Approach to the diagnosis and evaluation of low back pain in adults

Authors
Stephanie G Wheeler, MD
Joyce E Wipf, MD
Thomas O Staiger, MD
Richard A Deyo, MD, MPH

Section Editor
Steven J Atlas, MD, MPH

Deputy Editor
H Nancy Sokol, MD

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INTRODUCTION — Back pain is the second most common symptom-related reason for clinician visits in the United States [1]. Up to 84 percent of adults have low back pain at some time in their lives [1,2].

The spectrum of illness and morbidity associated with low back pain is broad. For many individuals, episodes of back pain are self-limited and resolve without specific therapy. For others, however, back pain is recurrent or chronic, causing significant pain that interferes with employment and quality of life. Rarely, acute back pain is a harbinger of serious medical illness, including infection, malignancy, or other systemic disease.

This discussion will focus on an approach to the initial evaluation of a patient presenting with low back pain. Diagnostic tests for low back pain and the treatment of acute, subacute, and chronic low back pain are discussed separately. (See "Diagnostic testing for low back pain" and "Treatment of acute low back pain" and "Subacute and chronic low back pain: Pharmacologic and noninterventional treatment" and "Subacute and chronic low back pain: Nonsurgical interventional treatment" and "Subacute and chronic low back pain: Surgical treatment".)

EPIDEMIOLOGY — In a 1989 to 1990 US survey, back pain accounted for approximately 2.5 percent of medical visits, resulting in 15 million office visits [3]; the percent of office visits due to back pain was essentially the same in 2002 [4].

The prevalence of back pain has been estimated in multiple surveys, representing different populations and different definitions:

- Fourteen percent of survey respondents in the US had back pain, and 2 percent had back pain with sciatica, lasting at least two weeks [1]. The physiologic cause of back pain symptoms cannot be definitively established in up to 85 percent of patients [5].
- A review of 23 studies reporting the prevalence of sciatica in the US between 1980 and 2006 found wide variation, with prevalence ranging from 1.2 to 43.0 percent [6]. This study, and most studies, based the diagnosis on patient-reported symptoms, rather than clinical assessment.
- In the 2002 US National Health Interview Survey (NHIS), with over 30,000 respondents, 26.4 percent reported experiencing back pain lasting at least a whole day in the prior three months [4].
- Fifty percent of the surveyed population in Saskatchewan, Canada had low intensity back pain over the prior six months, and 11 percent had disabling back pain over the prior six months [2].
- Surveys in Canada and Europe found the point prevalence of low back pain to be 22 to 48 percent [2,7]. A population-based survey in England found the prevalence of back pain within one month was 35 percent [8].
- Surveys in one state (North Carolina) conducted in 1992 and 2006 suggest that the prevalence of chronic

low back pain more than doubled (from approximately 4 to 10 percent) in the 14 year interval [9].

The total costs of low back pain in the United States exceed $100 billion per year [10]. Seventy-five percent of the total cost is attributable to fewer than 5 percent of the patients with low back pain.

Back pain has a substantial impact on lifestyle and quality of life. One US survey found that 72 percent of those who sought treatment for back pain gave up on exercising or sports-related activities. Sixty percent said they were unable to perform some daily activities, and 46 percent said they had given up sex because of their back condition [11].

Risk factors — Risk factors for the onset of back pain include smoking, obesity, older age, female gender, physically strenuous work, sedentary work, psychologically strenuous work, low educational attainment, Workers' Compensation insurance, job dissatisfaction and psychological factors such as somatization disorder, anxiety, and depression [2,7,10,12,13].

A population-based, prospective study in England found that physical activity outside the workplace was not associated with back pain, but that poor physical health in both men and women, and heavier weight in women, increased the risk of new back pain [14]. The same study found that jobs involving lifting, pulling, or pushing objects of at least 25 pounds, and jobs involving prolonged periods of standing or walking, were associated with a higher incidence of low back pain, especially among women [15].

Prospective studies have found that psychosocial variables strongly predicted both long-and short-term disability, but structural spine changes were only weakly associated with adverse outcomes [16,17]. In addition, twin studies indicate that genetic factors are associated with the development of degenerative changes on imaging [18]. Additionally, cultural differences may influence the perception of low back pain. As an example, a cross-sectional study, using multivariate analysis to adjust for potential confounders, found that the risk of back pain in West Germany was 2.5 to 3.5 times higher than in the United Kingdom [19].

Prognosis — The long-term outcome of low back pain is generally favorable. In one prospective study, 90 percent of patients seen for low back pain in primary care did not seek care after three months [20]. However, most patients were still experiencing low back pain, for which they did not seek care, one year after the initial episode.

Patients who have high expectations for recovery have better outcomes. A secondary analysis of a randomized trial comparing usual care to chiropractic care, acupuncture, or massage in adults with acute low back pain showed that higher expectations for recovery were associated with greater functional improvement at 12 week follow-up [21]. MRI evaluation to provide reassurance, however, does not lead to better prognosis [22].

A longitudinal study of 973 primary care patients with recent onset low back pain found that 83 percent had mild or no pain and 86 percent had minimal or no disability at one year follow-up; however, only 72 percent had completely recovered [23]. It should be noted that cross-sectional sampling of patients from clinical practices over-represents patients with recurrent pain, and these findings may not be applicable to the general population with low back pain. Indeed, 75 percent of the patients in this study reported previous back pain episodes, 39 percent had previous sick leave for back pain, and 19 percent had been involved in compensation claims.

Psychosocial variables are stronger predictors of long-term disability than anatomic findings found on imaging studies. In a systematic review of 20 prospective studies in patients presenting with acute low back pain, predictors of disabling chronic low back pain at one year follow-up included maladaptive pain coping behaviors, functional impairment, poor general health status, presence of psychiatric comorbidities, or nonorganic signs [24]. (See 'Physical examination' below.)

