Chapter 15 Examination, Radiologic and Diagnostic Evaluation, and Patient Indications

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KEYPOINTS

- The continued introduction of new treatment alternatives emphasizes the need for better methods to examine and evaluate patients.
- A well-documented patient history is the foundation to understanding the etiology of the patient's pain.
- Advanced imaging modalities (CT, MRI) are of significant value in visualizing the spine and associated soft tissue structures.
- The combination of examination and diagnostic tools is critical to the definition of potential treatment options.

INTRODUCTION

Low back pain (LBP) is a condition with a large multifaceted socioeconomic impact that affects both the individual and supporting healthcare system consuming significant therapeutic and financial resources. The condition has been reported throughout history[1] and remains one of the primary reasons for consulting a general practioner at all stages of a patient's life.

The common causes of low back pain include muscle strain, nerve irritation, radiculopathy, bony encroachment, and other conditions of the bone and joints. Common pain generators include the bone, disc, tendon, muscle, ligament and nerve. Taken individually, identification of the underlying cause of LBP is complex, however, when the potential causes present in combination, the diagnostic evaluation becomes even more challenging for the examiner.

One of the more difficult aspects of spine surgery in the lower back has always been the ability to understand and identify the proper patient indications for a given surgical procedure. The evolution of new technologies that promise a more minimally invasive approach without the permanence of fusion, make this an even more challenging task.[2]

The continued introduction of new treatment alternatives highlights the importance of developing better methods to effectively examine and evaluate patients. While the major elements of a "history and physical exam" have not changed over the course of time, the interpretation of results in the context of patient-driven-outcomes-measures has resulted in the more critical assessment of current diagnostic techniques and potential patient treatment procedures.

PATIENT HISTORY

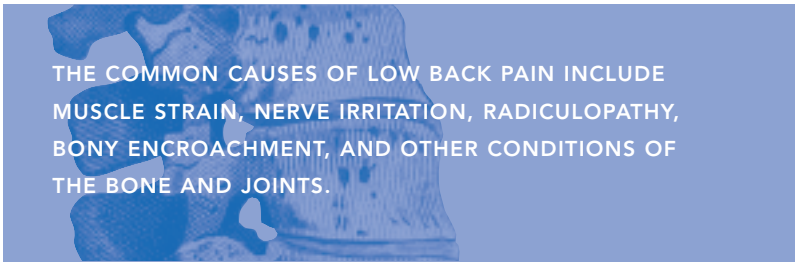
The cornerstone to any diagnosis is a good working knowledge of the patient's background and medical history. Thus, in addition to the patient's physical presentation, the social background, cultural differences, psychological state, and secondary gain scenarios (workers compensation or job dissatisfaction) must also be considered in the evaluation of discogenic back pain.

A well-documented history will also include careful consideration of the patient's chief complaint, pain duration, precipitating events, and activities that exacerbate or ameliorate the painful condition, as these items form the foundation for developing an understanding of the underlying cause of the patient's symptoms.

Patients that present with LBP are commonly seeking treatment for a physical ailment. As such, one of the primary tasks in the diagnosis of LBP is the ability to classify it as acute, subacute, or chronic. Acute back pain usually lasts for up to six weeks and subacute pain for six to twelve weeks, while chronic back pain lasts for more than twelve weeks and is recalcitrant to treatment. When assessing pain history, both the type of pain (sharp, shooting, dull, burning, aching, radiating) and corresponding location should be recorded to help the clinician understand the possible etiology.

The positional character of the patient's symptoms can often be of significant value in diagnosis. For example, LBP that is exacerbated as a result of sitting or bending forward is more likely to be discogenic in nature. Discogenic pain is typically located in the lower back and upper buttock and should not radiate below the level of the patient's knee. This type of pain may also increase when the patient attempts to carry load. LBP that worsens with extension is typically facet mediated.

If the patient complains of sciatic pain, the nerve root is most likely compressed. Nerve root compression most commonly results from disc herniation, but can also arise from foraminal stenosis, secondary to the severe disc space collapse associated with degenerative disc disease (DDD). Proper identification of such etiologies is extremely important when considering surgical intervention.[3]



THE COMMON CAUSES OF LOW BACK PAIN INCLUDE MUSCLE STRAIN, NERVE IRRITATION, RADICULOPATHY, BONY ENCROACHMENT, AND OTHER CONDITIONS OF THE BONE AND JOINTS.

PHYSICAL EXAMINATION

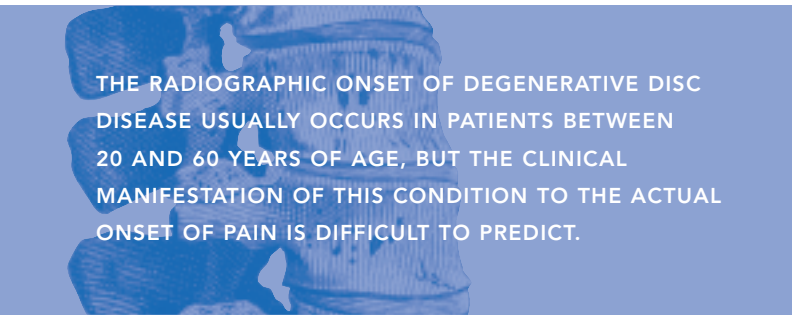
The physical examination of the spine should be standardized to ensure complete evaluation of the patient's posture, station, gait, and ability to move around in the examination room without pain. A thorough examination involves the evaluation of the patient's motor strength by individual muscle group, sensory function by dermatome, and reflex examination including the presence of long tract signs. Lumbar flexion, extension, lateral bending, and axial rotation should be performed with the ability to reproduce the pain symptoms duly noted.

