UPMC Rehab Grand Rounds

Diagnosis and Management of Lumbar Radiculopathy

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Clinical Vignette

A 43-year-old male presents with increasing back and right leg pain over the previous two years. He reports numbness in the lower back with throbbing-type pain to the lateral calf and tingling into the ankle which is especially notable when driving. He finds that standing relieves discomfort, yet his pain is worsened when sitting and sleeping. Review of systems is negative for night sweats, weight loss, and bowel or bladder changes. He had a sleep study and was previously diagnosed with restless leg syndrome. He did take ReQuip®, however this did not significantly help. He tried physical therapy for the past two months and notes some relief with stretching and traction, but reports limited improvement overall. On examination, muscle testing is normal but he can only flex comfortably to reach his knees. He has spine extension to approximately 30 degrees and tests for facet loading do not reproduce pain. Reflexes are normal in the upper limbs, while knee-jerk and ankle-jerk reflexes are decreased bilaterally. He has a positive modified slump-sit test on the right at 45 degrees and on the left at 90 degrees, causing right-sided leg pain. Pinprick sensation is slightly decreased at the first toe web space. He is asking for suggestions to improve his pain in order to return to a normal lifestyle.

Definition of Problem

There are an estimated 40.5 million yearly visits to physicians secondary to low back pain. Of these, 65% are secondary to back disorders comprising inflammatory spine conditions, spinal stenosis, lumbago, and spondylosis. Another 17% are secondary to "disc disorders," including herniation and degenerative disc disease.[1] The socioeconomic impact of low back pain is large; it is the most common cause of work-related disability in people under 45 years of age, exceeding over 100 billion dollars every year.[1, 2]

History and Physical Exam

Radiculopathy is the objective loss of sensory and/or motor function as a result of conduction block or loss of axons in a spinal nerve or its roots. Symptoms include numbness and weakness in the distribution of the affected nerve. Radicular pain and radiculopathy are not synonymous. The former is a symptom caused by ectopic impulse generation. The latter relates to objective neurological signs due to a conduction block or loss of axons. The two conditions may coexist and may be caused by the same lesion.[3] A thorough history should include site and radiation of pain, aggravating and relieving factors, change in bowel or bladder function, previous injuries and psychosocial stressors at home or at work. Low back pain that radiates in a dermatomal distribution down the leg, which may or may not be accompanied by numbness, weakness, and difficulty with ambulation, raises concern for lumbar radiculopathy. The pain may increase with actions that increase intra-abdominal pressure, such as coughing, sneezing, and bearing down during defecation.[2, 4, 5] "Red flags," indicating a nonspinal-related diagnosis (such as cancer, infection, and other systemic medical conditions), include weight loss, fever, history of cancer, age >50yrs, and failure to improve in one month.[2, 4]

Specific tests to assess for dural tension include straight-leg raise (SLR), contra-lateral straight leg raise, slump-sit SLR, and femoral nerve tension test. The SLR is associated with L5 or S1 radiculopathy; the femoral nerve tension test checks for L4 radiculopathy. For a dural tension test to be considered positive for a lumbar radiculopathy, the test must reproduce concordant pain into the leg, not just back pain. Slump-sit SLR was found to be more sensitive than the supine SLR, 0.84 (CI: 0.74-0.90), vs. 0.52 (CI:0.42-0.58).[6] (See figures 1, 2, and 3 for examples of dural tests.)

Other clinical problems can mimic radicular pain and should be considered as part of the differential diagnosis, including facet arthritis (zygapophyseal), hip arthritis or sacroiliac disease, piriformis syndrome, greater trochanter bursitis, iliotibial band syndrome, quadriceps/hamstring strain, vascular claudication/insufficiency, lumbosacral plexopathy or entrapment neuropathy, such as lateral femoral cutaneous neuropathy.[7]

Diagnostic Tests

Laboratory studies (CBC, ESR, comprehensive metabolic panels) are typically not a routine part of the initial evaluation, but are ordered based upon the history, physical exam, clinical concern, and initial treatment response.