TERMINOLOGY — Several terms are used to describe conditions related to the back, based upon radiological findings (spondylosis, spondylolisthesis, spondylolysis), physical findings (lumbar lordosis, kyphosis, scoliosis), and clinical or neurologic features (neurogenic claudication, radiculopathy, sciatica, cauda equina syndrome). These terms are defined in a table (table 1).

There are also clinical entities that have been associated with low back pain symptoms that are either hard to reliably diagnose or are not clearly associated with symptoms, including the piriformis syndrome, "back mouse," annular tears, and sacroiliac joint dysfunction.

- The piriformis syndrome is thought by some to be a condition in which the piriformis muscle, a narrow muscle located in the buttocks, compresses or irritates the sciatic nerve [25,26]. There is debate in the medical community whether this is a discrete condition, since it lacks objective evidence and therefore cannot be reliably assessed.

- The "back mouse," a term for a fibro-fatty nodule, has been proposed as a cause of low back pain [27], although only case reports exist and its correlation with back pain is unproven. Older case reports describe findings of fat herniation through a fascia just above the iliac crest in patients, mostly young athletic women, who complained of a tender mass [28].

- Annular tears are tears or fissures of the annulus fibrosus of the intervertebral disk, typically discovered on MRI. It is not clear that annular tears are clinically relevant since several small studies found no correlation between the presence of annular tear and back pain [17,29,30]. As an example, a prospective study of asymptomatic patients found that 38 percent had evidence of annular tears at baseline [31]. Follow-up after three years showed that annular tears were not associated with new back pain [17]. Thus, given available data, these imaging findings appear to have little clinical importance.

- "Sacroiliac joint dysfunction," a term to describe pain in the region of the sacroiliac joint believed to be due to malalignment or abnormal joint movement, is a controversial topic. Tests of pelvic symmetry or sacroiliac joint movement have been shown to have low intertester reliability [32-38] and provocative maneuvers such as fluoroscopically guided injections of the sacroiliac joint have been unreliable in diagnosis and treatment [37,39]. The sacroiliac joint may be a referred site of pain, including from a degenerative disc at L5-S1, spinal stenosis, or osteoarthritis of the hip.

CLINICAL EVALUATION — Low back pain is often attributed to disc degeneration, which is the primary target for many diagnostic approaches (figure 1) [40]. However, the importance of imaging findings associated with disc degeneration (osteophytes, disc narrowing, and herniation) remains unclear. Muscular and ligamentous sources of pain may be equally important.

Although the differential diagnosis of low back pain is broad (table 2), the vast majority of patients seen in primary care will have "mechanical" or non-specific low back pain, meaning that there is no neoplastic, infectious, or primarily inflammatory cause [40]. Among all primary care patients with low back pain, less than 5 percent will have serious systemic pathology. Although patients are often told a specific diagnosis for their back pain, reproducibility of these diagnoses (ie, muscle spasm, sacroiliac pain, trigger points) among providers is poor [32,33,41,42].

Diagnostic uncertainty exists even for those with back symptoms and well-described findings on scan, as these findings are common even in subjects without back pain, and may be unrelated to the symptoms. As an example, herniated disks can be identified in significant numbers of CT or MRI low back studies in subjects with no back pain. (See "Diagnostic testing for low back pain".)

In discussing the cause of a patient's back symptoms, clinicians should avoid using terms that imply deteriorating or damaged body parts. Patients may associate such labels with frightening mental images and serious abnormalities. Phrases such as “back strain,” “protruding disc,” and “normal wear and tear” are more acceptable to patients than "ruptured disc" or "degenerative arthritis" [43].

History — While it may not be possible to define a precise cause of low back symptoms for most patients, it is important to evaluate three key elements of the history:

- Is there evidence of systemic disease?
- Is there evidence of neurologic compromise?
- Is there social or psychological distress that may contribute to chronic, disabling pain?

The psychosocial history helps to estimate prognosis and plan therapy (eg, self-care versus exercise therapy) [44,45]. Potentially useful items are a history of failed previous treatments, substance abuse, and disability compensation. Screening for depression may be helpful.

Underlying systemic diagnosis — Clues that may suggest underlying systemic disease include:

- History of cancer
- Age over 50 years
- Unexplained weight loss
- Duration of pain greater than one month
- Nighttime pain
- Unresponsiveness to previous therapies
- History of abdominal aortic aneurysm

Pain that is not relieved by lying down can be found in patients whose back pain is due to cancer or infection, but is not specific for these conditions. Injection drug use, skin infection, urinary tract infection, or recent fever increase the suspicion of spinal infection. (See "Epidural abscess" and "Vertebral osteomyelitis and discitis".) The presence of ankylosing spondylitis is most commonly diagnosed in men under the age of 40. (See "Diagnosis and differential diagnosis of ankylosing spondylitis in adults".)

Sciatica — Evidence of nerve root irritation typically manifests as sciatica, a sharp or burning pain radiating down the posterior or lateral aspect of the leg, usually to the foot or ankle. Pain radiating below the knee is more likely to represent true radiculopathy than proximal leg pain [46]. Sciatic nerve pain is often associated with numbness or tingling. Sciatica due to disc herniation usually increases with coughing, sneezing, or performance of Valsalva maneuver.

Radiculopathy — The clinical presentations of lumbosacral radiculopathy vary according the level of nerve root or roots involved. The most frequent are the L5 and S1 radiculopathies. Patients present with pain, sensory loss, weakness, and reflex changes consistent with the nerve root involved (table 3).

Lumbosacral radiculopathy is discussed in detail separately. (See "Lumbosacral radiculopathy: Pathophysiology, clinical features, and diagnosis".)

