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Low Back Pain

by Nancy M. Major, M.D.

LEARNING OBJECTIVES

Upon completion of this article, participants should be able to:

1. Explain the epidemiology and clinical presentation of low back pain and basic treatment options.
2. Utilize MRI appropriately in patients with low back disorders.
3. Recognize the limitations of lumbar spine MRI.
4. Compare the utilization of MRI with alternate techniques for lumbar spine disorders.

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DR. MAJOR has no significant financial arrangement or affiliation with any manufacturer of any pharmaceutical or medical device and is not affiliated in any manner with any provider of any commercial medical or healthcare professional service.

Low back pain is a leading musculoskeletal cause of human impairment and disability.[1] The direct costs (healthcare, physical therapy) and indirect costs (lost work time, lost productivity) attributed to low back pain range from $16 billion to $50 billion per year.[2] Common causes of low back and/or radicular pain are lumbar strain, herniated nucleus pulposus, lumbar spondylosis, tumor, and infection.

MRI offers a noninvasive means of evaluating the lumbosacral spine without radiation exposure. It provides excellent soft-tissue resolution and improved imaging of life-threatening pathologies such as neoplasm and infection. Since MRI became available in the mid-1980s, evaluation of the lumbar spine has changed dramatically.

MRI—CLINICAL EXPERIENCE

On T1-weighted MR images, cerebrospinal fluid and other fluid consistencies will be low signal (dark), whereas on T2-weighted images, fluid will be bright (white). Use of different radiofrequency pulses enhances the differences between these two signals. High signal intensity is depicted as a bright (white) area, and, conversely, a dark (black) area is described as a low signal intensity. Two orthogonal planes are used to evaluate the spine. Sagittal and axial imaging planes are most commonly used for the lumbar spine and typically provide adequate visualization of the structures in question (Figure 1).[3,4] Coronal plane images are often added when evaluating the conus of the spinal cord or scoliosis. The conus must be assessed on sagittal MR images as part of the routine search pattern.

With its exceptional soft-tissue resolution, MR is the preferred imaging modality for intervertebral disc-related conditions. Disc desiccation at all stages is easily identified, and intervertebral disc protrusion is well visualized. Because of the

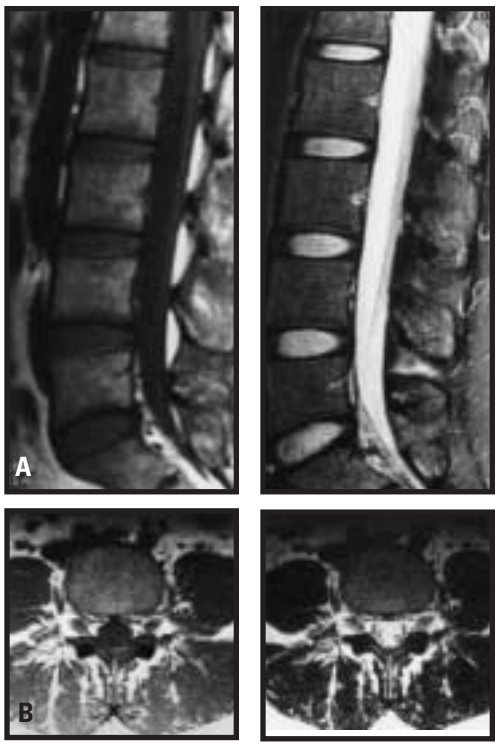

Figure 1. *Normal lumbar spine. A: Sagittal T1- (left) and T2- (right) weighted images. B: Axial T1- (left) and T2- (right) weighted images.*