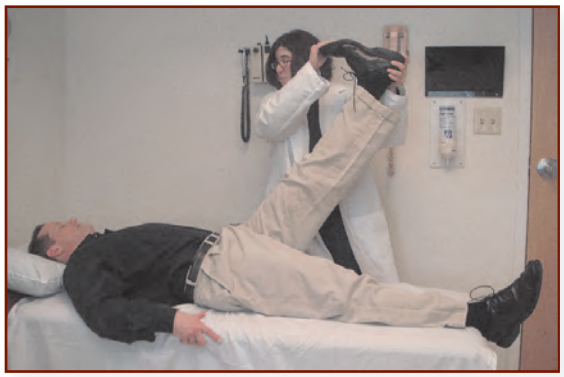
Imaging studies are the most commonly performed tests in the evaluation of low back pain. Clinical guidelines have been developed to improve the appropriate use of radiographic testing.[8] For patients with sciatica likely due to a herniated disc or spinal

Disk Level	Affected Nerve Root	Pain Distribution	Physical Exam Findings
L3-L4	L4	Lower back Posterolateral thigh Across patella Anteromedial leg	**Inspection:** Atrophy of quadriceps muscle **Motor:** Weakness with knee extension **Sensory:** Numbness in the anteromedial thigh and knee region **Affected Reflex:** Knee jerk (diminished)
L4-L5	L5	Sacroiliac region Posterolateral thigh Anterolateral leg	**Inspection:** Atrophy of the anterior calf muscles (minimal) **Motor:** Weakness with dorsiflexion of the first toe and foot **Sensory:** Numbness in the lateral leg and first web space **Affected Reflex:** None or absent posterior tibial reflex and medial hamstring reflex.
L5-S1	S1	Sacroiliac region Hip Posterolateral thigh/leg	**Inspection:** Atrophy of the gastrocnemius and soleus muscles **Motor:** Weakness with plantar flexion of the foot and first toe **Sensory:** Numbness in the back of calf, lateral heel, foot and toe **Affected Reflex:** Ankle jerk (diminished)

Adapted from Low back pain in the aging athlete, *Sports Med Arthrosc Rev, March 2008*[2] (Previously adapted from *The Aging Spine*. Philadelphia: WB Saunders; 1991:177)

Table 1: Clinical Features of Lumbar Radiculopathy

Tests to Assess for Dural Tension



Braggard's SLR modification

Figure 1: Straight Leg Raise (SLR)

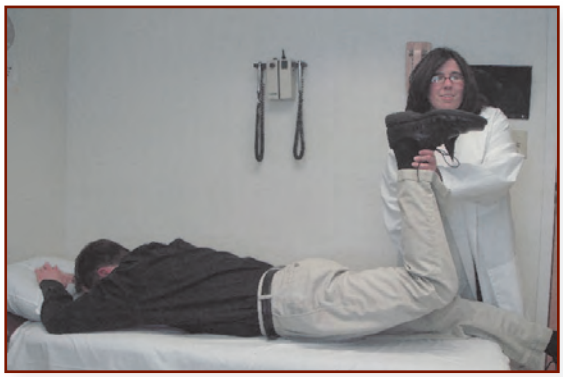


Figure 2: Femoral Nerve Tension Test

Figure 3: Slump-Sit

stenosis without major or progressing neurological abnormalities or intractable pain, imaging during the first four weeks is unnecessary because many patients will improve with conservative treatment.[8, 9, 10] Clinical presentation should drive the decision.

Plain films are easy to obtain and reveal bony detail and alignment. With flexion and extension views, instability of the spine can be seen. Soft tissue structures, however, are not well visualized as in other imaging studies. Computed tomography (CT) can offer better bony and soft tissue detail than plain films, but is more costly and has higher radiation exposure than plain films alone. CT with myelography can improve imaging detail for disc herniation and impingement of nerve roots. MRI offers the best soft tissue detail of the three imaging studies, but offers less bony detail than CT and can miss spinal instability seen with flexion and extension plain films. Selection of imaging studies is based on clinical findings and treatment plan or failure. In clinical situations when history, physical examination, and imaging studies are not revealing, EMG and nerve conduction studies may be useful to confirm myotomal axonal loss or to evaluate other causes of leg pain such as polyneuropathy.

Non-Pharmacological Treatments

A recent Cochrane review published in 2008[11] found that individual patient education programs are effective. One multicenter trial [12] specifically looking at L5 and S1 radiculopathy showed that 70% of patients had resolution of pain in one month, with 60% returning to work in that time period with conservative care. An earlier Cochrane review in 2004[13] comparing bed rest to activity in low back pain found that patients prescribed bed rest had slightly worse functional outcomes. However, in patients with sciatica, there was little to no difference; therefore, best practice is to advise a patient to stay active when they have an acute episode of low back pain.