Cauda equina — Bowel or bladder dysfunction may be a symptom of severe compression of the cauda equina, which is a medical emergency. Urinary retention with overflow incontinence is typically present, often with associated saddle anesthesia, bilateral sciatica, and leg weakness. The cauda equina syndrome is most commonly caused by tumor or a massive midline disk herniation. (See "Clinical features and diagnosis of neoplastic epidural spinal cord compression, including cauda equina syndrome".)

Spinal stenosis — Nerve root entrapment in lumbar spinal stenosis is caused by narrowing of the spinal canal (congenital or acquired), nerve root canals, or intervertebral foramina (figure 1). This narrowing is usually caused by bony hypertrophic changes in the facet joints and by thickening of the ligamentum flavum. Disc bulging and spondylolisthesis may contribute. Symptoms of significant lumbar spinal stenosis include back pain, transient tingling in the legs, and ambulation-induced pain localized to the calf and distal lower extremity, resolving with rest. This pain with walking, referred to as "pseudoclaudication" or "neurogenic claudication", is clinically distinguished from vascular claudication by the presence of normal arterial pulses (table 4) [47]. (See "Lumbar spinal stenosis: Pathophysiology, clinical features, and diagnosis" and "Lumbar spinal stenosis: Treatment and prognosis".)

Although pseudoclaudication is a classic finding, it is relatively uncommon. More common symptoms of spinal stenosis are simply persistent back and leg pain that are relieved by sitting or other spine flexion [48]. Among surgical patients with advanced lumbar spinal stenosis documented on myelogram, however, pseudoclaudication was found to be a more frequent symptom [49].

Physical examination — In general, the purpose of the physical examination is to identify features that suggest that imaging and/or other evaluations are indicated (algorithm 1), rather than to make a primary diagnosis. A 2010 systematic review found that many of these physical examination tests, when used alone, had poor diagnostic utility for identifying lumbar radiculopathy due to disc herniation (table 5) [50]. (See "Lumbosacral radiculopathy: Pathophysiology, clinical features, and diagnosis".)

The basic physical examination should include the following components:

- **Inspection of back and posture** — Inspection of the patient on physical examination can reveal

anatomic abnormalities such as scoliosis (lateral spinal curvature) or kyphosis (spinal curvature with posterior convexity). (See "Overview of hyperkyphosis in older persons".)

- **Range of motion** — Range of motion in flexion and extension does not reliably distinguish among pathologic causes, but can provide a baseline to use as an index of therapeutic response. Limited lumbar flexion is not sensitive or specific for diagnosing ankylosing spondylitis.

- **Palpation of the spine** — Palpation of the back is usually performed to assess vertebral or soft tissue tenderness. Vertebral tenderness is a sensitive, but not specific, finding for spinal infection [51]. However, the finding of soft tissue tenderness is poorly reproducible among observers.

- **Straight leg raising (for patients with leg symptoms)** — The straight leg raise test may be useful to help confirm radiculopathy. Straight leg raising is done with the patient supine. The examiner raises the patient's extended leg with the ankle dorsiflexed, being careful that the patient is not actively "helping" in lifting the leg. The test is considered positive when the sciatica is reproduced between 10 and 60 degrees of elevation.

  The crossed straight leg raising test refers to elevation of the unaffected leg. The test is positive when lifting the unaffected leg reproduces the sciatica in the affected leg. The seated straight leg test is done while the patient is in the seated position and the lower leg is slowly extended until the leg is flexed at the hip to 90 degrees. If sciatica is present, the pain will be reproduced as the leg is extended.

  A positive straight leg test has limited sensitivity and specificity for herniated disc (64 and 57 percent respectively) [50]. The crossed straight leg test is less sensitive for herniated disks, but is 90 percent specific.

- **Neurologic assessment of L5 and S1 roots (for patients with leg symptoms)** — For patients suspected of having a disc herniation, neurologic testing should focus on the L5 and S1 nerve roots, since 98 percent of clinically important disc herniations occur at L4-5 and L5-S1 (figure 2) [52]. Signs and symptoms of individual nerve root lesions are presented in the table (table 3).

  L5 motor nerve root testing evaluates strength of ankle and great toe dorsiflexion. L5 sensory nerve root damage would result in numbness in the medial foot and the web space between the first and second toe.

  The S1 nerve root is tested by evaluating ankle reflexes and sensation at the posterior calf and lateral foot. S1 radiculopathy may cause weakness of plantar flexion, but is difficult to detect until quite advanced. One strategy is to have the patient raise up on tip-toe three times in a row, on one foot alone and then the other.

  Although ankle reflexes are an important part of S1 nerve root testing, the absence of ankle reflexes becomes increasingly common with age. Among patients without a known pathologic cause of abnormal reflexes, most patients under age 30 have intact ankle reflexes [53]. However, absent reflexes were found in 30 percent of those between ages 61 and 70 and nearly 50 percent of those ages 81 to 90. Unilateral absence of ankle reflexes was found to be uncommon, though, occurring in only 10 percent of those over age 60. Therefore, unilateral absence of an ankle reflex is rare enough to be a clinically useful sign, with a specificity of 89 percent (table 6 and table 7) [54].

- **Evaluation for malignancy (breast, prostate, lymph node exam)** — When persistent pain or history strongly suggests systemic disease.

- **Peripheral pulses** — Especially in older patients with exercise-induced calf pain to rule out vascular claudication.

- **Nonorganic signs or Waddell's signs** — In patients with chronic pain, psychological distress may amplify low back symptoms, and may be associated with anatomically "inappropriate" physical signs. The most reproducible of these signs are superficial tenderness, distracted straight leg raising (ie, discrepancy between seated and supine straight leg raising tests), and the observation of patient overreaction during

the physical examination, also known as Waddell's signs [55]. Other Waddell's signs suggestive of symptom enhancement include nondermatomal distribution of sensory loss, sudden giving way or jerky movements with motor examination, inconsistency in observed spontaneous activity (dressing, getting off table) and formal motor testing, and pain elicited by axial loading (pressing down on top of head, or rotating the body at hips or shoulders). The presence of multiple Waddell's signs may suggest a behavioral component to a patient's pain. However, systematic reviews have not found an association between Waddell's signs and psychological distress, or claims for disability compensation or litigation [56,57].

