CHAPTER 19

Lesions of the Spine and Spinal Cord

Diseases of spine and spinal cord produce several distinct yet frequently overlapping clinical syndromes. It is major cause of vocational disability. A given patient can appear with one or combination of three major clinical pictures listed in Box 19-1.

Carefully performed mechanical spine evaluation and neurologic examinations are extremely important. The goals of the examination are to determine if supporting tissues (i.e., disks, vertebrae, ligaments, muscles, and facet joints) are involved; to assess whether the spinal cord is damaged and, if so, at what level; and to establish whether nerve roots are affected. Lifetime prevalence of low back pain is 60 to 90% with 50% annual incidence. The incidence of sciatica is lower. Patients with low back pain are evaluated by physicians in multiple specialties e.g., general and family practitioners, ED physicians, rheumatologists, neurologists, neurosurgeons, orthopedists, physical medical specialties as well as chiropractors. It is important to know when to order neuro-imaging studies based upon the clinical evaluation as majority of back pain resolves spontaneously or with symptomatic treatment.

ANATOMY

The spinal cord, roots, intervertebral disks, vertebrae, and soft tissues supporting spinal column are subject to disease or injury. Because of close interrelationship of these structures, disease in one can affect the function of another (e.g., rupture of intervertebral cervical disk can cause damage to cervical spinal cord or nerve roots). There are 8 cervical roots, 12 thoracic discs, 5 lumbar roots and 5 sacral roots. The spinal cord terminates at L-2 and below that is conus medullaris (termination of spinal cord) and exiting nerve roots (cauda equina). The intervertebral discs function as shock absorbers; therefore, they "wear out" over time and almost all elderly patients have degenerative or wearing-out phenomenon. MRI shows this desiccation or dehydration of disc material and loss of vertebral body height. To understand clinical syndromes fully, physician must know anatomic relationship of spine, cord, and roots. Figure 19-1 is superior view of cervical vertebra with cord and roots. Figure 19-2 is lateral view, and Figure 19-3 is posterior view with spines and transverse processes removed.

CLINICAL SYNDROMES

Back Pain

There are many causes of back pain, and this symptom must be viewed as complex diagnostic problem. Boxes 19-2 through 19-4 outline history, physical examination, and differential diagnosis of back pain. Low back pain involves region between lower rib cage and buttock region. Sciatica is pain and sensory disturbance in lumbo-sacral root distribution. Neurological claudication due to lumbar stenosis is back and leg pain worsened by walking and relieved by spine flexion due to reduced blood flow to cauda equina.

Evaluation

Evaluation of back pain cases without radiculopathy or myelopathy is individualized. Simple
mechanical back pain rarely requires imaging studies. The natural history is that 80 to 90% of patients obtain relief within 8 to 10 weeks irrespective of treatment strategy. Progressive unrelenting pain, which is most intense at night and does not resolve with rest suggests serious e.g. neoplasm, abscess this requires extensive study. Intermittent chronic back pain without nerve root or bladder symptoms rarely requires CT or MRI. Given these general guidelines, the seven tests most commonly employed to evaluate back pain are listed in Box 19-5. In most cases, cause of low back pain is believed to be non-specific "myofascial" and only 10 to 20% have specific anatomico-pathological diagnosis. Risk factors for low back pain include occupations requiring repetitive lifting in forward, bent and twisted position, exposure to vibration (automobile, heavy equipment), cigarette smoking, osteoporosis, genetic spinalrheumatological conditions.

**Root Lesions**

Symptoms of nerve root compression or damage are often initial and most prominent complaint of patients with spine disease. Principal symptoms are dermatomal pain, paresthesias, and sensory loss; selective motor loss; and bowel or bladder dysfunction if the cauda equina is involved. Autonomic dysfunction (bowel or bladder) is most consistent with spinal cord dysfunction. Root (radicular) pain can be seen from disease of viscera, so full medical history is advisable in patients with radiating pains. Disease of ureter can give pain to inner thigh and groin. Adnexal disease often produces pelvic pain or anterior high pain from involvement of femoral nerve in pelvis. Coronary pain classically produces pain along the inner surface of the left arm.

