

Back Pain

(See also *Harrison's Principles of Internal Medicine*, 17th Edition, Chapter 16)

Definition

- Low back pain may be:
 - Acute: lasting ≤ 3 months
 - Chronic: lasting > 3 months
- 5 basic types
 - Local pain
 - Caused by activation of pain-sensitive nerve endings near affected part of the spine
 - Pain referred to the back
 - Abdominal or pelvic in origin
 - Pain of spinal origin
 - Restricted to the back or referred to lower limbs
 - Radicular pain
 - Radiates from spine to leg in specific nerve root territory
 - Pain associated with muscle spasm
 - Accompanied by taut paraspinal muscles and abnormal posture

Epidemiology

- Prevalence
 - Back symptoms are the most common cause of disability in patients < 45 years of age.
 - Low back pain is the second most common reason for visiting a physician in the U.S.
 - $\sim 1,000$ per 100,000 persons in the U.S. population are chronically disabled because of back pain.
- The cost of back pain in the U.S. is \$20–\$50 billion annually.

Mechanism

Lumbar disk disease

- Usually at L4–L5 or L5–S1 levels
- Usually unilateral
 - Bilateral disease with large central disk herniations compressing multiple nerve roots may cause cauda equina syndrome (injury to multiple lumbosacral nerve roots resulting in some or all of the following symptoms: low back pain, weakness, areflexia in the lower extremities, saddle anesthesia, loss of bladder function).

- The mechanism by which intervertebral disk injury causes back pain is controversial.
 - The inner annulus fibrosus and nucleus pulposus are normally devoid of innervation.
 - Inflammation and production of proinflammatory cytokines within the protruding or ruptured disk may trigger or perpetuate back pain.
 - Ingrowth of nociceptive (pain) nerve fibers into inner portions of a diseased disk may be responsible for chronic "diskogenic" pain.
- Nerve root injury (radiculopathy) from disk herniation
 - May be due to compression, inflammation, or both
 - Pathologically, both demyelination and axonal loss are usually present.

Spinal stenosis

- A narrowed spinal canal producing neurogenic claudication (back, buttock, and/or leg pain induced by walking or standing and relieved by sitting)
- Symptoms are usually bilateral.
- Unlike vascular claudication, symptoms are provoked by standing without walking.
- Unlike lumbar disk disease, symptoms are relieved by sitting.
- Focal neurologic deficits are common.
- Severe neurologic deficits (paralysis, incontinence) are rare.
- Stenosis results from acquired (75%), congenital, or mixed acquired/congenital factors.
- Symptomatic treatment is adequate for mild disease.
- Surgery is indicated when pain interferes with activities of daily living or focal neurologic signs are present.
 - Surgery is successful in 65–80% of patients.
 - 25% develop recurrent stenosis within 5 years.

Trauma

- Traumatic vertebral fractures
 - Caused by falls from a height (a pars interarticularis fracture of the L5 vertebra is common), sudden deceleration in an automobile accident, or direct injury
 - Most result from injuries producing anterior wedging or compression.
 - With severe trauma, the patient may sustain a fracture-dislocation or a "burst" fracture involving the vertebral body and posterior elements.
- Sprain or strains
 - Minor, self-limited injuries associated with lifting a heavy object, a fall, or a sudden deceleration, such as in an automobile accident
 - Site of the anatomic lesion is usually uncertain.

Nontraumatic compression fracture

- Most common cause is osteoporosis.
- May also be seen in osteomalacia, hyperparathyroidism, hyperthyroidism, multiple myeloma, or metastatic carcinoma.
- Glucocorticoid use may predispose the vertebral body to fracture.

Spondylolisthesis

- Slippage of anterior spine forward, leaving posterior elements behind
- L4 on L5 most common; L5 or S1 occasionally
- Can produce low back pain or radiculopathy/cauda equina syndrome

Osteoarthritis (spondylosis)

- See Osteoarthritis.
- Occurs in later life and primarily involves the cervical and lumbosacral spine
- Patients often have back pain that is increased by motion and associated with stiffness or limitation of motion.
- Radiologic findings do not often correlate with severity of pain or location of pain.
- Facet syndrome: radicular symptoms and signs caused by nerve root compression by unilateral facet hypertrophy
- Loss of intervertebral disk height reduces vertical dimensions of intervertebral foramen; the descending pedicle can compress the exiting nerve root.