APPROACH TO IMAGING — Up to 90 percent of patients with back pain without associated symptoms improve rapidly. Given the favorable prognosis, imaging studies in the first four to six weeks are not necessary, unless there are neurologic findings or a high suspicion of a systemic etiology. Unnecessary imaging studies can expose individuals to radiation without good reason. As an example, gonadal radiation from a two view lumbar spine radiograph is equivalent to radiation exposure from a chest radiograph obtained daily for more than one year [22]. Relative radiation doses for spine imaging studies are shown in a table (table 8). (See "Radiation-related risks of imaging studies".)

Joint guidelines from the American College of Physicians and the American Pain Society (2007) explicitly recommend that "Clinicians should not routinely obtain imaging or other diagnostic tests in patients with nonspecific low back pain" and reserve imaging for patients with severe or progressive neurologic deficits or when serious underlying conditions are suspected on the basis of history and physical examination [58]. Early or frequent use of scanning is not recommended for most patients.

The American College of Physicians and the American College of Radiology have identified potential “red flags” which may identify patients at risk for a more dangerous cause of back pain and represent an indication for earlier imaging studies (table 9) [5,22,59-61]. However, there are very limited data to support the use of any of these criteria as an indication for early imaging. One systematic review examining studies that used one or more of these indications for imaging found that only a history of cancer has been shown to increase the probability of finding spinal malignancy [62]. Other so-called “red flags” had less predictive value or have been inadequately studied as a selection tool for imaging. (See "Diagnostic testing for low back pain".)

Among patients with lumbar pain who have a known abdominal aortic aneurysm (AAA), or those who meet current US Preventive Service Task Force (USPSTF) guidelines for screening for AAA (men ages 65 to 75 who have ever smoked), consider evaluating for AAA rupture or dissection. In one series of surgical patients in France, 17 percent of those with ruptured AAA had lumbar pain as their presenting symptom, and 14 percent had both lumbar and abdominal pain [63]. (See "Screening for abdominal aortic aneurysm".)

If clinical improvement has not occurred after four to six weeks, plain anteroposterior and lateral radiographs of the lumbosacral spine may be useful (two views total). The goal of radiography is to rule out tumor, infection, instability, spondyloarthropathy, and spondylolisthesis. (See "Diagnostic testing for low back pain".)

CT or MRI is indicated for progressive neurologic deficits, high suspicion of cancer or infection, and should be considered for those with more than 12 weeks of persistent low back pain. Computed tomography (CT) and magnetic resonance imaging (MRI) are more sensitive than plain radiographs for detecting infection and cancer, and can show herniated discs and spinal stenosis. MRI is preferred over CT scan for better visualization of soft tissue and absence of radiation exposure [22]. However, MRI or CT findings may be incidental and unrelated to the etiology of low back pain.

A more detailed discussion of testing modalities is presented separately. (See "Diagnostic testing for low back pain".)

INDICATIONS FOR REFERRAL — Referral, usually to a neurosurgeon or orthopedist specializing in back surgery, is indicated when any of the following signs or symptoms are present [64]:

- The cauda equina syndrome – Typical features are bowel and bladder dysfunction (urinary retention), saddle anesthesia, and bilateral leg weakness and numbness. The cauda equina syndrome is a surgical emergency.
- Suspected spinal cord compression – This may present as acute neurologic deficits in a patient with

cancer and risk of spinal metastases, and requires emergent evaluation for surgical decompression or radiation therapy, with specific management determined by the underlying pathology.

- Progressive or severe neurologic deficit

Patients may also be referred to a neurologist or physiatrist if any of the following are present:

- Neuromotor deficit that persists after four to six weeks of conservative therapy
- Persistent sciatica, sensory deficit, or reflex loss after four to six weeks in a patient with positive straight leg raising sign, consistent clinical findings, and favorable psychosocial circumstances (eg, realistic expectations and absence of depression, substance abuse or excessive somatization)

APPROACH TO THE PATIENT — A suggested approach to patients presenting with low back pain is shown in an algorithm (algorithm 1). A somewhat more comprehensive algorithm, that addresses diagnosis and treatment for patients with acute or chronic low back pain, has been developed by the American College of Physicians and the American Pain Society [22].

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient information: Low back pain in adults (The Basics)" and "Patient information: Spinal stenosis (The Basics)" and "Patient information: Herniated disc (The Basics)" and "Patient information: Muscle strain (The Basics)" and "Patient information: Do I need an X-ray (or other test) for low back pain? (The Basics)")
- Beyond the Basics topics (see "Patient information: Low back pain in adults (Beyond the Basics)")

SUMMARY

- Back pain is the second most common symptomatic reason for medical office visits in the US. Risk factors include age, general health, occupation, lifestyle, psychosocial, and cultural factors. (See 'Epidemiology' above.)
- Patients with low back pain should undergo a focused history and examination. The history should include location, duration, and severity of the pain, and details of any prior back pain. Patients should be asked about features that suggest a serious underlying cause (table 9). (See 'History' above.)
- A specific etiology cannot be reliably established for most patients with low back pain, and less than 5 percent have a serious systemic pathology. Systemic disease is suggested by age over 50 years, history of cancer, unexplained weight loss, duration of pain greater than one month, nighttime pain, or unresponsiveness to previous therapies. Spinal infection is suggested by fever, history of injection drug use, or recent skin or urinary infection. (See 'Underlying systemic diagnosis' above.)
- Neurologic involvement is suggested by symptoms of sciatica or pseudoclaudication. Pain radiating below the knee is more likely to represent true radiculopathy than pain radiating only to the posterior thigh. Numbness or weakness in the legs increases the likelihood of neurologic involvement. (See 'Sciatica' above.)
- The cauda equina syndrome is a surgical emergency. Common findings are bladder dysfunction (especially urinary retention) and saddle anesthesia, in addition to sciatica and weakness. (See 'Cauda equina' above.)