Fear-avoidance model "presumes that catastrophic interpretations of pain give rise to fear and associated safety behaviors that in the long term paradoxically worsens the problem and augments disability levels."[14] A recent review by Brox et al. in 2008[15] examined three randomized controlled trials using fear-avoidance training. Similar outcomes, compared to spinal fusion, led them to recommend fear-avoidance training as an alternative to spinal fusion.

Core stabilization is an exercise principle used to diminish pain from a lumbar disc herniation. The "core" is best thought of as a muscular box, consisting of the abdominals in the front, the paraspinal and gluteal muscles in the back, the diaphragm as the roof, and the pelvic floor and hip girdle as the floor.[16] The purpose of lumbar stabilization is to restore normal strength and endurance to the muscles of the spine, such as the multifidi, and improve neural processing so that the muscles work more efficiently.[16, 17] Lumbar stabilization programs also focus on muscles involved with direction-specific movement and with carrying weight, such as the latissimus dorsi and superficial paraspinals.

Long et al.[18] reported significant improvement of clinical symptoms and decrease in pain medication use in low back pain patients, with and without radicular symptoms, who were treated with directional preference (DP) exercises as determined by McKenzie Method/Mechanical Diagnosis and Therapy (MDT). DP is posture or movement such as flexion, extension, or side-glide/rotation that decreases or abolishes back pain or causes radicular pain to centralize to midline.

Lumbar traction has mixed outcomes in treating lumbar radiculopathy. Unlu et al.[19] found that traction, ultrasound, and low power laser therapy reduced pain and disability scores as well as decreased size of the herniated disc. A recent review by Gay et al.[20] concluded that axial traction may not be useful in decreasing pain.

Spinal manipulation occurs "when manual loads are applied to the spine by using short or long lever methods and high velocity thrusts that move a spinal joint beyond its restricted range of motion."[4] It is performed by several medical practitioners, including osteopathic physicians, physical therapists, and chiropractors. In the Annals review of 2007, it was noted that spinal manipulation is associated with small to moderate short-term benefits.[4]

Pharmacological Therapy

Acetaminophen is equally effective to other nonsteroidal anti-inflammatory medications (NSAIDs) for initial management.[21, 22] It avoids gastrointestinal side effects of ulcer development and has little effect on increasing bleeding time. Risk of liver toxicity increases with total doses greater than 4 grams/day. NSAIDs, including aspirin and celecoxib, are commonly used for symptomatic relief of low back pain secondary to their analgesic and anti-inflammatory mechanisms of action. A recent Cochrane review published in 2008[21] reviewed the use of NSAIDS in the treatment of low back pain with and without radiculopathy. NSAIDs were found to be slightly effective for short-term symptomatic relief of acute and chronic pain without sciatica. In patients with acute sciatica, no differences were seen comparing

NSAIDs to placebo. The authors concluded that NSAIDs were not more effective than other medications, including acetaminophen, narcotics, and muscle relaxants.

Anti-depressants are frequently used for off-label treatment of patients with low back pain for three main reasons: to relieve neuropathic pain, to improve sleep, and to reduce depression. They are mainly prescribed in the chronic low back pain population. Ten trials[23] comparing antidepressants vs. placebo in the treatment of low back pain determined that there was no clear evidence to support the use of anti-depressants in patients with chronic low back pain. Although the evidence supporting the use of adjunctive analgesics for chronic low back pain is limited, it appears reasonable to use low-dose anti-depressants in mild to moderately painful radiculopathy after acetaminophen and NSAIDs have been tried.[24]

Anti-epileptics, including gabapentin and topiramate, also have been used in the off-label treatment of low back pain with radiculopathy. In three trials comparing gabapentin and placebo, and one trial comparing topiramate with placebo, these medications were associated with small improvements in pain scores.[22]

Systemic corticosteroids are used both in the treatment of acute low back pain and in chronic back pain. In three trials that compared systemic corticosteroids to placebo in patients with acute sciatica, there was no clinically significant benefit to giving oral or IV corticosteroids.[22] Opioids should be used only if pain is unlikely to be controlled with acetaminophen or NSAIDs, secondary to risks of addiction, somnolence, and poor functioning.[4, 25] There is insufficient evidence to recommend one opioid over another.[4]

Nonsurgical Spine Intervention Treatment

Epidural steroid injections are commonly used for the treatment of radicular symptoms associated with symptomatic lumbar intervertebral disc herniations. There is no consensus on how epidural injection therapy should be done with respect to the volume and the mass of steroid or type of anesthetic injected.