Ankylosing spondylitis

- See Ankylosing Spondylitis.
- This distinctive arthritic spine disease typically presents with the insidious onset of low back and buttock pain.
- Inflammation and erosion of the outer fibers of the annulus fibrosus at the point of contact with the vertebral body
- Followed by ossification and bony growth that bridges adjacent vertebral bodies and reduces spine mobility in all planes

Other immune disorders

- Rheumatoid arthritis
- Reiter's syndrome
- Psoriatic arthritis
- Chronic inflammatory bowel disease

Neoplasms

- Back pain is the most common neurologic symptom in patients with systemic cancer.
 - May be the presenting symptom of cancer
- Metastatic carcinoma (breast, lung, prostate, thyroid, kidney, GI tract), multiple myeloma, and non-Hodgkin's and Hodgkin's lymphomas frequently involve the spine.
- Usually cause destructive lesions in 1 or several vertebral bodies without disk space involvement

Vertebral osteomyelitis

- Usually caused by staphylococci, but other bacteria or tuberculosis (Pott's disease) may be responsible
- A primary source of infection (lung, urinary tract, or skin) is found in 40%.
- Intravenous drug abuse is a risk factor.
- Destruction of the vertebral bodies and disk space is common.

Lumbar spinal epidural abscess

- Presents as back pain and fever
- Signs of nerve root injury or spinal cord compression may be present.
- The abscess may track over multiple spinal levels.

Lumbar arachnoiditis

- May follow inflammatory response to local tissue injury within the subarachnoid space
- Fibrosis results in nerve root adhesions, producing back and leg pain associated with motor, sensory, or reflex changes.
- May be caused by multiple lumbar operations, chronic spinal infections, spinal cord injury, intrathecal hemorrhage, intrathecal injection of glucocorticoids or anesthetics, or foreign bodies

Referred pain from visceral disease

- Upper-abdominal diseases generally refer pain to the lower thoracic or upper lumbar region (eighth thoracic to the first and second lumbar vertebrae).
 - Peptic ulcers
 - Stomach cancer with retroperitoneal extension
- Lower-abdominal diseases refer to the lumbar region (second to fourth lumbar vertebrae).
 - Diseases of the pancreas produce back pain to the right of the spine (head of the pancreas involved) or to the left (body or tail involved).
 - Abnormality in retroperitoneal structures (hemorrhage, tumors, pyelonephritis) produces paraspinal pain that radiates to the lower abdomen, groin, or anterior thighs.
 - Abdominal aortic aneurysm
 - Inflammatory bowel disorders (colitis, diverticulitis) or cancers of the colon
- Pelvic diseases refer to the sacral region.
 - Typically gynecologic disorders involving the uterosacral ligaments
 - Endometriosis or cancers of the uterus
 - Menstrual pain
 - Chronic prostatitis, prostate cancer with spinal metastasis, and diseases of the kidney and ureter

Other causes

- Postural back pain
 - No anatomic or pathologic lesion can be found despite exhaustive investigation.
 - Physical examination is unrevealing except for "poor posture."
- Psychiatric disease
 - Back pain may be encountered in patients who seek financial compensation, in malingerers, or in those with concurrent substance abuse, chronic anxiety states, or depression.

Symptoms & Signs

History

- Understanding the type of pain experienced by the patient is the essential first step.
- Significant risk factors for a possible serious underlying cause of back pain
 - Age > 50 years
 - Prior diagnosis of cancer or other serious medical illness
 - Intravenous drug use
 - Glucocorticoid use
 - No relief with bed rest
 - Urinary incontinence or recent nocturia

- Focal leg weakness or numbness
- Pain radiating into the leg(s) from the back
- Chronic infection (pulmonary or urinary)
- Pain increasing with standing and relieved by sitting
- History of spine trauma
- Local pain
 - The site of the pain is near the affected part of the back.
- Referred pain
 - Usually described as primarily abdominal or pelvic, but is accompanied by back pain and usually unaffected by posture
 - The patient may occasionally experience back pain only.
- Pain of spinal origin
 - May be located in the back or referred to the buttocks or legs
 - Diseases of the upper lumbar spine refer pain to the upper lumbar region, groin, or anterior thighs.
 - Diseases of the lower lumbar spine refer pain to the buttocks or posterior thighs.
 - Pain is aggravated by motion and relieved by rest.
- Radicular back pain
 - Typically sharp
 - Radiates from the spine to the leg within the territory of a nerve root
 - Coughing, sneezing, or voluntary contraction of abdominal muscles (lifting heavy objects or straining at stool) may elicit the radiating pain.
 - The pain may increase in postures that stretch the nerves and nerve roots.
- Pain associated with muscle spasm
 - Spasms are accompanied by abnormal posture, taut paraspinal muscles, and dull pain.
- Pain from hip disease may resemble the pain of lumbar spine disease.