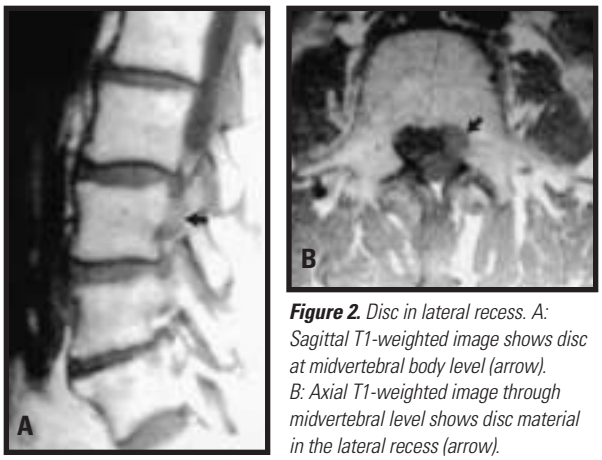

Figure 2. *Disc in lateral recess. A: Sagittal T1-weighted image shows disc at midvertebral body level (arrow). B: Axial T1-weighted image through midvertebral level shows disc material in the lateral recess (arrow).*

high prevalence of spinal pathology in the asymptomatic population, the practitioner must be careful to correlate the results of imaging studies with the patient's clinical examination. Clinicians must avoid the emotional trap associated with a patient in severe pain and not order imaging studies prematurely in those whose symptom will soon subside. A problematic approach to evaluating lumbosacral spine disorders is the philosophy, "Let's order an MRI just to take a look." This inflates medical costs and may lead to unnecessary overtreatment.

State-of-the-art imaging includes sagittal T1- and T2-weighted imaging. Contiguous axial imaging through the lumbar spine is necessary with T1 and T2 weighting. If evaluation in the axial plane is limited to the intervertebral disc space, then such entities as a free fragment of disc material that has migrated away from the disc space, pars interarticularis defect, and intraspinal synovial cysts can easily be overlooked (Figures 2 and 3). Contrast enhancement is recommended for evaluating the symptomatic postsurgical lumbar spine to assist in distinguishing disc material (nonenhancement) from scar formation (enhancement) and for evaluating spinal cord tumors.

ANATOMICAL TYPES

Information concerning the location and type of pain, gathered from history and clinical examination, should guide the physician in planning the MRI evaluation.

• *Lumbosacral strain.* Often the low back is plagued by conditions, such as strain of the lumbar soft tissues, that result from the natural aging process. Symptoms are typically activity-dependent, well localized to the lumbar spine, and nonradiating. On physical examination, objective findings include paraspinal tenderness, limitation of spinal motion, and normal neurological evaluation.

Because of the acute nature of the condition, the differential diagnosis includes degenerative disc/facet disease, acute compression fracture, and early disc herniation. The indications for MR scanning in this clinical situation are limited. Without clinical evidence of neurologic involvement or underlying systemic process, no further imaging is required.

Nonoperative treatment remains the mainstay of care for lumbar strain. Judicious use of nonsteroidal anti-inflammatory medication in combination with bed rest limited to two days or less is appropriate.[5] Other treatment options include soft-tissue injections, physiotherapeutic conditioning, and lumbar stabilization exercises.

• *Herniated nucleus pulposus.* Herniated nucleus pulposus (HNP) is one of the most common causes of sciatica, with a lifetime prevalence of approximately 40%.[2] Presentation can be very similar to lumbar strain. The most distinguishing characteristic is the dermatomal distribution of leg pain, which is more defined in HNP. Gait abnormalities, bowel or bladder dysfunction, and positive Valsalva maneuvers are frequent subjective complaints. Objectively, patients can have a well-defined dermatomal loss of sensation, focal motor loss, and reflex changes.

Differential diagnosis includes spinal stenosis, compression fracture, tumor, or infection with extra-osseous extension. With clinical findings that support the diagnosis of HNP, conservative management may be indicated. Nonoperative techniques for management of HNP focus on pain control and functional rehabilitation. Initially, medication and limited bed rest of less than two days are recommended.[5] In individuals whose symptoms persist, the use of epidural steroid injections and physical therapy can be of great benefit.[6] Patients whose clinical complaints persist or progress warrant surgical consultation.

GUIDELINES FOR USING MRI

MRI is an excellent modality for evaluation of radicular pain of lumbosacral origin. The ideal time to order further imaging is when the results will change treatment interventions. In the evaluation of a suspected lumbosacral disc protrusion, early MRI utilization is frequently unnecessary.