Ackerman[26] conducted a randomized controlled study demonstrating that transforaminal (TF) route or epidural steroid placement is more effective than caudal or interlaminar (IL) routes for treatment of lumbar radiculopathy secondary to a herniated disc. This finding was attributable to a higher incidence of steroid placement in the ventral epidural space when the TF method is used.

Schaufele et al.[27] conducted a prospective case-control study comparing interlaminar and transforaminal injection techniques. TF injections for the treatment of symptomatic lumbar disc herniation resulted in better short-term pain improvement and fewer long-term surgical interventions than IL epidural steroid injection.[27] Scans of a transforaminal injection can be viewed at http://www.rehabmedicine.pitt.edu/content.asp?id=1937.

In addition to TF injections, selective nerve root block (SNRB) also can be performed to treat lumbar radiculopathy. Scans of a SNRB procedure can be viewed at http://www.rehabmedicine.pitt.edu/content.asp?id=1937. The terminology TF and SNRB are often used interchangeably, in the sense that both approaches involve delivery of injectate into the foramen. TF route delivers medication to the disc level in question. By definition, a SNRB delivers medication to the nerve root sheath, and can be used as a diagnostic test as well as a therapeutic procedure. Both TF and SNRB injections can be effective for treating lumbar radiculopathy. However, it is important to note that TF and SNRB injections do not "cure" the disc herniation, but can offer pain relief so that a patient is able to tolerate physical therapy.

For clinical situations where the level of involvement is uncertain, a SNRB can be performed for diagnostic purposes. Typically, 2% of preservative-free lidocaine without the addition of corticosteroid is injected. The occurrence (positive) or lack (negative) of significant decrease in pain (>50-80%) is recorded after the procedure. Placebo effect can not be avoided and false positive rates are not known. Once the root level is "diagnosed" a therapeutic SNRB can be performed with the addition of corticosteroid.

Epidural steroid injections and SNRB procedures can be accomplished most effectively with fluoroscopic guidance. Fluoroscopy-guided injections in the axial skeleton are safe and can be quickly administered. The primary goal of using contrast material is to document the correct needle position and prevent inadvertent paraspinal, intravascular, intrathecal, or intra-articular injections.[28]

Riew et al.[29] conducted the first prospective, randomized, double-blind, controlled study evaluating the efficacy of selective nerve root block in the treatment of lumbar radicular pain. This study also determined whether an operation could be avoided in patients with lumbar radicular pain who were otherwise considered to be operative candidates. Riew found that 20 of 28 patients who received therapeutic SNRB opted not to have surgery upon follow-up

(13 to 28 months). Interestingly, nine of the 27 patients who received bupivacaine alone still managed to avoid operation. Compared with injection of bupivacaine alone, injection of bupivacaine with steroids was significantly more likely ($p<0.004$) to result in the avoidance of an operation.[29] Seventeen of 21 patients (81%) contacted at five-year follow-up still had not had any operative intervention.

Surgical Treatment

Surgery is typically recommended only if symptoms persist after a period of conservative treatment.[30, 31] However, there is no consensus on how long conservative treatment should be tried before surgery is considered.[30, 32, 33] Socio-cultural preferences account for a wide variation in the rates of surgery;[30, 34] for example, in the United States and the Netherlands the rates of surgery are relatively high. Dutch guidelines recommend offering the patient the option of surgery if symptoms do not improve after six weeks of conservative treatment. However, the optimal timing of disk surgery has not been established.

Peul[30] conducted a multicenter, prospective, randomized trial among patients with six to 12 weeks of severe sciatica. This study tried to determine whether early surgery leads to better outcomes compared to using conservative treatment for six months followed by surgery only for patients who do not have improvement. Although this study found that early surgery had faster relief of symptoms, overall one-year functional recovery rate was equal to conservative treatment. During the 12 months after randomization, 89% of patients in the early-surgery group and 39% of those in the conservative-treatment group underwent microdiskectomy. At one-year of follow-up, there were no significant differences between the groups for any outcome measure, including leg pain. Thus, the major advantage of early surgical treatment is faster relief of sciatica.[30]

The Future

Etanercept is a water-soluble form of tumor necrosis factor (TNF)-alpha receptor that reduces TNF-alpha activity by binding to TNF-alpha proteins and preventing its interaction with cell surface receptors.[35] Tobinick and Davoodifar[36] evaluated the use of peri-spinal subcutaneous etanercept in a group of 20 patients with chronic cervical or lumbar radicular pain who had previously failed conservative therapy. They received 25 mg of etanercept by localized subcutaneous injection into the perispinal area in closest proximity to the site of presumed disk herniation. All patients reported substantial and sustained clinical improvement with reductions in pain and disability scores and analgesic use. Eight patients discontinued use of opioids. In addition, response to treatment with etanercept was rapid, with 19 of the 20 patients reporting pain relief within 24 hours. Two patients who had previously been disabled were able to return to work full time.[36]

