MRI

Thomas Kishen
Spine Surgeon
Sparsh Hospital for Advanced Surgeries
Bangalore
Magnetic Resonance Imaging

**MRI:** Absorption and emission of radiofrequency energy by hydrogen nuclei placed in a strong magnetic field $B_0$

Without $B_0$: Random orientation of nuclei spin angular momentum $\textit{u}$
With $B_0$: \textit{Magnetization} phenomenon
Hydrogen nuclei of the body

(a) No magnetic field

(b) Align in magnetic field

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RF pulse applied

Relaxation of nuclei
Permanent magnet

Magnetic field originates from permanently ferromagnetic materials

No need for additional electrical power or cooling

Disadvantages –

- Low field strengths of 0.4 T.
- Cost of magnet and supporting structures
- Varying changes in the magnetic field
Electromagnet

- Coils of wire wound on an iron core. Magnetised as current flows through.

- Superconducting magnets - partially built from superconducting materials

- No resistance at absolute zero temp.

- High magnetic field
Contraindications for MRI

- Cerebral aneurysmal clips
- Metallic foreign bodies in eye
- Pacemaker
- Metallic implant in the area being scanned
Open MRI
Open MRI
<table>
<thead>
<tr>
<th></th>
<th>Fat</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T1 images</strong></td>
<td>Bright</td>
<td>Dark</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(hypointense)</td>
</tr>
<tr>
<td><strong>T2 images</strong></td>
<td>Less bright</td>
<td>Bright</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(hyperintense)</td>
</tr>
</tbody>
</table>
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MRI

Disc herniation
Far lateral disc herniation
Absence of disc extension beyond the interspace
Disc bulge

- circumferential symmetrical extension beyond the interspace
• Focal, symmetric disc extension beyond the interspace
• Base is broader than any other diameter of the protrusion
• Remains within the outermost fibres of the annulus fibrosus
- Focal, asymmetric disc extension beyond the interspace
- Base is narrower than the diameter of the protrusion
- Penetrates annulus fibrosus but contained by posterior ligament
Disc Sequestration

The extruded disc is not in continuity with the rest of the disc.
Lumbar canal stenosis
L4-L5 canal stenosis
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Multi-level canal stenosis
Facet joint
Facet cyst
Disc Degeneration

High intensity zone
HIZ
High intensity zone - HIZ

Sensitivity and specificity of HIZs was 27% and 87%


HIZ a reliable marker of painful outer annular disruption in patients with LBP

Peng et al. Eur Spine J 2006
## MODIC CHANGES

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE 1</td>
<td>↓</td>
<td>↑</td>
<td>edema</td>
</tr>
<tr>
<td>TYPE II</td>
<td>↑</td>
<td>→</td>
<td>fatty degeneration (or slight ↑)</td>
</tr>
<tr>
<td>TYPE III</td>
<td>↓</td>
<td>↓</td>
<td>bony sclerosis</td>
</tr>
</tbody>
</table>

**Explanation:**
- **TYPE 1**: Decrease in T1 and increase in T2 indicates edema.
- **TYPE II**: Increase in T1 and fatty degeneration (or slight increase).
- **TYPE III**: Decrease in both T1 and T2 indicates bony sclerosis.
Type I
Type II
Type III
Significance of Modic changes

- 22% to 50% Modic changes in DDD

- 73% with Type I change and 11% with Type II, had significant low back pain.  
  Toyone et al. JBJS 1994

- Conversions occur  
  Kuisma et al. Spine 2006
<table>
<thead>
<tr>
<th>Radiologic Exam Procedure</th>
<th>Appropriateness Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain Lumbar X-Rays</td>
<td>8</td>
</tr>
<tr>
<td>Plain MRI</td>
<td>5</td>
</tr>
<tr>
<td>MRI + Gadolinium</td>
<td>4</td>
</tr>
<tr>
<td>Isotope Bone Scan</td>
<td>4</td>
</tr>
<tr>
<td>CT</td>
<td>4</td>
</tr>
<tr>
<td>Myelogram</td>
<td>2</td>
</tr>
<tr>
<td>Myelogram/CT</td>
<td>2</td>
</tr>
</tbody>
</table>
• High signal intensity in fractured vertebra

• Fresh fracture
- 50 year old lady
- Metastatic tumor in T10 vertebra (from thyroid)
- Early paraparesis