Physical examination

- Significant signs
 - Unexplained fever
 - Unexplained weight loss
 - Positive straight leg-raising (SLR) sign, crossed SLR sign, or reverse SLR sign (see below for details)
 - Percussion tenderness over the spine or costovertebral angle
 - An abdominal mass (pulsatile or nonpulsatile)
 - A rectal mass
 - Focal sensory loss (saddle anesthesia or focal limb sensory loss)
 - Leg weakness
 - Spasticity or reflex asymmetry
- Inspection
 - Lateral curvature of the spine (scoliosis)
 - Asymmetry in the paraspinal muscles suggests muscle spasm.
- Palpation
 - May elicit pain over a diseased spine segment
 - Common in pain of bony spine origin
- Hip pain
 - May be confused with spine pain
 - Can be reproduced by internal and external rotation at the hip with the knee and hip in flexion (Patrick sign) and by tapping the heel with the examiner's palm while the leg is extended

- SLR sign
 - Elicited by passive flexion of extended leg at the hip with patient in supine position
 - The maneuver stretches L5/S1 nerve roots and sciatic nerve passing posterior to the hip.
 - SLR is positive if the maneuver reproduces the pain.
- Crossed SLR sign
 - Positive when SLR on 1 leg reproduces symptoms in the opposite leg or buttocks
 - Nerve/nerve root lesion is on the painful side.
- Reverse SLR sign
 - Passive extension of leg backwards with patient standing
 - The maneuver stretches L2–L4 nerve roots and femoral nerve passing anterior to the hip.
- Pain referred from visceral organs may be reproduced during:
 - Palpation of the abdomen (pancreatitis, abdominal aortic aneurysm)
 - Percussion over the costovertebral angles (pyelonephritis, adrenal disease)

Neurologic examination

- Includes a search for weakness, muscle atrophy, focal reflex changes, diminished sensation in the legs, and signs of spinal cord injury
- Be alert to the possibility of breakaway weakness, defined as fluctuating levels of strength in ≥ 1 muscle groups on examination.
 - May be due to pain or a combination of pain and underlying true weakness
 - Breakaway weakness without pain is due to lack of effort.
- Lumbosacral radiculopathy: neurologic features
 - L2
 - Pain distribution: anterior thigh
 - Sensory: upper anterior thigh
 - Motor: psoas (hip flexion)
 - Reverse SLR sign present
 - L3
 - Pain distribution: anterior thigh, knee
 - Sensory: lower anterior thigh, anterior knee
 - Motor: psoas (hip flexion); quadriceps (knee extension), or thigh adduction
 - Reverse SLR sign present
 - L4
 - Pain distribution: knee, medial calf, anterolateral thigh
 - Reflex: quadriceps (knee)
 - Sensory: medial calf
 - Motor
 - Quadriceps (knee extension) receive the majority of innervation from this root.
 - Thigh adduction
 - Tibialis anterior (foot dorsiflexion)
 - Reverse SLR sign present
 - L5
 - Pain distribution: lateral calf, dorsal foot, posterolateral thigh, buttocks
 - Sensory: dorsal surface of foot, lateral calf
 - Motor
 - Peroneii: foot eversion (these muscles receive the majority of innervation from this root)
 - Tibialis anterior: foot dorsiflexion

- Gluteus medius: hip abduction
 - Toe dorsiflexors
 - SLR sign present
- S1
 - Pain distribution: bottom foot, posterior calf, posterior thigh, buttocks
 - Reflex: gastrocnemius/soleus (ankle)
 - Sensory: plantar surface and lateral aspect of foot
 - Motor
 - Gastrocnemius/soleus: foot plantar flexion (these muscles receive the majority of innervation from this root)
 - Abductor hallucis: toe flexors (these muscles receive the majority of innervation from this root)
 - Gluteus maximus: hip extension
 - SLR sign present