Tissue engineering based on cell therapy is one of the most promising new approaches to repair various tissues, including the intervertebral disc (IVD). This process involves the use of various cell types that have the potential to repair IVD by acting as progenitor cells. Variety of cells available for use in IVD tissue engineering ranges from undifferentiated pluripotent stem cells[37, 38] to well differentiated nucleus pulposus cells.[39, 40]

Clinical Vignette Outcome

The patient had previously taken a Medrol Dosepak® and undergone a L4-5 IL epidural steroid injection underneath CT guidance and found that both were not helpful. He was evaluated with plain x-rays of the lumbar spine without flexion or extension, showing bilateral facet joint arthropathy at L4-5 and L5-S1. Because of prolonged symptoms and lack of progress, he had a lumbar MRI that revealed a broad-based disc bulge at L4-5 superimposed with a right paracentral disc protrusion contacting the traversing right L5 nerve root and extending caudally. He did not wish to undergo surgery.

He underwent two therapeutic right L5 transforaminal epidural steroid injections with significant improvement of his symptoms. He was started on Neurontin® (gabapentin) at 100 mg at bedtime with a titration to 300 mg as tolerated to help with residual right leg symptoms and to improve his sleep. In addition, with the reduction of his pain, he was able to tolerate a brief repeat period of physical therapy to undergo lumbar core stabilization and gluteal strengthening with continued improvement of his symptoms.

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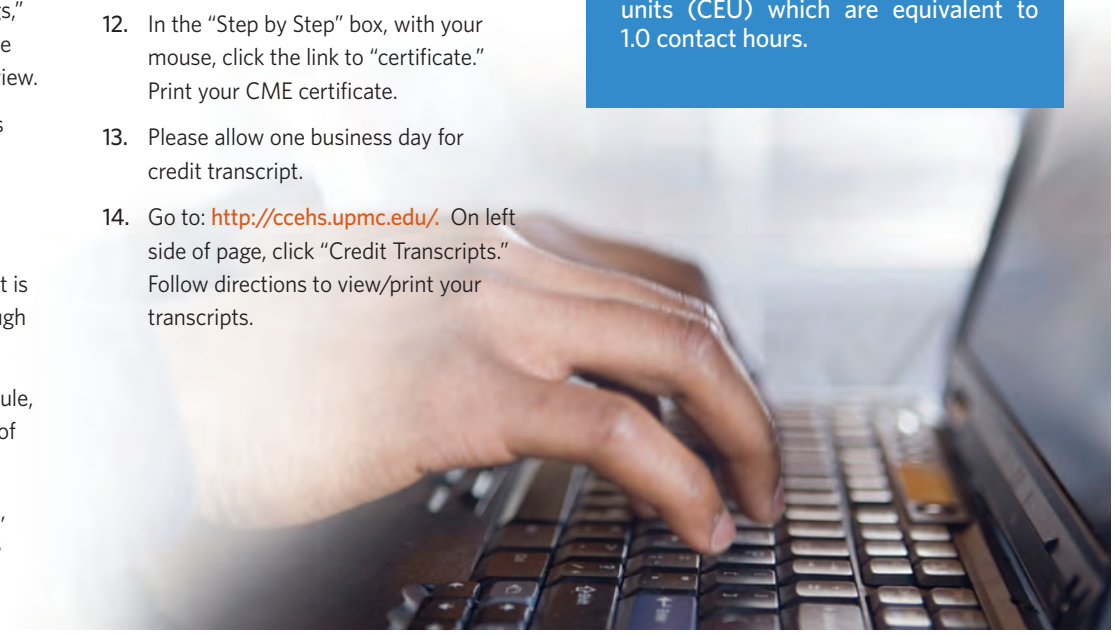

According to data compiled by the National Institutes of Health (NIH) for fiscal year 2006, the University of Pittsburgh Department of Physical Medicine and Rehabilitation ranks second among the more than 50 physical medicine and rehabilitation departments in the nation in research funding — funding used to directly support original research — and fifth highest in total NIH dollars. For more information about our research, go to http://www.rehabmedicine.pitt.edu.

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