Clinical Practice

Herniated Lumbar Intervertebral Disk


A 41-year-old man reports the sudden onset of low back and left leg pain. The symptoms began while he was doing yard work and pulling out large bushes. Since the onset of the pain 2 days ago, it has worsened, although he took a single dose of ibuprofen when the pain began. The patient has no clinically significant medical history, and the physical examination is normal other than severe pain in the left leg with a straight-leg-raising maneuver to 40 degrees. He says, “I’m sure I slipped a disk,” and he requests magnetic resonance imaging (MRI) of the low back. What testing and treatment would you recommend?

The Clinical Problem

Low back pain and leg pain are common symptoms. Two thirds of adults have back pain at some time in their lives, and approximately 10% of adults report back pain that has spread to below the knees within the previous 3 months. “Sciatica” refers to pain in a sciatic-nerve distribution, but this term is sometimes used indiscriminately to describe back and leg pain. Lumbar “radiculopathy” more specifically refers to pain with possible motor and sensory disturbances in a nerve-root distribution. After lumbar stenosis, spondylolisthesis, and fracture have been ruled out, approximately 85% of patients with sciatica are found to have a herniated intervertebral disk.

Herniation, which refers to displacement of intervertebral disk material beyond the normal margins of the disk space, was initially described as disk “rupture.” The disk material may include elements of the nucleus pulposus, annulus fibrosus, or both. Symptomatic herniation most often occurs in the posterolateral aspect of the disk, but midline herniations also occur. Disk-related radiculopathy appears to be both a biochemical and mechanical process. Contact of the nucleus pulposus with a nerve root provokes the inflammation that may be necessary in order for mechanical compression to cause pain. Disk herniation does not necessarily cause pain; MRI commonly shows herniated disks in asymptomatic persons, and the prevalence of herniated disks increases with age. Thus, symptoms may be misattributed to incidental MRI findings.

Both genetic and environmental factors may be important causes of disk herniation. Epidemiologic studies suggest that strenuous activities and cigarette smoking are risk factors. Studies of familial aggregation and studies involving twins suggest that genetic factors may confer a predisposition to disk degeneration and herniation; these factors may be related to the structure of collagen and other disk elements.
The natural history of herniated lumbar disks is generally favorable, but patients with this condition have a slower recovery than those with nonspecific back pain. In one study involving patients with a herniated disk and no indication for immediate surgery, 87% who received only oral analgesics had decreased pain at 3 months. \(^9\) Even in randomized trials that enrolled patients with persistent sciatica, the condition of most patients who did not undergo surgery improved. \(^10,11\)

The condition of patients who have motor deficits corresponding to a single nerve root (such as weakness on dorsiflexion of the foot, or foot drop) associated with herniated disks also improves over time. In one study, 81% of patients with initial paresis had recovered without surgery after 1 year. \(^12\) Sensory deficits may be more persistent; the rate of recovery is 50% at 1 year. MRI shows shrinkage of most herniated disks over time, and up to 76% partially or completely resolve by 1 year. \(^13\) However, recurrences of pain are common. In one study involving a cohort of persons who presented with sciatica, 25% of those whose sciatica resolved had a recurrence of symptoms within 1 year. \(^14\)

**Key Clinical Points**

**Herniated Lumbar Intervertebral Disk**

- Herniated lumbar disks are the leading cause of sciatica, but they also are detected on imaging (MRI or CT) in asymptomatic persons.
- The natural history of herniated lumbar disks is favorable. One study showed that without surgery, pain decreases in approximately 87% of patients within 3 months.
- MRI or CT is indicated in patients with persistent sciatica that lasts 4 to 6 weeks and in whom epidural glucocorticoid injections or surgery are being considered.
- Oral medications and supervised exercise provide slight relief of symptoms. Epidural glucocorticoid injections are an option for patients with severe persistent sciatica, but they do not reduce rates of subsequent surgery.
- Patients with severe or progressive neurologic deficits require a referral for surgery. Elective surgery is an option for patients with congruent clinical and MRI findings and a condition that does not improve within 6 weeks. The major benefit of surgery is relief of sciatica that is faster than relief with conservative treatment, but results of early surgical and prolonged conservative treatment tend to be similar at 1 year of follow-up. Patients and physicians should share in decision making.