Jensen et al offer a clear, concise, and easily understood classification of disc ruptures:

- bulge: circumferential symmetric extension beyond the interspace (around the end plates);
- protrusion: focal or asymmetric extension of the disc beyond the interspace, with the base against the disc of origin broader than any other dimension of the protrusion; and
- extrusion: more extreme extension of the disc beyond the interspace, with the base against the disc of origin narrower than the diameter of the extruding material itself or with no connection between the material and the disc of origin.[7]

The terms sequestration or free fragment are also used to describe complete separation of a disc fragment from its disc of origin.

A great percentage of herniated discs identified on MR imaging will eventually resolve.[8] MRI is not a screening test and should be used only to confirm the information obtained from a comprehensive history and physical examination.[9] It should be reserved for certain clinical scenarios: when more invasive interventions such as spinal injections or surgery are contemplated, when the etiology of the radicular pain remains uncertain, with cauda equina syndrome, or in cases of suspicion for underlying life-threatening disease states such as infection or neoplasm.

If surgery is being planned, MR examination is strongly recommended to evaluate the precise location of the suspected disc material. If this material is laterally protruding, it will affect the nerve root at the level caudal to the area of suspicion. Failure to identify a lateral disc could result in failed back surgery.

MRI demonstrates disc pathology in a high percentage of patients even without symptoms. In symptomatic patients, a cause-and-effect relationship between MR abnormalities and patients' symptoms should not be casually assumed. Up to 27% of asymptomatic patients can demonstrate disc protrusions on MRI, and 52% have disc bulges (Figure 4). Given these numbers and the prevalence of low back pain, a disc bulge or protrusion will often be an incidental finding on MRI, without clinical significance.

Factors such as size and position of the

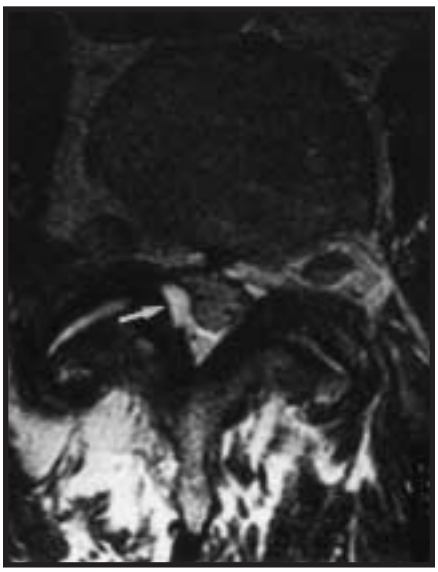

Figure 3 *Axial T2-weighted image shows intraspinal synovial cyst (arrow) with mass effect on the thecal sac. The synovial cyst is from a degenerative facet joint.*

Figure 4. *On MRI evaluations of asymptomatic individuals, Boden et al found a herniated nucleus pulposus in 20% of individuals younger than 60 and in 36% of those older than 60.*

disc protrusion and the morphology of the spinal canal have not been found to differentiate asymptomatic from symptomatic discs. Presently, the history and physical examination provide the only insight into this dilemma. When the history and physical examination findings are consistent with disc herniation and further imaging is necessary, MRI is the most accurate diagnostic study.

• *Lumbar spondylosis.* Lumbar spondylosis (arthritis) and spinal stenosis are conditions along the same continuum. They result from a progressive, noninflammatory arthritis of the lumbar facet joints, with associated degeneration of the lumbar disc. Degenerative changes within the disc and facet joints can reduce the size of the spinal canal, causing the clinical condition of spinal stenosis. Symptoms of lumbar spondylosis include deep, achy discomfort in the low back, which is activity-dependent and exacerbated by certain postures. Spinal stenosis, when symptomatic, produces complaints of lower extremity pain, exacerbated by walking and eased by rest or lumbar flexion. Objective findings in lumbar spondylosis include limited spinal motion in combination with spinal deformities such as degenerative scoliosis and kyphosis.