- Lumbar spinal stenosis may present with pseudoclaudication, characterized by leg pain during ambulation that improves with rest, and may include numbness and pain radiating to the foot. (See 'Spinal stenosis' above.)
- The physical examination should include: observation of walking, changing positions, and spinal motion; peripheral pulses (in older patients with leg symptoms); a focused neurologic examination based on history, with testing of L5 and S1 nerve roots in patients with leg symptoms; and an appropriate detailed examination related to any red flags found in the history. Patients with back pain and psychological distress may display anatomically "inappropriate" signs of pain amplification. (See 'Physical examination' above.)
- Imaging studies in the first four to six weeks are not necessary, unless there are progressive neurological findings or a high suspicion of a systemic etiology. A plain anteroposterior and lateral X-ray of the lumbar spine is appropriate if clinical improvement has not occurred after four to six weeks. (See 'Approach to imaging' above.)
- CT and MRI studies are more sensitive than plain films for detecting infection, cancer, disc pathology, and spinal stenosis. However, bulging discs are seen in more than 50 percent of asymptomatic patients; asymptomatic herniated discs are seen as well, though less frequently. Disc extrusions have more diagnostic significance than disc protrusions. CT or MRI is indicated for progressive neurologic deficits, high suspicion of cancer or infection, or after 12 weeks of persistent low back pain. (See 'Approach to imaging' above.)
- Urgent referral is indicated for patients with suspected cauda equina syndrome or spinal cord compression. Surgical referral is also indicated for patients with progressive or severe neurologic deficits. Patients with persistent sciatica, sensory deficits, or reflex loss after four to six weeks, and who have consistent clinical findings, may also benefit from a specialist evaluation. (See 'Indications for referral' above.)

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Topic 7782 Version 27.0

GRAPHICS

Terminology used in back pain

Spondylosis: arthritis of the spine. Seen radiographically as disc space narrowing and arthritic changes of the facet joint.

Spondylolisthesis: anterior displacement of a vertebra on the one beneath it. A radiologist determines the degree of slippage upon reviewing spinal x-rays. Slippage is graded I through IV:

- Grade I - 1 percent to 25 percent slip
- Grade II - 26 percent to 50 percent slip
- Grade III - 51 percent to 75 percent slip
- Grade IV - 76 percent to 100 percent slip

Generally, Grade I and Grade II slips do not require surgical treatment and are treated medically. However, Grade III and Grade IV slips, and some milder grade slips, may benefit from surgery if persistent and disabling symptoms are present.

Spondylolysis: a fracture in the pars interarticularis where the vertebral body and the posterior elements, protecting the nerves are joined. In a small percent of the adult population, there is a developmental crack in one of the vertebrae, usually at L5.

Spinal stenosis: local, segmental, or generalized narrowing of the central spinal canal by bone or soft tissue elements, usually bony hypertrophic changes in the facet joints and by thickening of the ligamentum flavum.

Radiculopathy: impairment of a nerve root, usually causing radiating pain, numbness, tingling or muscle weakness that corresponds to a specific nerve root.

Sciatica: pain, numbness, tingling in the distribution of the sciatic nerve, radiating down the posterior or lateral aspect of the leg, usually to the foot or ankle.

Cauda equina syndrome: loss of bowel and bladder control and numbness in the groin and saddle area of the perineum, associated with weakness of the lower extremities. This condition can be caused by abnormal pressure on the bottom-most portion of the spinal canal and spinal nerve roots, related to either bony stenosis or a large herniated disc.

Lordosis, kyphosis, scoliosis:

- Kyphotic curves refer to the outward curve of the thoracic spine (at the level of the ribs).
- Lordotic curves refer to the inward curve of the lumbar spine (just above the buttocks).
- Scoliotic curving is a sideways curvature of the spine and is always abnormal.