Patients with symptoms of root disease may have back pain and symptoms of spinal cord disease; thus careful history and examination should be carried out to differentiate isolated root lesion from combined spine, cord, and root lesion. If no cord or spine findings are present, root disease must then be differentiated from peripheral nerve lesions. In lumbar radiculopathy, sensory symptoms begin on top of toes; whereas in peripheral neuropathy, sensory symptoms begin on bottom of feet. In patients with pronounced back pain, manual motor and reflex testing may be different to perform; therefore, EMG-NCV may be required to determine presence of radiculopathy or neuropathy.

**Disk Disease**

Many conditions can cause root syndromes, but most common is intervertebral disk disease, either acute herniation or chronic degeneration. In acute herniation, annulus fibrosus of disk tears and disk material extrudes either laterally to trap exiting nerve root or centrally. Central herniation in cervical region (Figure 19-4) compromises spinal cord, whereas in lumbar area it can affect lower sacral nerve roots (cauda equina) (Figure 19-5). In cases of chronic degeneration, disks age by becoming dry and less resilient. They flatten and eventually encroach both on spinal canal and neural foramina. Calcium is deposited along their surfaces, and protruding "hard disk" is formed. In addition to disk degeneration or spondylosis, facet joints can become hypertrophic and further compromise both spinal canal and neural foramina (Figures 19-6 and 19-7). The clinical picture of root disease is similar whether process is acute or chronic. Following are descriptions of most common root syndromes. The lower cervical and lower lumbar disks are by far the most frequently involved. In cervical area, root exits above its corresponding numbered vertebral body. In lumbar area, root exits below numbered vertebra. In
lumbar area, root exits quite high on vertebra so L4-L5 disk herniation will usually trap L5 root (see Figure 19-3). Large disk protrusions can damage several roots. On occasion several disks can be involved; this is especially true with degenerative disease where multilevel involvement is common (Table 19-1).

**Lumbar Stenosis**

In lumbar area, progressive hypertrophy of facets and degeneration of disks give rise to severe root encroachment at multiple levels (Figure 19-8). This condition, often-referred to as lumbar stenosis, produces bilateral root symptoms in L4, L5, and S1 roots. With extensive degeneration or multiple traumas, spine can also become unstable. With forward flexion, one vertebra can ride forward over the one below then slip back with extension of back. This retrolisthesis accentuates spinal stenosis. In conjunction with multiple root problems, these patients also experience curious symptom called lumbar claudication. When walking or standing for long time, they begin to develop pain and heaviness proximally in their legs. Paresthesias and weakness follow if they cannot rest. These symptoms are due to irritation of roots because they are rubbed over spinal spurs. Also, there may be diminished blood flow to cauda equina which is cause of neurological claudication. Symptoms can also arise when patient lies down. Anti-inflammatory medications can help, but many patients require surgery to relieve symptoms. Full evaluation including electromyography, flexion and extension lateral lumbar x-rays with patient standing (weight bearing), and metabolic evaluation should be carried out. Amyotrophic lateral sclerosis or peripheral neuropathy can mimic lumbar stenosis and must be included in differential diagnosis in patient with multiple radiculopathies. Remember ALS has only motor dysfunction and in peripheral neuropathy, symptoms begin on bottom of feet bilaterally and ascend symmetrically.

**Cauda Equina Syndrome**

Cauda equina syndrome consists of damage to roots of sacral plexus. The cause can be extruded central disk (as high as L1-L2 or, if very large, at L5-S1), tumor of the filum terminale (ependymoma), lipoma (common with spina bifida or other dorsal defects), or other masses in lower lumbar canal. Clinical features are bowel and bladder incontinence, numbness in perianal region, occasionally pelvic or buttock pain, and if S1 root is involved, calf and leg weakness. On examination, anus is atonic, sensation in S2-S5 (perianal or saddle) region is decreased, and ankle jerks are diminished.