Differential Diagnosis

- Serious causes of spine pathology that require urgent intervention include:
 - Infection
 - Cancer
 - Trauma
 - Risk factors for a possible serious underlying cause of back pain include:
 - Age > 50 years
 - Prior diagnosis of cancer or other serious medical illness
 - Intravenous drug use and glucocorticoid use
- General causes of back pain
 - Congenital/developmental (low back only)
 - Spondylolysis and spondylolisthesis
 - Kyphoscoliosis
 - Spina bifida occulta
 - Tethered spinal cord
 - Minor trauma
 - Strain or sprain
 - Fractures
 - Traumatic: falls, motor vehicle accidents
 - Atraumatic: osteoporosis, neoplastic infiltration, exogenous glucocorticoids
 - Intervertebral disk herniation
 - Degenerative
 - Disk-osteophyte complex
 - Internal disk disruption
 - Spinal stenosis with neurogenic claudication (low back only)
 - Arthritis
 - Spondylosis
 - Facet or sacroiliac arthropathy
 - Autoimmune (e.g., ankylosing spondylitis, Reiter's syndrome)
 - Neoplasms: metastatic, hematologic, primary bone tumors
 - Infection/inflammation
 - Vertebral osteomyelitis
 - Spinal epidural abscess
 - Septic disk
 - Meningitis
 - Lumbar arachnoiditis (low back only)

- Metabolic
 - Osteoporosis: hyperparathyroidism, immobility
 - Osteosclerosis (e.g., Paget's disease)
- Other
 - Referred pain from visceral disease
 - Postural
 - Psychiatric, malingering, chronic pain syndromes
- Chronic low back pain
 - The differential diagnosis is similar to that of acute low back pain.

Diagnostic Approach

- Most episodes of acute low back pain are benign, self-limited, and mechanical in nature.
- The initial approach for acute and chronic low back pain are similar.
 - Medical history and examination
 - Includes abdominal, rectal, and neurologic examination
 - If there are risk factors for a serious cause (see Symptoms & Signs), assess for the cause.
 - Spine infections, fractures, tumors, or rapidly progressive neurologic deficits require urgent diagnostic evaluation.
 - The diagnosis of nerve root injury is most secure when the history, examination, and results of imaging studies and electromyography (EMG) are concordant.
 - If there are no risk factors for a serious cause:
 - No diagnostic tests are necessary.

Laboratory Tests

- Routine laboratory studies, such as a complete blood count, erythrocyte sedimentation rate, chemistry panel, and urinalysis, are rarely needed for initial evaluation of nonspecific acute low back pain.
 - If risk factors for a serious underlying disease are present, laboratory studies (guided by the history and examination) are indicated.

Imaging

- MRI and CT myelography (see Figure 1, Figure 2)
 - Radiologic tests of choice for evaluation of most serious diseases involving the spine
 - Generally not indicated for chronic back pain within the first month after initial evaluation in the absence of risk factors for a serious underlying cause
 - Up to one-third of asymptomatic adults have a disk protrusion detected by CT or MRI.
 - Should be performed only in circumstances where results are likely to influence surgical or medical treatment
 - MRI is superior for the definition of soft-tissue structures.
 - CT myelography provides optimal imaging of bony lesions and is tolerated by claustrophobic patients.
 - With rare exceptions, conventional myelography and bone scan are inferior to MRI and CT myelography.
 - Nerve root injury
 - Correlation between CT and EMG for localization of nerve root injury is 65–73%.

- Plain film radiography
 - Plain spine films are rarely indicated in the first month of symptoms with acute low back pain unless spine fracture is suspected.
 - Plain films of the lumbar or cervical spine are helpful when risk factors for vertebral fracture (trauma, chronic steroid use) are present.
- Diskography
 - Reproduction of the patient's typical pain with the injection is often used as evidence that a specific disk is the pain generator, but it is not known whether this information has any value in selecting candidates for surgery.
 - Provides no additional anatomic information beyond what is available by MRI.
- Thermography
 - There is no proven role for this test in the assessment of radiculopathy.



Figure 1: MRI of lumbar herniated disk; left S1 radiculopathy. Sagittal T1-weighted image on the left with arrows outlining disk margins. Sagittal T2 image on the right reveals a protruding disk at the L5-S1 level (*arrows*), which displaces the central thecal sac.