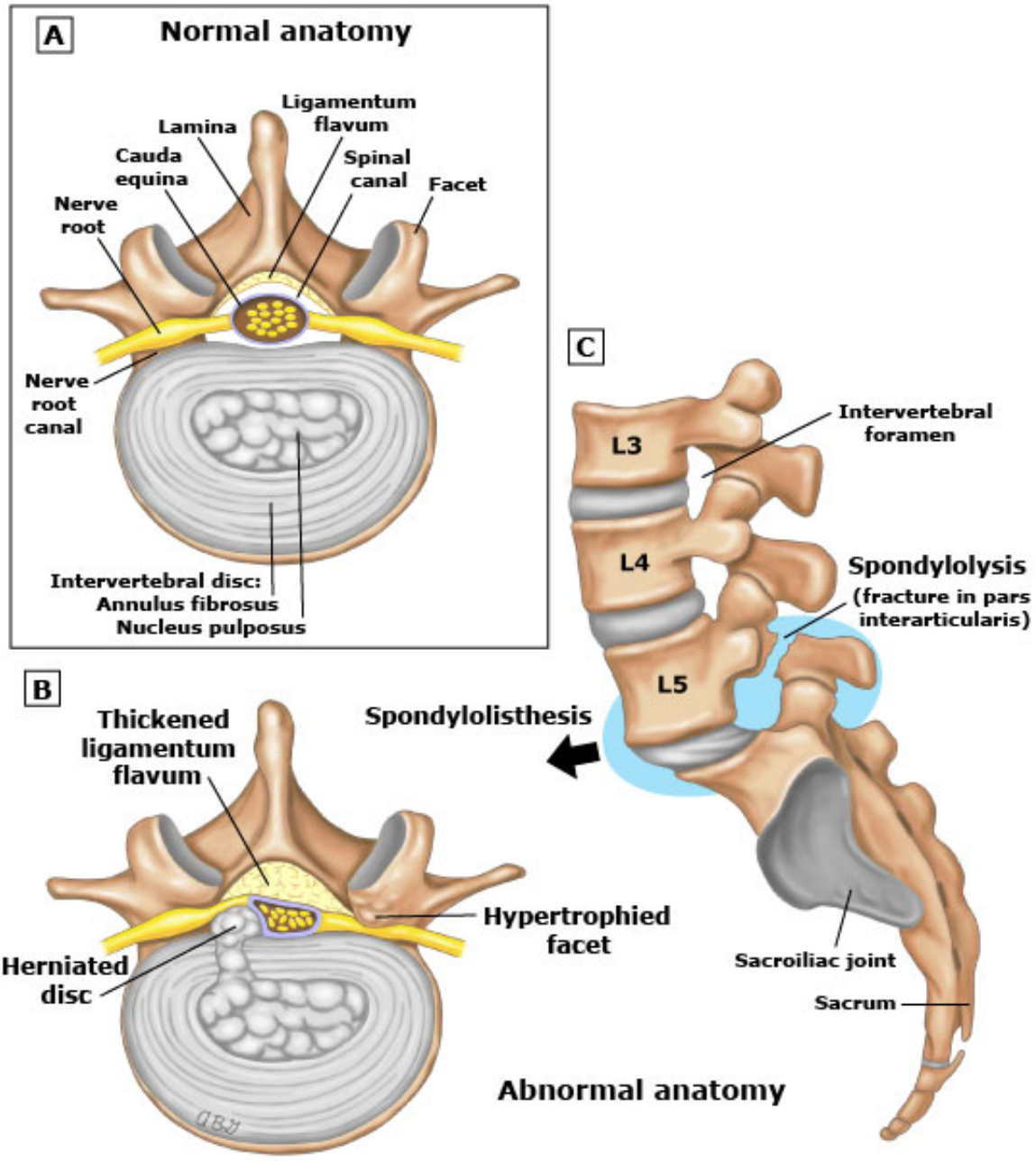
A small degree of both kyphotic and lordotic curvature is normal. Too much kyphotic curving causes round shoulders or hunched shoulders (Scheuermann's disease).

Too much lordotic curving is called swayback (lordosis). Lordosis tends to make the buttocks appear more prominent.

Piriformis syndrome: thought to be a condition in which the piriformis muscle compresses or irritates the sciatic nerve. The piriformis muscle is a narrow muscle located in the buttocks. There is debate among the medical community whether this is a discrete condition since it lacks objective diagnostic evidence and therefore cannot be reliably assessed.

Graphic 78051 Version 1.0

Common pathoanatomical conditions of the lumbar spine



(A) A superior view of a normal lumbar vertebra with cauda equina, nerve roots, intervertebral disc and ligamentum flavum.
(B) A superior view demonstrating abnormalities including a thickened ligamentum flavum, a hypertrophied facet and a herniated disc. These pathological structures cause the canal to narrow and can impinge on the cauda equina and nerve roots.
(C) A lateral view of the lumbosacral spine demonstrating spondylolysis and spondylolisthesis. Spondylolysis is a fracture in the pars interarticularis of the vertebra. Spondylolisthesis occurs when this fracture widens and the vertebral body slides forward on the one below it.

Graphic 74811 Version 3.0

Differential diagnosis of low back pain

Mechanical low back pain	Non-mechanical spine disease	Visceral disease
Lumbar strain	Neoplasia ▪ Multiple myeloma ▪ Metastatic carcinoma ▪ Lymphoma and leukemia ▪ Spinal cord tumors ▪ Retroperitoneal tumors	Pelvic organs ▪ Prostatitis ▪ Endometriosis ▪ Chronic pelvic inflammatory disease
Degenerative disease ▪ Discs (spondylosis) ▪ Facet joints	Infection ▪ Osteomyelitis ▪ Septic discitis ▪ Paraspinous abscess ▪ Epidural abscess ▪ Bacterial endocarditis	Renal disease ▪ Nephrolithiasis ▪ Pyelonephritis ▪ Perinephric abscess
Spondylolisthesis	Inflammatory arthritis (often HLA-B27 associated) ▪ Ankylosing spondylitis ▪ Psoriatic spondylitis ▪ Reiter's syndrome ▪ Inflammatory bowel disease	Aortic aneurysm
Herniated disc	Scheuermann's disease (osteochondrosis)	Gastrointestinal disease ▪ Pancreatitis ▪ Cholecystitis ▪ Penetrating ulcer
Spinal stenosis	Paget's disease	Fat herniation of lumbar space
Osteoporosis		
Fractures		
Congenital disease ▪ Severe kyphosis ▪ Severe scoliosis ▪ Possible type II transitional vertebra*		
Possible spondylolysis		
Possible facet joint asymmetry		

* A transitional vertebra is a congenital anomaly in which there is a naturally occurring articulation or bony fusion between the transverse processes of L5 and the sacrum, but there is still a small remnant disc space between L5 and sacrum. Type II means that one or both transverse processes appear to form a diarthrodial joint with the sacrum, but there is no bony fusion.

