SPINAL MAGNETIC RESONANCE IMAGING INTERPRETATION

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INTRODUCTION

- MRI is a non-invasive imaging modality
- Produces 3-dimensional anatomical images by recording changing magnetic fields in tissues
- MRI is based on the principle of nuclear magnetic resonance (NMR)

• Basic principles of NMR
  - Atoms with an odd number of protons or neutrons have spin
  - A moving electric charge, be it positive or negative, produces a magnetic field
PULSE SEQUENCES/ CONTRAST MRI

1. Spin echo sequences
   a. T1 weighted
   b. T2 weighted

2. Inversion recovery sequences
   a. Short tau inversion recovery (STIR)
   b. Fluid attenuation inversion recovery (FLAIR)
   c. Turbo inversion recovery magnitude (TIRM)
   d. Double inversion recovery (DIR)

3. Diffusion weighted sequences

4. Gradient echo sequences

5. Saturation recovery sequences

6. Echo-planar pulse sequences

7. Spiral pulse sequences

Contrast MRI
- Gadolinium-DTPA - paramagnetic compound
- Especially on T1 images
- Evaluation of spine tumors, demyelinating diseases, & intradural/extramedullary lesions
- Post-operatively - can differentiate disc material (non-enhancing) from scar tissue (enhancing)
# MRI Pulse Sequences

<table>
<thead>
<tr>
<th>IMAGE TYPE</th>
<th>FAT</th>
<th>WATER</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Bright</td>
<td>Dark</td>
<td>Best anatomic detail, rapid acquisition</td>
<td>Poor demonstration of pathology/edema</td>
</tr>
<tr>
<td>T2</td>
<td>Bright</td>
<td>Bright</td>
<td>Moderately sensitive for pathology/edema, good myelographic effect</td>
<td>Decreased soft-tissue detail, time-consuming</td>
</tr>
<tr>
<td>Fat-suppressed T2 or STIR</td>
<td>Very dark</td>
<td>Bright</td>
<td>Most sensitive for pathology/edema, excellent myelographic effect</td>
<td>Decreased soft-tissue detail, time-consuming</td>
</tr>
<tr>
<td>Gradient echo</td>
<td>Intermediate</td>
<td>Bright</td>
<td>Evaluation of articular cartilage, degenerative changes, and ligaments; excellent for blood</td>
<td>Very susceptible to metallic artifacts (prostheses), exaggerates effect/appearance of osteophytes</td>
</tr>
</tbody>
</table>
## MRI Tissue Characteristics

<table>
<thead>
<tr>
<th>TISSUE TYPE</th>
<th>T1</th>
<th>T2</th>
<th>STIR</th>
<th>GRADIENT ECHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortical bone</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>Red marrow</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Yellow marrow</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Spinal cord</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Cerebrospinal fluid</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Intervertebral disc</td>
<td>Intermediate</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Fat</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Muscle</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low/intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Ligament</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Physeal scar</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
NORMAL MRI- T1 & T2 WEIGHTED IMAGES

1, Spinal cord;
2, Conus medullaris;
3, Cauda equina;
4, Subarachnoid space;
5, Posterior epidural fat;
6, Ligamentum flavum;
7, Interspinous ligament;
8, Supraspinous ligament;
9, Basivertebral venous plexus;
10, Epidural venous plexus;
11, Anterior epidural fat;
12, Aorta
NORMAL MRI – T1 WEIGHTED IMAGES

Parasagittal T1-weighted image, lumbar spine.

- 1, Lumbar vein;
- 2, Lumbar artery;
- 3, Inferior foraminal veins;
- 4, Dorsal root ganglia;
- 5, Superior foraminal veins;
- 6, Facet joints;
- 7, Transversospinalis (multifidis) muscle;
- 8, Erector spinae muscle group;
- 9, Thoracolumbar fascia, posterior layer.
NORMAL MRI– T2 WEIGHTED AXIAL IMAGES

- Disc
- Neural foramina
- Thecal sac/spinal cord
- Posterior arch
  - Cortical disruption
  - Facet or ligamentum flavum thickening
- Facet joints
SPINAL TRAUMA

• Best imaging method is T2W FS or STIR MR
  – Abnormal T2 hyperintensity or gross discontinuity of spinal ligamentous structure
  – Flexion-extension films: Segmental instability

• STIR and T2WI FS to evaluate spinal ligamentous injury
  – Normal ligament should be thin, contiguous, and low in signal intensity on both T1 and T2WI
  – Increased signal within ligamentous structure indicative of edema, hemorrhage, or inflammation (stretch injury, strain, partial tear)

• Complete discontinuity of ligamentous structure on T2WI indicative of disruption

C4/C5 anterolisthesis with cord compression

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DEGENERATIVE SPINE DISEASES

- Disc
- Vertebral bone
- Nerve root crowded in foramen
- Nerve root (dark) surrounded by fat (white)

Normal Disc

Degenerated Disc. Shows less water content (blacken) on MRI.

Herniated Disc. This disc is also degenerated.
DEGENERATIVE SPINE DISEASES

Thickened ligamentum flavum

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SPINAL INFECTION

Spondylodiscitis

- Ill-defined hypointense vertebral marrow on T1WI with loss of endplate definition on both sides of disc
- Loss of disc height and abnormal disc signal
- Destruction of vertebral endplate cortex
- Vertebral collapse
- Paraspinal — epidural infiltrative soft tissue

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SPINAL INFECTION

- Skip lesions
- Disc sparing
- Large paraspinal abscess
- Entire or multiple vertebral body involvement
- Tendency to spread underneath the ALL than in the anterior epidural space

Tuberculosis of the spine
INTRINSIC CORD MYELOPATHIES

Syrinx

Multiple sclerosis
SPINAL TUMOURS

Vertebral body metastasis L2-L4 in a patient with lung cancer

Plasmacytoma

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SPINAL TUMOURS

Mediastinal Schwannoma - dumb bell appearance

Spinal Meningioma
CONCLUSION

✓ Spinal MR imaging is an excellent tool for identifying soft tissue anatomy of the spine.

✓ As advancements continue to be made in both MR imaging hardware and software, spinal MR imaging continues to expand its role in the delineation of both normal and abnormal spinal anatomy.
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