**Conus Medullaris Syndrome**

This is termination of spinal cord. Clinical findings include numbness on bottom of feet plus saddle region (S-2 to S-4), incontinence, weakness of bilateral gastrocnemius muscle, absent ankle reflexes and bilateral plantar extensor responses.

**Sciatica**

Sciatica, or pain down back of leg to foot, is another common yet multifaceted syndrome affecting sciatic nerve and its contributing roots. Differential diagnosis includes disk disease, tumor of roots, pelvic tumors or masses, spine disease in L5-S1, inflammatory disease in pelvis, endometriosis, adnexal masses, and sarcoma at head of femur, vascular malformation in cord, or spasm of pyriformis muscle. Back pain that radiates down back of leg but stops at knee usually represents ischio-gluteal bursitis. Localized diffuse low back pain without leg irradiation is referred to as lumbago.
Other Isolated Root Syndromes
Although disk disease is most common cause of root symptoms, many other diseases must be considered in differential diagnosis. Neurofibromas or schwannomas are often multiple. Cysts of root sleeves, although usually asymptomatic, can occasionally give rise to root symptoms, other tumors of cord, vascular malformations, epidural abscess, vertebral disease with collapse (back pain usually prominent), and retroperitoneal or paravertebral tumors (primary or metastatic).

Evaluation
Box 19-6 shows clinical and neurodiagnostic tests used to evaluate radiculopathy (nerve root disease).

Spinal Cord Lesions
The principal constituents of spinal cord are descending motor and autonomic fibers, ascending sensory fibers, lower motor neurons anterior horn cells), and cell bodies of both sympathetic chain and spinothalamic sensory system. Disease of cord or pressure on it from external lesion can produce symptoms in one or more of functions subserved by these elements. The neurologic deficit is frequently bilateral and progressively affects symptoms only distal (caudal) to lesion. Myelopathy is the general term for spinal cord dysfunction (Box 19-7). Because there is such a difference in the sense of urgency and also in the differential diagnosis between acute myelopathy and chronic, slowly progressive myelopathy, the two are discussed separately.

Acute Myelopathy
Acute myelopathy is usually vascular, infectious, or demyelinating in mechanism, although occasionally it is neoplastic. MRI is study of choice and should be performed immediately.

Transverse Myelitis
Transverse myelitis is an unusual inflammatory demyelinating condition that is probably of viral or postinfectious origin. It can also be seen after immunization and in vasculitis such as with systemic lupus. Cord symptoms evolve over 6 to 24 hours and involve motor, sensory, and autonomic functions. Lesion is usually in upper to mid thoracic level. Often antecedent viral infection is reported. Pain is not prominent. CSF usually has lymphocytes (50 to 200) and increased protein. Myelin basic protein or oligoclonal bands can be present; this suggests multiple sclerosis. MRI is almost always negative, although occasionally it shows swollen cord with increased signal on T2 unless S causes abnormal finding. Prognosis is variable. If recovery occurs, improvement is usually seen in 3 to 4 weeks.

Epidural Abscess
Patients with spinal abscess usually have constitutional signs of infectious disease. Cutaneous and pelvic infections are frequent sites of origin. Neurologic signs evolve over several days. Focal, localizing back pain and spin: tenderness are present and usually marked. There are usually rapidly evolving motor, sensory, and autonomic signs to indicate spinal cord compression. Cells are present in F, and protein is markedly elevated (particularly if block exists).
Spinal Cord Tumors
Spinal cord tumors usually progress over weeks to months but can occasionally cause acute cord decompensation (malignant lesions such as metastases, lymphoma). Back and radiating root pain are often present in extramedullary tumors. There is no history of antecedent illness unless tumor is metastatic or multifocal such as lymphoma.

Vascular Lesions
The following describes what happens with various vascular lesions:

- *Arteriovenous malformations*. When they rupture, patient experiences sudden back pain, root pain at level of lesion, and evidence of myelopathy. Neck is often stiff.
- *Spinal cord stroke*. Spinal cord strokes are rare but can be found in patients with severe aortic atherosclerosis or small vessel disease such as systemic lupus or diabetes. These disorders usually affect anterior spinal artery and give the typical picture of arm flaccidity and leg spasticity (anterior spinal artery syndrome).
- *Cord ischemia with a dissecting aortic aneurysm or after aortic aneurysm surgery.*

Acute cervical disk. Acute cervical disk is almost always seen with significant neck trauma and does not pose major diagnostic problem.