**Clinical Diagnosis**

The differential diagnosis of sciatica includes conditions other than herniated disks. These conditions include tumors, a vertebral fracture, an epidural abscess, spondyloolisthesis, lumbar stenosis, a synovial cyst or cysts, and herpetic and diabetic mononeuropathies. \(^3\) Clues to these conditions (e.g., a history of cancer or trauma or the presence of fever) are usually apparent from the history and physical examination. Back pain may precede sciatica, but the pain and paresthesia of sciatica often become dominant, and the pain typically radiates to below the knee. Often there is no specific precipitating event; a “nonsudden” onset is common. \(^35\)

Data obtained from the patient’s clinical history and physical examination are moderately accurate in establishing the diagnosis (Table 1). \(^15-17\) The straight-leg-raising test for nerve-root compression is widely used, and it is typically considered to be positive if sciatica is reproduced by elevating the leg to between 30 and 70 degrees. \(^3\) A positive ipsilateral straight-leg-raising test (in which the leg with sciatica is raised and pain is elicited on the side of the raised leg) is sensitive but not specific. In contrast, a positive crossed straight-leg-raising test (in which sciatica is reproduced by raising the opposite leg) is specific but not sensitive (Table 1). \(^17\)

In two studies of surgery for sciatica, at least 95% of herniated disks were at the L4–L5 or L5–S1 levels. \(^10,11\) Thus, neurologic examination can focus on the L5 and S1 nerve roots (Fig. 1). \(^18\)

Rarely, a massive midline disk herniation may compress the cauda equina; this is known as the cauda equina syndrome. This compression typically causes unilateral or bilateral sciatica, motor weakness, and urinary incontinence or retention. Saddle anesthesia (loss of sensation in the area of the buttocks, posterior superior thighs, and perineum) is characteristic, and anal sphincter tone may be diminished. \(^19\)
Table 1. Estimated Accuracy of Findings on Clinical Assessment for Diagnosis of Nerve-Root Compression Due to a Herniated Disk, According to Either MRI or Surgical Findings.*

<table>
<thead>
<tr>
<th>Assessment and Finding</th>
<th>Patient Sample</th>
<th>Reference Standard</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10% Prevalence</td>
<td>50% Prevalence</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>percent</td>
<td>percent</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical history†</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg pain worse than back pain</td>
<td>Referred from primary care to neurology</td>
<td>MRI</td>
<td>82</td>
<td>54</td>
<td>17</td>
</tr>
<tr>
<td>Typical dermatomal pattern of symptom distribution</td>
<td>Referred from primary care to neurology</td>
<td>MRI</td>
<td>89</td>
<td>31</td>
<td>13</td>
</tr>
<tr>
<td>Pain worse on coughing, sneezing, or straining</td>
<td>Referred from primary care to neurology</td>
<td>MRI</td>
<td>50</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td><strong>Physical examination‡</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive ipsilateral straight-leg-raising test</td>
<td>Primary care</td>
<td>MRI</td>
<td>64</td>
<td>57</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Referred for surgery</td>
<td>Surgical findings</td>
<td>92</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>Positive crossed straight-leg-raising test</td>
<td>Referred for surgery</td>
<td>Surgical findings</td>
<td>28</td>
<td>90</td>
<td>24</td>
</tr>
<tr>
<td>Paralysis</td>
<td>Primary care</td>
<td>MRI</td>
<td>27</td>
<td>93</td>
<td>30</td>
</tr>
<tr>
<td>Muscle atrophy</td>
<td>Referred for surgery</td>
<td>Surgical findings</td>
<td>15–38</td>
<td>50–94</td>
<td>3–41</td>
</tr>
<tr>
<td>Impaired reflexes§</td>
<td>Primary care</td>
<td>MRI</td>
<td>15</td>
<td>93</td>
<td>19</td>
</tr>
<tr>
<td>Neurologist’s assessment based on clinical history and physical examination†</td>
<td>Referred from primary care to neurology</td>
<td>MRI</td>
<td>81</td>
<td>52</td>
<td>16</td>
</tr>
</tbody>
</table>

* Estimates vary substantially among studies, in part because of varying patient selection criteria and procedures. The prevalence of a herniated disk as the cause of back and leg pain may be approximately 10% in primary care and 50% in specialty care. MRI denotes magnetic resonance imaging.

† Data on clinical history are calculated from the data in a study by Vroomen et al.16 That study included patients with back and leg pain. MRI showed herniated disk and nerve-root compression in 152 patients, and 122 patients had other diagnoses.