Figure 2: Spinal stenosis. Sagittal T2 fast spin echo MRI of a normal (*left*) and stenotic (*right*) lumbar spine, revealing multifocal narrowing (*arrows*) of the cerebrospinal fluid spaces surrounding the nerve roots within the thecal sac.

Diagnostic Procedures

- Many conditions that produce chronic low back pain can be identified by a combination of neuroimaging and electrophysiologic studies.
- EMG
 - The diagnostic yield of needle EMG is higher than that of nerve conduction studies for radiculopathy.
 - Denervation changes in a myotomal (segmental) distribution are detected by sampling multiple muscles supplied by different nerve roots and nerves.
 - The pattern of muscle involvement indicates the nerve root(s) responsible for the injury.
 - Needle EMG provides objective information about motor nerve fiber injury when the clinical evaluation of weakness is limited by pain or poor effort.
- Sensory nerve conduction studies
 - Lower diagnostic yield than EMG
- Mixed nerve somatosensory evoked potentials and F-wave studies
 - Uncertain value in the evaluation of radiculopathy
- Diagnostic nerve root blocks
 - Have been advocated to determine if pain originates from a specific nerve root
 - Improvement, however, may result even when the nerve root is not responsible for the pain syndrome.
 - This may occur with placebo effects, painful lesions located distally along the peripheral nerve, or anesthesia of the sinuvertebral nerve.

Treatment Approach

Acute low back pain

- Perform detailed history and physical examination.
- If risk factors for a serious cause exist, work-up for the suspected cause should begin.
- If there are no risk factors for a serious cause:
 - No diagnostic tests are necessary.
 - Reassurance and education
 - Full recovery occurs in ~85%.
 - Use available treatment methods.
 - Temporarily suspend activity known to increase mechanical stress on the spine (heavy lifting, prolonged sitting, bending or twisting, straining at stool).
 - Use strategies to prevent future exacerbations.
 - Pain relief
 - Acetaminophen or NSAIDs
 - Short-duration muscle relaxants or opioids optional
 - No more than 2 days of bed rest
 - Clinical trials have shown no benefit of prolonged (>2 days) bed rest for uncomplicated acute low back pain.
 - There is evidence that bed rest is also ineffective for patients with sciatica or for acute back pain with findings of nerve root injury.
 - Traction for acute low back pain is not effective.
 - Spinal manipulation is optional.
 - Physical therapy is optional.

- Follow-up in 2 weeks
 - If there is relief:
 - Encourage early return to normal activities, but no heavy manual labor
 - Have the patient alter activities to minimize symptoms.
 - If no relief:
 - Review response to initial treatment.
 - Review risk factors.
 - Modify symptom treatment.
- Follow-up in 2 weeks for those with continued symptoms
 - If there are leg symptoms:
 - MRI, CT, or myelography if clear nerve root signs
 - If neurologic and imaging are concordant, consult with a spine surgeon; consider surgery.
 - EMG or nerve conduction studies if symptoms present but there are no clear nerve signs on examination
 - If studies suggest a radiculopathy, perform MRI, CT, or myelography, as above.
 - If studies do not suggest radiculopathy, consider consultation with a specialist.
 - If there are no leg symptoms:
 - Look for underlying cause; evaluate and treat.
 - Reconsider treatment options.

Chronic low back pain

- Treatment is directed toward the underlying cause when known.
 - When a specific cause not found, conservative management is recommended.
- Management is complex and not amenable to a simple algorithmic approach.
 - Pharmacologic and comfort measures are similar to those described for acute low back pain.
 - Exercise regimens are effective in returning some patients to work, diminishing pain, and improving walking distances.
 - Hydrotherapy may be useful.
 - Some patients experience short-term pain relief with percutaneous electrical nerve stimulation.
 - Surgical intervention based on neuroimaging alone not recommended.
 - Up to one-third of asymptomatic young adults have a herniated lumbar disk by CT or MRI.

Specific Treatments

Pharmacologic pain relief

- NSAIDs and acetaminophen
- Muscle relaxants may provide short-term benefit (4–7 days).
 - Cyclobenzaprine: 5–10 mg PO tid; maximum, 60 mg/d
 - Methocarbamol: 1,500 mg PO qid
 - Side effects include drowsiness that may limit daytime use.