Common objective findings in lumbar stenosis include radicular pain, dermatomal sensory loss, and motor weakness. Plain-film x-ray is the imaging study of choice for the initial evaluation of lumbar spondylosis and stenosis. Treatment depends upon the presence and magnitude of neurologic dysfunction. Individuals with low back pain only need appropriate coordination of physical therapy, medications, bed rest, and brace immobilization. Individuals who also show signs of progressive neurologic dysfunction are candidates for further radiographic evaluation and surgical consultation. Those individuals with well-localized spinal stenosis and confirmatory diagnostic tests are candidates for surgical decompression.[10]

The appearance of the intervertebral disc on T2-weighted images provides information concerning the hydration of a disc as well as its macromolecular composition and organization.[11] Although the loss of intervertebral disc signal intensity may represent disc desiccation, its usefulness as a diagnostic value remains an important unanswered question. Utilization of discography continues to be controversial, although it remains the sole diagnostic test allowing correlation of radiographic findings and a patient's pain response. Several studies have compared discography with MRI in hopes of providing a noninvasive means for the evaluation of discogenic pain.[12,13] An extensive review contrasting MRI and discography, completed by Herzog, outlines the difficulties of identifying pain generators noninvasively.[9]

Overall, MRI appears to accurately assess the intervertebral disc morphology but cannot accurately identify the painful disc segment in order to guide more aggressive interventions.

• *Spinal infections.* Spinal infections are an uncommon but serious cause of low back pain. Vertebral osteomyelitis has been reported to account for 2% to 4% of all cases of osteomyelitis.[1] The vertebral body and disc can be involved, and gram-positive cocci (*Staphylococcus aureus*) are the primary cause of spinal infection. The predominant complaint remains low back pain, although constitutional symptoms of fever, chills, and weight loss may be present. Findings on physical examination include bony tenderness and paravertebral spasm, with limitation of spine and hip motion. Advanced infections may present with spinal deformity (kyphosis or scoliosis) and associated neurologic dysfunction.

Figure 5. *Decreased vertebral marrow signal intensity on T1-weighted images and corresponding hyperintense signal on T2-weighted images are seen in spinal infections.*

Laboratory evaluation includes CBC, erythrocyte sedimentation rate (ESR), C-reaction protein, blood cultures, and tissue biopsy when indicated. Plain-film x-rays demonstrate structural changes one to two months following the onset of infection. Differential diagnosis includes discitis, spinal tumor, severe lumbar spondylosis, or compression fracture. The treatment of a spinal infection is dependent on the magnitude of infection and clinical presentation. Surgical management is reserved for individuals whose clinical course is refractory to medical management or demonstrates progressive neurologic dysfunction.[14]

MRI has been shown to be as accurate as combined bone scintogram and gallium scan, with 94% accuracy in diagnosing vertebral osteomyelitis.[15] It provides earlier detection and improved localization, with additional information concerning epidural spread and neural element involvement.[16] Decreased vertebral marrow signal intensity on T1-weighted images and corresponding hyperintense signal on T2-weighted images are seen, with increased signal intensity in the intervertebral disc space (Figure 5). Postoperative discitis rates vary between 0.7% and 2.8%.[17] The most common MRI patterns in pyogenic spondylitis are:

—Low signal intensity on T1-weighted images and intermediate to high signal intensity on T2-weighted images involving the vertebral marrow endplates on either side of the disc and moving away from the disc space to involve the entire adjoining vertebral bodies. These inflammatory changes result in marked postcontrast enhancement of the involved marrow.

—The disc will generally show reduced height and will be hyperintense on the T2-weighted images.

—Secondary signs of infection may be present, including paravertebral granulation tissue, epidural extension, ligamentous involvement, paraspinal or soft-tissue abscess, and leptomeningitis.[17]

• *Epidural hematomas.* In the cervical spine, an epidural hematoma requires emergent evacuation to prevent compromise of the spinal cord.[18] In the lumbar spine, as the study by Dorsay and Helms reveals, the occurrence of epidural hematomas is more frequent than previously suspected. Spontaneous epidural hematoma is frequently associated with a protruded disc and an acute event such as a sneeze or cough. Most cases of spontaneous epidural hematomas resolve spontaneously prior to surgery. MR imaging can reliably identify epidural hematoma and distinguish between hematoma and large disc extrusions. The signal intensity is different in the two structures: The T1-weighted image shows high signal representing blood products and will be slightly higher in signal intensity than the extruded disc material (Figure 6).