‡ Estimates are based on data from a systematic review of multiple studies by van der Windt et al.17

§ The L5 nerve root affects neither the Achilles tendon nor the patellar reflex and is one of the two most commonly affected nerve roots. Thus, in a person with suspected L5 radiculopathy, normal reflexes convey no information.
Plain radiography does not show herniated disks, but it helps to rule out a tumor or fracture, infection, and spondylolisthesis. Most guidelines recommend the use of plain radiography only in patients who have a high risk of underlying systemic disease (e.g., a history of cancer) and patients who use injection drugs or receive oral or parenteral glucocorticoids.

Computed tomography (CT) or MRI can confirm a clinical diagnosis of a herniated disk. Early MRI is indicated in patients with progressive or severe deficits (e.g., multiple nerve roots) or clinical findings that suggest an underlying tumor or infection (e.g., findings that indicate injection-drug use or fever). Otherwise, CT or MRI is necessary only in a patient whose condition has not improved over 4 to 6 weeks with conservative treatment and who may be a candidate for epidural glucocorticoid injections or surgery.

On imaging, disk bulging is common among asymptomatic persons (in approximately 60% of persons at 50 years of age), as is disk protrusion (in 36% of persons at 50 years of age). Thus, there is a substantial risk of misleading MRI findings, and an ill-advised cascade of subsequent testing and intervention may result. We therefore do not recommend the routine use of CT or MRI.

CT and MRI terminology was inconsistent in the past, but a consensus now distinguishes among disk bulging, protrusion, extrusion, and sequestration (Fig. 2). The latter three terms define a herniated disk, whereas bulging does not. Extrusion and sequestration are most likely to cause radicular symptoms.

Electromyography is usually unnecessary. However, it may be helpful in patients with ambiguous symptoms or findings on examination and CT or MRI.

**CONSERVATIVE THERAPY**

Cohort studies suggest that the condition of many patients with a herniated lumbar disk improves in 6 weeks; thus, conservative therapy is generally recommended for 6 weeks in the absence of a major neurologic deficit. In one study, 36% of patients reported improvement in their condition at 2 weeks, and this percentage increased substantially with longer follow-up. Furthermore, persistent pain after 6 weeks of conservative therapy has been the entry criterion in most randomized trials of disk surgery.

The favorable natural history of sciatica may explain why certain treatments that have not proved to be effective in clinical trials have been
perceived as being effective. For example, randomized trials have not shown that recovery from sciatica or back pain is faster with bed rest than with watchful waiting. Similarly, a meta-analysis of 32 randomized trials (16 of which were judged to have a low risk of bias) showed no significant benefit of lumbar traction over sham therapy with respect to pain relief, improved function, or reduced absenteeism from work.

There is no evidence that conservative treatments change the natural history of disk herniation, but some offer slight relief of symptoms. Nonsteroidal antiinflammatory drugs (NSAIDs) reduce back pain somewhat in the short term, but they have a less clear benefit in patients with sciatica. The few randomized trials of NSAIDs for sciatica are generally of low quality, and trials to assess the use of acetaminophen in patients with sciatica are lacking.

Randomized trials show no significant advantage of systemic glucocorticoid therapy over placebo with respect to pain relief or reduced rates of subsequent surgical intervention, and they show little, if any, advantage with respect to improvement in physical function. Adverse effects, including insomnia, nervousness, and increased appetite, are common. There is insufficient evidence to judge the efficacy of antiepileptic drugs, antidepressants, or muscle relaxants in patients with sciatica.

Data from randomized trials to support the use of opioids in patients with sciatica are lacking. Systematic reviews suggest that opioids have slight short-term benefits with respect to reduced back pain. Convincing evidence of benefits of long-term use is lacking, and there is growing concern regarding serious long-term adverse effects such as fractures and opioid overdose and abuse. The use of opioids should be limited to patients with severe pain and should be time-limited from the outset.

The use of epidural glucocorticoid injections in patients with herniated disks has increased rapidly in recent years, although these injections...
are used on an off-label basis. A systematic review showed that patients with radiculopathy who received epidural glucocorticoid injections had slightly better pain relief (by 7.5 points on a 100-point scale) and functional improvement at 2 weeks than patients who received placebo. There were no significant advantages at later follow-up and no effect on long-term rates of surgery. Procedural complications are rare, but neurologic events such as paraplegia have been reported, and the Food and Drug Administration recently required a warning on product labels for glucocorticoids. Systemic side effects, including cortisol suppression and osteopenia, may also occur.