- Opioid analgesics
 - Are no more effective than NSAIDs or acetaminophen for initial treatment of acute low back pain, nor do they increase the likelihood of return to work
 - Short-term use of opioids in patients unresponsive to or intolerant of acetaminophen or NSAIDs may be helpful.
- Epidural glucocorticoids
 - May occasionally produce short-term pain relief in acute low back pain and radiculopathy, but proof is lacking for pain relief beyond 1 month.
 - Epidural anesthetics, glucocorticoids, or opioids are not indicated in the initial treatment of acute low back pain without radiculopathy.
- Therapeutic nerve root blocks
 - Injection of glucocorticoids and a local anesthetic is an option after conservative measures fail, particularly when temporary relief of pain is necessary.

Physical therapy or spinal manipulation

- A short course for symptomatic relief of uncomplicated acute low back pain is an option.
 - Prospective, randomized study comparing physical therapy, chiropractic manipulation, and education interventions for patients with acute low back pain found modest trends toward benefit at 1 year with both physical therapy and chiropractic manipulation.
 - The value of such treatment beyond 1 year is unknown.
 - Specific physical therapy or chiropractic protocols that may provide benefit have not been fully defined.
- With chronic low back pain, exercise programs can reverse atrophy in paraspinal muscles and strengthen extensors of the trunk.
- Intensive physical exercise or "work hardening" regimens (under the guidance of a physical therapist) have been effective in returning some patients to work, improving walking distances, and diminishing pain.
 - Benefit can be sustained with home exercise regimens; compliance with the exercise regimen strongly influences outcome.
- Hydrotherapy
 - May reduce the duration and intensity of back pain and analgesic drug consumption, as well as improve spine mobility, and improve function

Other approaches

- Surgery for nerve root injury
 - The diagnosis of nerve root injury is most secure when the history, examination, results of imaging studies, and the EMG are concordant.
 - Surgical intervention that is based solely on radiologic findings increases the likelihood of an unsuccessful outcome.
- Proof is lacking to support treatment with the following agents.
 - Acupuncture
 - Transcutaneous electrical nerve stimulation
 - Massage
 - Ultrasonography
 - Diathermy
 - Electrical stimulation
- Percutaneous electrical nerve stimulation
 - Has been shown to provide significant short-term relief of chronic low back pain
 - Additional studies regarding its long-term efficacy and cost are needed.

- Ice or heat
 - Evidence regarding the efficacy is lacking, but these interventions are optional given the lack of negative evidence, low cost, and low risk.
- Biofeedback
 - Has not been studied rigorously
- Trigger point and ligament injections are not recommended.
- A role for modification of posture has not been validated by rigorous clinical studies.

Monitoring

- Any patient with neurologic findings needs urgent referral.
- After initial evaluation, follow up in 2 weeks and monitor until the patient is able to return to normal activity.
- If patient still has pain after 6 weeks of follow-up, consider referral to a specialist.

Complications

- There are no serious complications associated with acute, self-limited low back pain.
- Complications of back pain caused by serious disease are related to the underlying cause.

Prognosis

- Full recovery can be expected in 85% of adults with acute low back pain when it is not accompanied by leg pain.
- Serious, persistent disability is rare.
- Risk factors for chronic back pain include:
 - Pre-existing psychological distress
 - Disputed compensation issues
 - Other chronic pain
 - Job dissatisfaction

Prevention

- Proper lifting mechanics, ergonomic measures, and back exercises may be helpful but have not been studied systematically.

ICD-9-CM

- 724.2 Lumbago (includes low back pain)
- 724.5 Backache, unspecified

See Also

- Ankylosing Spondylitis
- Neck and Shoulder Pain

Internet Sites

- Professionals
 - Homepage
American Academy of Orthopaedic Surgeons

- Homepage
American Chiropractic Association
- Homepage
American Physical Therapy Association
- Patients
 - Back pain
MedlinePlus

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PEARLS

- Most cases of isolated acute low back pain (with no associated worrisome symptoms or signs) can and should be treated conservatively, without surgical intervention.
- A "dropped reflex" (unilateral loss of an ankle or patellar reflex) can be a sign of radiculopathy in a patient with acute low back pain and normal strength in the legs.
 - This finding should trigger further investigation with neuroimaging.
- EMG can provide objective evidence of specific nerve root injury and allow correlation with neuroimaging studies.
- Nerve conduction studies of peripheral nerves remain normal even in severe radiculopathy, as the site of injury to the nerve (e.g., from a herniated disk) is proximal to the dorsal root ganglion (which lies outside of the spinal cord, distal from the disk).