Graphic 60679 Version 4.0

Solitary nerve root lesions of the lumbosacral spine

Root	Pain	Sensory loss	Weakness	Stretch reflex loss
L1	Inguinal region	Inguinal region	Rarely hip flexion	None
L2-L3-L4	Back, radiating into anterior thigh, and at times medial lower leg	Anterior thigh, occasionally medial lower leg	Hip flexion, hip adduction, knee extension	Patellar tendon
L5	Back, radiating into buttock, lateral thigh, lateral calf and dorsum foot, great toe	Lateral calf, dorsum foot, web space between first and second toe	Hip abduction, knee flexion, foot dorsiflexion, toe extension and flexion, foot inversion and eversion	Semitendinosus/semibranosus (internal hamstrings) tendon
S1	Back, radiating into buttock, lateral or posterior thigh, posterior calf, lateral or plantar foot	Posterior calf, lateral or plantar aspect of foot	Hip extension, knee flexion, plantar flexion of the foot	Achilles tendon
S2-S3-S4	Sacral or buttock pain radiating into the posterior aspect of the leg or the perineum	Medial buttock, perineal, and perianal regions	Weakness may be minimal, with urinary and fecal incontinence as well as sexual dysfunction	Bulbocavernosus, anal wink

Graphic 75645 Version 2.0

Findings that distinguish neurogenic pseudoclaudication (primarily attributable to spinal stenosis) from vascular claudication*

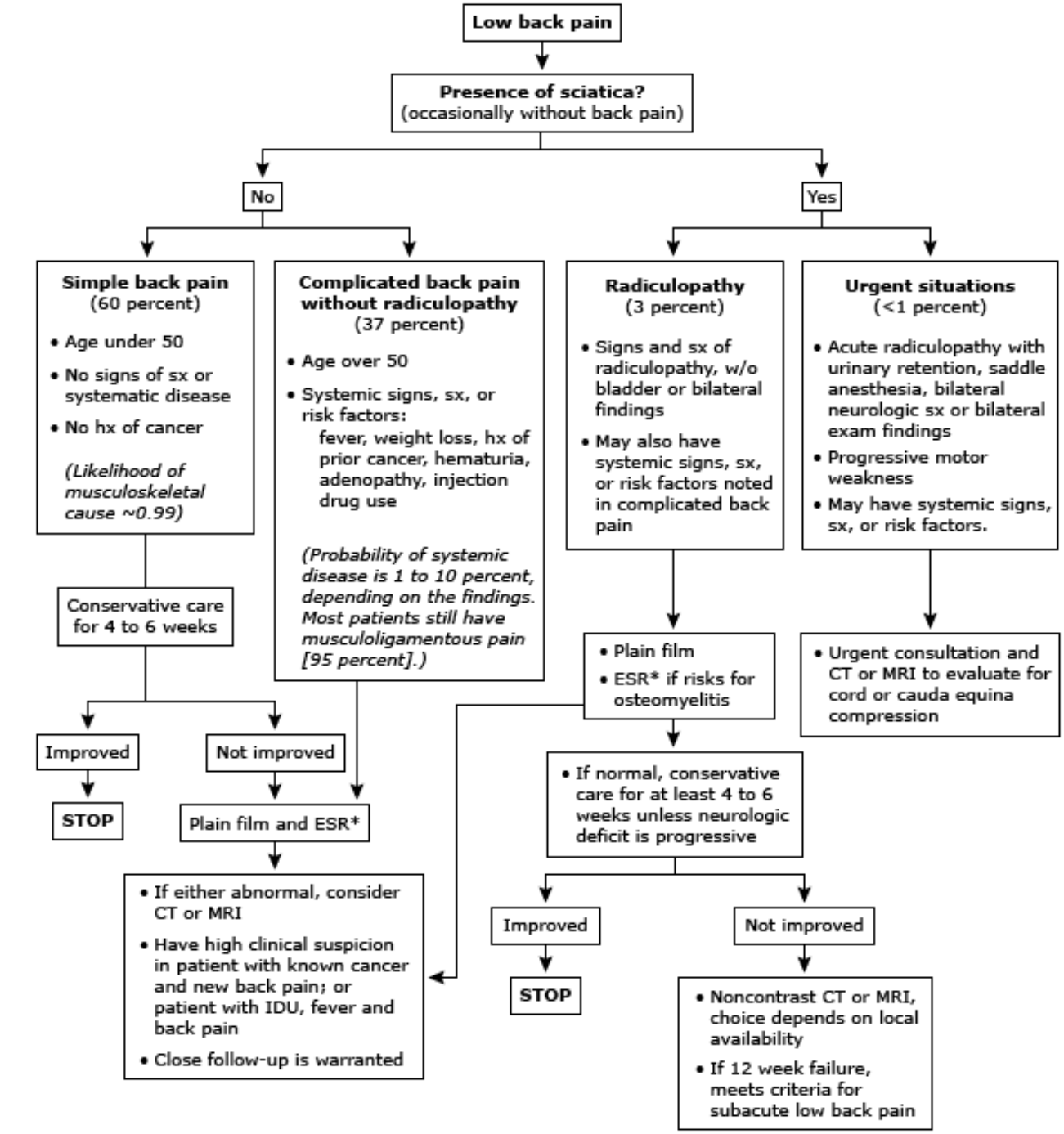
	Vascular claudication, n = 26	Neurogenic "pseudoclaudication", n = 23
Pain on standing alone (without ambulation)	27 percent	65 percent
Pain with coughing or sneezing	0 percent	38 percent
Distance to claudication constant	88 percent	38 percent
Paresthesias on walking	12 percent	43 percent
Mean time to relief of walking-induced symptoms	5.0 minutes	12.7 minutes
Normal femoral, popliteal, and dorsalis pedis pulses	0 percent	83 percent
Femoral or aortic bruit	54 percent	9 percent
Sensory deficit	12 percent (always stocking distribution)	55 percent (usually dermatomal distribution)
Limited straight leg raising	0 percent	30 percent
Muscle weakness	12 percent	39 percent

* Values are a percentage of patients with each finding (sensitivities).

Data from: Hawkes, CH, Roberts, GM. Neurogenic and vascular claudication. J Neurol Sci 1978; 38:337.

Graphic 80547 Version 1.0

Diagnostic algorithm of low back pain



ESR: erythrocyte sedimentation rate.

* Some clinicians obtain C-reactive protein test in addition to ESR as an inflammatory marker.