In addition, pain and function associated with range of motion studies of the hips and knees, and the condition of the sacroiliac joints should be assessed. Assessment of the sacroiliac joints is achieved by applying manual pressure over the joints and performing the Patrick's flexion, abduction, external rotation maneuver. Finally, a vascular examination including an assessment of pulses, edema, and trophic changes should be performed.

INTERVERTEBRAL DISC ASSESSMENT

The intervertebral discs constitute roughly one third of the vertebral column length. Thus, changes that occur in the disc, such as a loss in height or herniation, can have a profound effect on other spinal structures including the facet joints, paraspinous muscles, and exiting nerves resulting in pain. Degeneration of the disc itself, can also be a pain generator due to innervation of the annulus.[4]

Degenerative disc disease has been classified in stages.[5] The radiographic onset of the disease usually occurs in patients between 20 and 60 years of age, but the clinical manifestation of this condition to the actual onset of pain is difficult to predict.[6] Some authors have also reported that disc degeneration in certain individuals may be a result of genetic predisposition.[7]



THE RADIOGRAPHIC ONSET OF DEGENERATIVE DISC DISEASE USUALLY OCCURS IN PATIENTS BETWEEN 20 AND 60 YEARS OF AGE, BUT THE CLINICAL MANIFESTATION OF THIS CONDITION TO THE ACTUAL ONSET OF PAIN IS DIFFICULT TO PREDICT.

In a normal disc, the properly hydrated nucleus pulposus accepts compressive load and distributes it, via hydrostatic pressure, to the annulus fibrosus. As the disc degenerates, the nucleus loses water content resulting in a reduced intradiscal pressure and corresponding loss in height, altering the biomechanics of the spine.

Consequently, the annulus assumes the role of distributing the excess compressive load resulting in stress induced morphological changes. Such morphological changes can be evaluated using several diagnostic methods to assist in the identification of the pain source and aid in developing a suitable therapeutic strategy.

DIAGNOSTIC EVALUATION

The most common spine imaging modalities include plain x-rays, computed tomography (CT) and magnetic resonance imaging (MRI). Additional imaging studies, such as discography or myelography, may also be requested by spine specialists. Many of these imaging modalities have established grading systems that can be used to describe the stage of disc degeneration.[8]

Figure 1

Figure 2

RADIOGRAPHY

X-ray is the most commonly performed spinal imaging study as it is readily available in primary care settings. AP and lateral plain films provide key information in regard to spinal alignment, scoliosis, spondylolisthesis, bone quality/density, and potential fractures. Films taken in flexion and extension positions may also help identify normal spinal motion or potential instabilities. In addition, properly scaled films allow for the measurement of vertebral body and disc dimensions that may be used in surgical planning (Figures 1 & 2).

A more detailed review of plain films can be used to identify variations in endplate morphology, such as Schmorl´s nodules, which represent protrusions of the nucleus pulposus into the vertebral body. The presence of Schmorl´s nodes, may indicate that degenerative processes are underway and may be advanced in the affected spinal segments.[9]

While x-ray has many apparent advantages, there are a few well-recognized disadvantages that include the two dimensional nature of the information, exposure to radiation, and an inability to directly assess the condition of the cartilaginous endplate and surrounding soft tissue structures.

AS THE DISC DEGENERATES, THE NUCLEUS LOSES WATER CONTENT RESULTING IN A REDUCED INTRADISCAL PRESSURE AND CORRESPONDING LOSS IN HEIGHT, ALTERING THE BIOMECHANICS OF THE SPINE.

COMPUTED TOMOGRAPHY

Computed tomography (CT) represents an advanced radiographic technique that provides three dimensional imaging for analysis. This imaging method offers improved resolution and provides better visualization of the bony structures of the spine in comparison to plain radiography.

CT provides a more detailed view that can be utilized to assess facet integrity and health, disc space height, endplate sclerosis, and the presence of vacuum phenomena. When imaging is being performed to evaluate bone-related issues, CT is preferable to other methods as it allows direct visualization of the cortical bone. Thus, abnormalities such as pars defects, bony foraminal stenosis, and calcification of disc herniations can readily be assessed (Figures 3 a, b & c).