Collapse of diseased vertebrae. Vertebrae that have been weakened by osteoporosis, infection, or metastatic cancer can suddenly collapse and cause spinal cord compression. Back pain and root symptoms are also present. Myelopathy can be present.

Chronic Progressive Myelopathy
*Cervical spondylosis (neurologic manifestations of radiculopathy or myelopathy as result of arthritis of any cause) or degenerative disk disease.* Degenerative disk can encroach on spinal canal and press or rub on cord; this process produces cord damage by direct pressure or ischemia secondary to pressure on cord blood supply. Most common levels of cord to be affected are C5-6 and C6-7. Clinical syndrome consists of progressive spasticity in legs and frequently root symptoms in hands with weakness, atrophy, and sensory loss. Complaints of arm and neck pain can be present. Such patients are vulnerable to forceful or prolonged neck extension, and neck trauma is poorly tolerated. Treatment can be surgical with removal of the disk anteriorly or decompression posteriorly. Some return of function can be seen, although full restoration is not expected. Use conservative therapy with bed rest and intermittent cervical traction; anti-inflammatory drugs can be used.

Tumor
Fifteen percent of tumors of central nervous system occur in spinal cord or spinal canal (see Chapter 15). Extramedullary (arising from tissue within spinal canal but not in spinal cord itself) tumors are most frequent, with metastatic tumor being the most common, followed by schwannoma and meningioma. Intrinsic cord tumors (gliomas) are less common. Most metastatic tumors spread to bony spine, although some are epidural or intrinsic in cord. Clinically there is slowly progressive, often asymmetric spasticity with sensory loss below level of lesion. Bowel and bladder symptoms are common in epidural metastases. Radicular pain and sensory loss are common, particularly in extramedullary tumors (Table 19-2). Mild to moderate back pain is often present and can precede neurologic symptoms. Pain is increased when lying down because of blockage of venous flow.
**Multiple Sclerosis**
Multiple sclerosis can present as acute transverse myelopathy, but some patients, particularly those with middle-age onset, experience progressive myelopathy without history of remissions and exacerbations. If MRI is negative, physician should obtain CSF for special immunologic studies, (oligoclonal bands, increased immunoglobulin production) because at least 50% of unexplained progressive myelopathy is due to demyelinating disease.

**Amyotrophic Lateral Sclerosis**
Amyotrophic lateral sclerosis is common neurologic disease of middle-age that can present primarily with spasticity and lower motor neuron findings but without sensory change.

**Subacute Combined Degeneration**
This is result of vitamin B₁₂ deficiency. Condition can appear without evidence of pernicious anemia. Spasticity with loss of position and vibratory sense is hallmark of this disease. Bowel and bladder findings are often present. At times diffuse paresthesias with signs of neuropathy heralds the onset.

**Tabes Dorsalis**
Although uncommon, late complications of parenchymatous syphilis must be considered. Appropriate studies to rule out syphilis should be obtained on CSF examination on any patient with spinal cord disease and positive serology in serum.

**Other Medical Disease**
Systemic lupus erythematosus, sarcoid, cryptococcal meningitis, sickle cell disease, and other disorders can appear as acute or chronic myelopathy.

**Syringomyelia**
This condition causes long cystic cavities within spinal cord. The cavity, or syrinx, is usually in cervical cord but can extend through lumbar region. It is believed to be nonobliterated and expanded central canal. In some cases, syrinx is part of cystic astrocytoma of the cord or can be late development after cord trauma. Symptoms can be asymmetrical, symmetrical, or strictly unilateral. Spasticity is present below the lesion. At level of syrinx, there is segmental loss of pain and temperature with preservation of touch (sensory dissociation); this often produces insensitive hands that are subjected to repeated trauma and burns. Radicular pain may be present. Posterior column sensation is usually spared. Scoliosis is often present, and fasciculations and atrophy can be seen at level of lesion.