Graphic 50346 Version 3.0

Physical examination test performances in identifying radiculopathy due to lumbar disc herniation in patients with low back pain and sciatica*

Test	Pooled estimate for sensitivity (95% CI)•	Pooled estimate for specificity (95% CI)•
Straight leg raise	0.64 (0.56 to 0.71)	0.57 (0.47 to 0.66)
Paresis or muscle weakness	0.27 (0.20 to 0.37)	0.93 (0.88 to 0.97)
Impaired reflexes	0.15 (0.09 to 0.21)	0.93 (0.88 to 0.97)
Sensory deficits	0.28 (0.21 to 0.36)	0.66 (0.56 to 0.74)

* Diagnosis confirmed by diagnostic imaging or findings at surgery.
• Cohort studies (16) or case-control studies (3).

Data from: van der Windt DA, Simons E, Riphagen II, et al. Physical examination for lumbar radiculopathy due to disc herniation in patients with low-back pain. Cochrane Database of Syst Rev 2010; :CD007431.

Graphic 90349 Version 1.0

Testing for lumbar nerve root compromise

Nerve root	L4	L5	S1
Pain			
Numbness			
Motor weakness	Extension of quadriceps	Dorsiflexion of great toe and foot	Plantar flexion of great toe and foot
Screening examination	Squat and rise	Heel walking	Walking on toes
Reflexes	Knee jerk diminished	None reliable	Ankle jerk diminished

Data from: Bigos S, Bowyer O, Braen G, et al. Acute Low Back Problems in Adults. Clinical Practice Guideline, Quick Reference Guide Number. 14. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research, AHCPR Pub. No. 95-0643. December 1994.

Graphic 68791 Version 2.0

Likelihood ratios for lumbosacral radiculopathy, in patients with sciatica*

Finding•	Sensitivity, percent	Specificity, percent	Positive LR	Negative LR
Motor examination				
Weak ankle dorsiflexion	54	89	4.9	0.5
Ipsilateral calf wasting	29	94	5.2	0.8
Sensory examination				
Leg sensation abnormal	16	86	NS	NS
Reflex examination				
Abnormal ankle jerk	48	89	4.3	0.6
Other tests				
Straight-leg raising maneuver	73-98	11-61	NS	0.2
Crossed straight-leg raising maneuver	23-43	88-98	4.3	0.8

LR: likelihood ratio; NS: not significant.

* Diagnostic standard: for *lumbosacral radiculopathy*, surgical finding of disc herniation compressing nerve root.

• Definition of findings: for *ipsilateral calf wasting*, maximum calf circumference at least 1 cm smaller than contralateral side; for *straight-leg raising maneuvers*, flexion at hip of supine patient's leg, extended at the knee, causes radiating pain in affected leg (pain confined to back or hip is negative response); for *crossed straight-leg raising maneuver*, raising contralateral provokes pain in affected leg.

Graphic 56027 Version 1.0

Likelihood ratios for localizing lumbosacral radiculopathy*

Finding•	Sensitivity, percent	Specificity, percent	Positive LR	Negative LR
Motor examination				
Weak hallux extension, detecting L5 radiculopathy	12-51	72-91	1.8	NS
Weak ankle plantarflexion, detecting S1 radiculopathy	26	99	26.6	0.7
Ipsilateral calf wasting, detecting S1 radiculopathy	43	82	2.4	0.7
Sensory examination				
Sensory loss L5 distribution, detecting L5 radiculopathy	20-28	94-98	4.6	0.8
Sensory loss S1 distribution, detecting S1 radiculopathy	32-49	86-90	3.0	NS
Reflex examination				
Asymmetric quadriceps reflex, detecting L3 or L4 radiculopathy	30	96	6.9	NS
Asymmetric Achilles reflex, detecting S1 radiculopathy	63-91	69-94	NS	NS

LR: likelihood ratio; NS: not significant.

* Diagnostic standard: for *level of radiculopathy*, surgical findings or myelography.

• Definition of findings: for *ipsilateral calf wasting*, maximum calf circumference at least 1 cm smaller than contralateral side.

Graphic 69710 Version 1.0

Relative radiation doses for spine imaging studies

Procedure	Modality	Average effective dose (mSv)	Number of chest x-rays (PA/lateral) with equivalent radiation dose*
Skull radiograph	Conventional radiography	0.1	1
Cervical spine radiograph	Conventional radiography	0.2	2
Thoracic spine radiograph	Conventional radiography	1.0	10
Lumbar spine radiograph	Conventional radiography	1.5	15
CT head	Computed tomography	2	20
CT neck	Computed tomography	4	40
Angiogram head/neck	Conventional fluoroscopy or interventional radiology	5	50
CT spine	Computed tomography	6	60
Brain perfusion	Nuclear medicine	6.9	69
CT angiogram (rule out stroke)	Computed tomography	14	140
Brain PET	Nuclear medicine	14	140

PET: positron-emission tomography.
* PA and lateral chest radiograph = .1 mSv.

Data from:

1. *Mettler FA, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology 2008; 248:254.*
2. *Smith-Bindman R, Lipson J, Marcus R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. Arch Intern Med 2009; 169:2078.*
3. *Shrimpton PC, Hillier MC, Lewis MA, Dunn M. National survey of doses from CT in the UK: 2003. Br J Radiol 2006; 79:968.*

Graphic 55620 Version 5.0

"Red flags" for a potentially serious underlying cause for low back pain

Trauma, cumulative trauma
Unexplained weight loss
Age >50 years, especially women, and males with osteoporosis or compression fracture
Unexplained fever, history of urinary or other infections
Immunosuppression, or diabetes mellitus
History of cancer
Intravenous (IV) drug use
Prolonged use of corticosteroids, osteoporosis
Age >70
Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome
Duration longer than six weeks
Prior surgery
History of abdominal aortic aneurysm

Graphic 68550 Version 12.0