Figure 3a

Figure 3b

Figure 3c

MRI

Magnetic resonance imaging (MRI) is a powerful imaging modality that can provide extraordinary detail. By using different relaxation techniques (T1, T2, T1ρ), MRI can be utilized to obtain high contrast images of the bone and soft tissue structures. In fact, this imaging method is sensitive enough to differentiate between different soft tissue structures such as the annulus fibrosus and the nucleus pulposus. For diagnostic purposes, the use of MRI can assist in identifying the presence of high intensity zones, annular fissures, and disc herniations allowing resultant neurologic compression to be quantified. MRI has also been used to characterize signal changes in the bone marrow adjacent to the vertebral endplates; a three-stage classification has been described by Modic.[10]

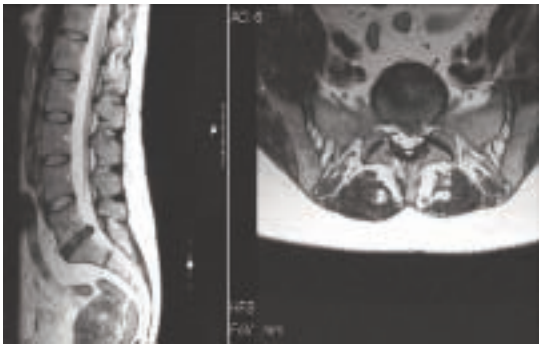


Figure 4

When imaging the intervertebral disc, the major advantages of MRI are best recognized by the use of T2 weighted, sagittal imaging. With the T2 technique, the hydration of the disc nucleus can be easily visualized and compared from one level to the next allowing classification into degenerative stages (Figure 4).

Additional diagnostic information can be obtained using T1ρ spin lock relaxation. This processing technique aids in assessing the proteoglycan content of the nucleus which directly correlates with the water binding capacity. The T1ρ technique also has the potential to detect degeneration of the disc at a significantly earlier point in comparison to the more commonly used MRI techniques.[11] This becomes relevant for the application of treatment strategies such as biological repair enhancement[12] or nucleus pulposus replacement.

While MRI is well-recognized as an excellent tool for visualization of the vertebral bodies, spinal discs, nerves and surrounding structures, the diagnostic value of MRI to predict or identify potential pain generators in the spine remains controversial.[13, 14, 15, 16, 17]

DISCOGRAPHY (DISCOGRAM)

Discography is the injection of contrast media directly into the nucleus pulposus to assess the extent of disc damage and characterize the pain response. This invasive diagnostic method is rarely used in acute low back pain and should only be performed if adequate attempts with non-invasive diagnostic tests have failed to identify the pain source.

Discography is often required to identify an individual disc as the pain source, particularly when several discs have been identified as potential candidates via MRI. The application of this technology is technique dependent and should be performed with the patient awake enough to communicate the character, intensity, and location of their pain during the test.

During injection, the opening pressure, infused fluid volume, and concordance of pain are all recorded. After all discs under evaluation have been injected, a CT scan can be obtained to assess the disc integrity. This combined approach allows anatomical and functional assessment of a problematic disc.

A positive discogram produces a concordant pain response upon injection into the symptomatic disc. Conversely, injection into unaffected or control discs is not painful or produces pain different from that under evaluation.[18] Some authors advocate the use of anesthetic discograms following the provocative portion of the study. If symptoms are relieved or improved with the injection of anesthetic into the disc, this further supports the role of that disc as the pain generator (Figure 5).

Figure 5

PATIENT INDICATIONS

The use of examination and diagnostic tools is critical to developing and understanding a patient's pain etiology and, subsequently, defining potential treatment options. To properly evaluate the use of nucleus arthroplasty, a review of the patient indications is appropriate.

In Nucleus Arthroplasty™ procedures, the goal is to restore, maintain or improve physiologic function of the degenerating disc, while preserving motion. Current nucleus arthroplasty technologies are designed to replace the diseased portion of the nucleus with a substitute material. The ability to preserve motion by replacing only the nuclear core requires that patients are identified in an early disease state in which the degenerative processes are mainly focused in the spinal disc without involvement of the facets. Thus, patients that have pathologies that result in abnormal motion deterioration or significant alteration of the posterior elements would not be appropriate candidates.

By using this information in combination with the anticipated physiological and biomechanical demands, a general outline of patient selection criteria can be developed to improve the potential for achieving good long-term clinical outcomes. Below is a general list of inclusion and exclusion criteria for the use of nucleus arthroplasty technologies that is based on available literature.[2, 3, 19, 20, 21]

Inclusion

- Mild to moderate DDD
- Back pain and/or leg pain (L2-S1)
- Skeletally mature
- Failed conservative care (6+ months)
- Loss in disc height less than 50%, based on adjacent normal disc
- Reasonable physical condition and weight (BMI < 30)
- Documented pain/impact on quality of life (VAS, ODI, SF-12/36)

Exclusion

- Allergies to device materials
- Congenital bony or spinal abnormalities
- Spondylolisthesis
- Spinal stenosis (severe)
- Spinal segment instability
- Facet degeneration
- Schmorl´s nodules or endplate irregularities
- Osteoporosis
- Infection or malignancy
- Significant emotional or psychological issues

As noted previously, this represents a general list of criteria suggested for the application of current nucleus arthroplasty technologies. As the medical community continues to gain more clinical experience with these technologies, the criteria will certainly change. However, in the early stages, the ability to strictly adhere to the inclusion and exclusion criteria defined for a particular technology will be of the utmost importance in obtaining encouraging clinical results.

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