**Congenital Lesions**
These lesions are usually noted in childhood, particularly meningomyelocele and diastematomyelia. Occasionally lipomas associated with spina bifida can present in adulthood. A cutaneous lesion (dimple, sinus tract, hair patch) is often noted on the overlying skin.

**Familial Spinal and Spinocerebellar Degenerations**
These are rare diseases appearing in childhood with gait abnormalities. Familial spastic paraplegia and Friedreich ataxia are two examples. Onset of Friedreich's ataxia is usually in later...
childhood, with slurred speech, high-arched instep, and scoliosis, as well as spinal cord and cerebellar findings.

**Radiation Myelopathy**
Progressive cord symptoms can appear 6 to 12 months after irradiation that includes spinal cord.

**Vertebral Junctional Abnormalities**
These (Arnold-Chiari malformations, foramen magnum meningiomas, and congenital bony abnormalities of upper cervical vertebrae) produce bilateral limb findings and lower cranial nerve findings. MRI is first-choice procedure when these lesions are suspected.

**Parasagittal meningioma**
These will produce bilateral leg spasticity with bladder symptoms. This should be considered when routine spine evaluation is negative, but clinical symptoms are confined to both legs. Evaluation Summary for Spinal Cord Disease can be seen in Box 19-8.

**Spinal Trauma**
Forceful extension, flexion, or rotation of spine may result in damage to disks, vertebrae, or muscular and ligamentous supporting soft tissues of spinal column. Lumbar and cervical vertebrae are most frequently affected, and severity of clinical symptoms is usually but not always related to violence of trauma. Lifting a piece of furniture can cause mild back pain from over-stretching ligaments, whereas accident on motorcycle can cause tearing of ligaments, dislocation of cervical vertebrae, rupture of disks, and severe spinal cord injury.

**Severe Cervical Injuries**
Most neck injury is due to hyperextension or rotation of neck. Hyperflexion is prevented by chin hitting chest, and excessive lateral motion is restricted by shoulders. With rapid violent hyperextension, anterior spinal ligament is stretched and may tear. Posterior spinal ligament is weak, and pressure on disk during hyperextension can cause disk to herniate posteriorly in midline, thus impinging on spinal cord. Facets can fracture and cause dislocation, hemorrhage can occur under anterior or posterior ligaments and supporting ligaments, and muscles can be torn or stretched. Vertebral bodies can sublux (slide over each other—dislocate) and, particularly in children, return to normal position. In severe injury, spinal cord is damaged by pressure from extruded disk, blow to actual cord during dislocation (this causes contusion or hemorrhage), and infarction secondary to damage to cord vessels. In violent cervical trauma, revulsion of medullopontine junction may occur. If this occurs, death is instantaneous. Elderly persons are vulnerable to extension injuries because chronic disk degeneration and facet overgrowth have reduced diameter of spinal canal (spinal stenosis), leaving cord very little room for displacement during neck movement. With trauma spinal cord compression can rapidly develop.

Acute cervical injury must be very carefully managed. Usually spinal cord damage has occurred with initial trauma, but 5% to 10% of patients with cord damage from trauma have neurologic symptoms, which appear or significantly worsen after accident because of improper patient handling. In some cases, facets have been fractured and spine rendered unstable, but cord remains intact. Delayed neurologic deficits are usually attributed to failure to those handling patient to appreciate and protect the unstable neck.
Steps in Acute Management are listed in Box 19-9. Long-term management of spinal cord injury patients is complex rehabilitation effort that can take many months or even years before patient achieves final functional level.