In patients with acute disk herniations, avoidance of prolonged inactivity is important. Most patients can be encouraged to stand and walk. The ability to sit comfortably is a sign of improvement in the patient’s condition and suggests that more structured exercise can be undertaken. Evidence regarding the effects of physical therapy and exercise is limited. A systematic review of five randomized trials showed that patients who participated in supervised exercise had greater short-term pain relief than patients who received counseling alone, but this reduction in pain was small and these patients did not have a long-term benefit with respect to reduced pain or disability.

A randomized trial of chiropractic manipulation for subacute or chronic “back-related leg pain” (without confirmation of nerve-root compression on MRI) showed that manipulation was more effective than home exercise with respect to pain relief at 12 weeks (by a mean 1-point decrease on a pain-intensity scale on which scores ranged from 0 to 10, with higher scores indicating greater severity of pain) but not at 1 year. In addition, a randomized trial involving patients who had acute sciatica with MRI-confirmed disk protrusion showed that at 6 months, significantly more patients who underwent chiropractic manipulation had an absence of pain than did those who underwent sham manipulation (55% vs. 20%).

Neurologic complications in the lumbar spine, including worsened disk herniation or the cauda equina syndrome, have been reported anecdotally, but they appear to be extremely rare.

SURGERY

Wide geographic variations in rates of spinal surgery have aroused concern about overuse of spinal surgery in some areas. Unless patients have major neurologic deficits, surgery is generally appropriate only in those who have nerve-root compression that is confirmed on CT or MRI, a corresponding sciatica syndrome, and no response to 6 weeks of conservative therapy. The major benefit of surgery is that relief of sciatica is faster than relief with conservative therapy, but, on average, there is a smaller advantage of surgery with respect to the magnitude of relief of back pain. North American Spine Society guidelines note that, on average, patients with signs of psychological distress such as somatization or depression have worse surgical outcomes than those who do not have these signs, and patients with a positive straight-leg-raising test have better surgical outcomes than those with negative results on this test.

Several randomized trials have compared surgery with conservative treatment for herniated lumbar disks. These trials included patients with minor neurologic deficits but not major or progressive deficits (for whom delaying surgery is ill-advised). All the trials involved the use of open diskectomy or microdiskectomy. Conservative care was not standardized, but it included at least the use of pain medication and physical therapy. None of the trials were blinded (i.e., none required sham surgery), so bias owing to patient expectations was possible. Each trial had substantial crossover between the conservative group and the surgical group; this may have “diluted” a benefit of surgery.

These trials have consistently shown faster relief of pain with surgery than with conservative treatment. However, most, although not all, trials showed no significant advantage of surgery over conservative treatment with respect to relief of sciatica at 1 to 4 years of follow-up. For example, in one trial, the median time to resolution of symptoms was 4 weeks with early surgery and 12 weeks with prolonged conservative therapy; at 1 year, 5% of patients in each group had not recovered. In patients assigned to conservative treatment who later crossed over to the surgical group, the results of surgery were similar to those in patients who underwent earlier surgery; this suggests the absence of a therapeutic window for surgery that closed quickly. Recovery from mild motor deficits occurred in most patients with or without surgery.

Given these results, either surgery or conser-
Clinical Practice

Conclusions and Recommendations

The patient described in the vignette presents with back and leg pain and a positive straight-leg-raising test that suggests a herniated disk. Patients should be reassured regarding the favorable prognosis of herniated disks with sciatica. Clinicians should avoid the use of frightening terms such as

Areas of Uncertainty

Data from epidemiologic studies and biomechanical models suggest that lifestyle modifications such as smoking cessation, weight loss, and regular exercise may prevent sciatica or help to reduce its recurrence. However, we are unaware of relevant randomized trials. There is insufficient evidence to make a recommendation regarding acupuncture for sciatica.

An inflammatory component to lumbar radiculopathy has been recognized, and anticytokine therapy has been proposed. Limited clinical-trial data have been inconsistent, and this approach remains experimental.

Guidelines

A guideline from the American College of Physicians recommends the use of CT or MRI in patients without severe neurologic deficits only if they are candidates for surgery or epidural glucocorticoid injections after a 1-month trial of conservative therapy. An American Pain Society guideline recommends epidural glucocorticoid injections as an option for patients with persistent radiculopathy due to a herniated disk, with shared decision making and consideration of the inconsistent evidence, moderate short-term benefits, and lack of long-term benefits associated with this treatment. It similarly recommends shared decision making regarding surgery. The recommendations in this review are generally concordant with the guidelines of the American College of Physicians, the American Pain Society, and the North American Spine Society.