• *Spinal tumors.* Tumors of the lumbar spine, either benign or malignant, are uncommon causes of low back pain, but these conditions are often associated with significant morbidity and mortality. The ratio of metastatic to primary tumors is 25 to 1.[19] A gradual onset of low back pain remains the predominant symptom; night and rest pain, pain with recumbency, loss of appetite, and weight loss are not uncommon.

Paresthesia and muscle weakness can occur as a result of neural compression or spinal instability. Patients may present with cachexia, localized back tenderness, numbness, or muscle weakness.

Differential diagnosis includes osteoporotic compression fracture, primary and secondary malignant tumor, infection, and other infiltrative disorders. Diagnosis is made by following a comprehensive history and physical examination with appropriate laboratory and radiographic studies. Laboratory studies should include but are not limited to CBC, general chemistries, serum protein electrophoresis, urine protein electrophoresis, ESR, urinalysis, and prostate-specific antigen. Tumor biopsy provides the definitive diagnosis.

Treatment of spinal tumors is tissue-specific and depends greatly on the anatomic location of the lesion. In metastatic and myelomatous conditions, the combination of radiation and chemotherapy remains the mainstay of management. Surgery plays an important role in patients with primary bone tumors, spinal instability, and situations of neural compression.[20]

MR is the preferred imaging modality for intraspinal tumors, spinal infections, syringomyelia, cord infarction, multiple sclerosis, and intramedullary tumors.[3,5,21] In patients with a history that raises concern for an underlying systemic process, MRI provides high sensitivity for inflammatory processes in soft tissue or bone.

Differentiating the location of the spinal tumor to intramedullary, intradural, extramedullary, and extradural compartments greatly aids in the differential diagnosis. MR is a noninvasive imaging modality, with minimal associated morbidity, that is able to evaluate the entire spinal column, including the spinal cord with intra- and extradural compartments, in one examination. Appearance of individual tumors varies greatly depending on relaxation times and utilization of gadolinium.

Fractures, such as sacral insufficiency and sacral stress fractures, can also be evaluated readily with MRI. Patients who are osteoporotic or who have had radiation therapy to the sacrum are susceptible to insufficiency fractures. These patients can present with symptoms confusing for disc disease, but they may have debilitating back pain. Sacral stress fractures, on the other hand, occur in athletes who do a great deal of running and have normal bone density. The diagnosis clinically is often confused for disc disease. These fractures are seen as abnormal signal intensity in the sacrum paralleling the sacroiliac joints on T1- and T2-weighted images.

Figure 6. *Hematoma. Sagittal T1-weighted image shows epidural hematoma.*

DISCUSSION

MRI has been compared with other neuroimaging techniques, and some controversy still remains in the literature. Forristall et al compared contrast CT with MRI for the identification of a lumbar disc herniation.[22] It appears that CT scans provide very good bone resolution but do not provide adequate information regarding neural compression unless combined with myelography.[23] T1-weighted MR images allow adequate visualization of bone anatomy. The multiplanar capability of MRI allows superior evaluation of the foramen and direct visualization of the nerve roots. Myelography is an invasive procedure, can sometimes be painful, and is not risk-free. Most back surgeons therefore use MRI for preoperative evaluations.

Future research endeavors must study the natural history of disc abnormalities noted on MR imaging studies. Bulges, herniation, dehydration, and degeneration are common in asymptomatic persons. The clinical relevance of these changes and whether they predict future difficulties such as disc herniation, radiculopathy, or back pain remain to be determined.

Identifying the etiology of low back pain can be challenging. MRI has been an invaluable advance to medicine, but in the evaluation of low back disorders, it must follow a thorough history and physical examination. Injudicious use increases the likelihood of false-positive results and potential misdiagnosis. MRI is a costly diagnostic test with a high incidence of false-positive findings. It must be reserved for those clinical scenarios in which patient management will be affected. Correlation with clinical presentation is imperative, especially when considering invasive interventions. Future efforts must focus on the natural history of intervertebral disc abnormalities. Results from well-defined prospective studies will provide the basis for strict guidelines for MRI use in patients with low back pain. These precautions will eliminate overutilization of MRI.

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