naive Engineer
Brain Functional Imaging
Listening to Someone Reading Prose

Music Professor

Engineer

Courtesy of Jim Potchen, MD