Repetitive treatment may be a reasonable option, depending on the patient’s preferences for immediate pain relief; how averse the patient is to surgical risks, and other considerations. Thus, shared decision making involving both patients and physicians is valuable; meaningful involvement requires that patients be well informed about these options and their associated benefits and risks. In one randomized trial, patients with a herniated disk who saw a computer-based decision aid were less likely to choose surgery than those who received conventional written materials. Despite these findings, rates vary substantially according to the surgeon.

Even after adjustment for patient demographic factors and coexisting conditions, rates of reoperation at 4 years in one state varied from 10% to 19%; this suggests variability in patient selection, quality of care, and surgical skill.

Several diskectomy techniques are available (Fig. 3). With the emergence of microdiskectomy (see the video) and minimally invasive techniques, there has been a striking shift from inpatient to ambulatory surgery. Patients may return to work quickly even after they have undergone open diskectomy. In a case series involving patients who had no restrictions on activity after surgery, one third returned to work within 1 week, and 97% returned to work by 8 weeks. The interval between surgery and return to full duty was longer in patients with physically strenuous occupations.

Procedural complications of lumbar diskectomy are less common than procedural complications of other types of spine surgery. A registry study indicated that an estimated 0.6 deaths per 1000 procedures had occurred at 60 days after the procedure. New or worsening neurologic deficits occur in 1 to 3% of patients, direct nerve-root injury occurs in 1 to 2%, and wound complications (e.g., infection, dehiscence, and seroma) occur in 1 to 2%. Incidental durotomy, which occurs in approximately 3% of patients, is associated with increases in the duration of surgery, blood loss during surgery, and the length of inpatient stay, as well as potential long-term effects such as headache. All tissues at the surgical site heal with some scarring, which contracts and binds nerves to surrounding structures. Normally, nerve roots glide a few millimeters in the neuroforamen with each walking step. Stretch of tethered nerves may be one source of chronic postsurgical pain.

Repeat operations, for a variety of reasons, occur in approximately 6% of patients after 1 year and in approximately 13% of patients after 4 years; rates vary substantially according to the surgeon.
“ruptured disk” (which implies severe tissue damage) in favor of terms such as “protruded” disk. Conservative therapy for 6 weeks, often including NSAIDs and exercise-based physical therapy, is appropriate for most patients in the absence of severe neurologic deficits, and we would recommend this approach for the patient described. The use of CT or MRI should be discouraged unless the symptoms do not decrease over 4 to 6 weeks and the patient is considered to be a

Figure 3. Technique of Microdiskectomy.

Open diskectomy with a standard surgical incision, often involving a laminectomy, has largely been replaced by microdiskectomy. A posterolateral disk herniation is shown (Panel A). The location where a small incision is made with the aid of a surgical microscope and a small laminotomy (Panel B) are shown. Although diskectomy (Panel C) is a common procedure, it is technically challenging. Surgery at the wrong spinal level can occur. Disk fragments are small, and visually distinguishing them from adjacent dura and nerve roots deep within a small incision is difficult, particularly with surgical instruments and pooling fluids in the way. Retraction of the nerve roots can result in their injury or in laceration of the dura. Newer minimally invasive techniques include endoscopic diskectomy and tubular diskectomy, the latter of which involves the use of a tubular retractor and muscle-splitting technique rather than muscle incision. Trials comparing minimally invasive techniques with microdiskectomy have generally shown similar rates of pain relief, complications, and re-operation.
candidate for epidural glucocorticoid injections or surgery, at which point MRI would be the best test for diagnostic confirmation and surgical planning. Epidural glucocorticoid injections may offer temporary relief in patients with the most severe pain.

In patients with pain that persists beyond 6 weeks and symptoms, findings on examination, and MRI results that are congruent, surgery is an option. Patients and physicians should be engaged in shared decision making regarding surgery, with attention to potential risks and benefits. Patients should be informed that relief of leg pain will probably be faster with surgery than with conservative therapy, that later surgery remains an option if they continue to receive conservative care, and that by 1 year, outcomes of early surgery generally do not differ from those of prolonged conservative therapy.

Dr. Deyo reports receiving a financial award from NuVasive as part of a lifetime achievement award from the International Society for the Study of the Lumbar Spine. No other potential conflict of interest relevant to this article was reported.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.