**Benign Cervical Injury (Whiplash)**
If no signs of spinal cord or root damage are present and cervical roentgenograms are negative, cervical injury is diagnosed as cervical strain or sprain. This is largely soft tissue injury that is similar in many ways to sprain anywhere else in the body. Symptoms can be present directly after injury or be delayed for several days. Principal symptom of whiplash injury is posterior neck pain and spasm. Pain can radiate to occiput and over head or down into shoulders and between shoulder blades. Shoulder pain is usually referred pain from spinal ligaments and is not result of C5 nerve root impingement. Neck motion is painful. In first week, anterior neck muscles will be sore, but this usually heals quickly. Examination of patients should be guided toward identifying any root or subtle cord symptoms before instituting conservative management. Some false root signs, especially C8, can be seen with spasm of anterior scalenus muscle, so it is important to assess patient carefully before considering MRI. List below are nine management steps.

**Management**
- **Rest.** In severe injury 2 to 3 weeks rest can be necessary. If significant pain is present after 24 hours patient should stay in bed at least 1 week.
- **Soft collar.** Wear soft collar 24 hours per day for 2 to 3 weeks, then intermittently for 4 to 6 weeks in serious injury. The collar should allow slight neck flexion and prevent extension.
- **Medications.** Muscle relaxants, sedation, analgesics, and anti-inflammatory medicines are all useful in first several weeks.
- **Heat and massage.**
- **Activity Restrictions.**
  - Avoid neck extension (reaching above head and looking up).
  - Sleep on the side—never on the face—in bed at least 10 hours a day.
  - Avoid riding in car as much as possible.
  - Avoid emotional tension; symptoms of tension headache markedly increase symptoms in neck.
- **Cervical traction (head slightly flexed).** Traction can be used if it relieves symptoms. Pain and neck stiffness can be prolonged for many months. Physical exercise or heavy work can exacerbate symptoms. If symptoms are present after 6 weeks, they will probably last 6 months or more; 10% to 15% of patients may be unable to do heavy work for several years. Anxiety, depression, and anger (against those responsible for the injury) may exacerbate symptoms. Disputes with employers and receipt of workers' compensation are definitely negative factors in recuperation. Repeated trauma or effects of degenerative spine disease can result in chronic neck pain. This is best treated conservatively with rest, heat, and medication.

**Lumbar Injuries**
Low back trauma is quite common and is major source of aggravation and disability yet does not hold serious threat to neurologic function that is present with cervical trauma. Most low back
injuries are result of falls, improper or excessive lifting, or sudden twisting motion. Often initial insult can be as innocent as getting out of bed or mopping floor.

Mechanism of low back injury involves three elements: (1) tearing or pulling ligaments and muscle insertions; (2) damage to annulus fibrosus of disk with subsequent herniation of nucleus pulposus (ruptured or "slipped" disk); and (3) strain on posterior (facet) joints. The last mechanism is more common in older persons. Damage in sacroiliac joint is very rare and usually seen with violent pelvic trauma. Major symptom of low back injury is pain; however, in disk herniation major symptom can be that of root impingement. Most common disks to herniate are those between L4-L5 and L5-S1. Spinal cord ends at the L1 or L2 level so cord is not involved. On occasion disk will extrude centrally in upper lumbar region and press on cauda equina, thus producing bowel and bladder symptoms. When taking history from patient with low back injury, symptoms listed in Box 19-10 should be explored. Examination of low back involved looking for spasm, observe motion, performing neurologic examination with careful examination for root lesion, and perform rectal examination.

Initial management of lumbosacral injury consists of lumbar spine films and then the following:

- Bed rest: Supine or on side with legs flexed, firm mattress, getting up only to go to bathroom. Never lie on stomach! Length of bed rest is determined by severity of injury, but prolonged bed rest may lead to physical deconditioning and accepted period of bed rest has recently been decreased to several days only.

- Sedation, analgesics, heat, anti-inflammatory medications, and muscle relaxants as outlined under cervical injury previously and utilized on regular and not as needed basis. Pelvic traction exercise programs, ultrasound, head and cold, transcutaneous electrical stimulation are frequently utilized but evidence to their efficacy is not established. Early return to usual activities and more emphasis on physical activity to prevent recurrence and chronic pain.

- Surgery should be considered acutely in following cases: bowel or bladder dysfunction, weakness of muscle groups supplied by one or two nerve roots (10% of lumbar disk herniations involve two disks), progressing neurologic deficit, and unrelenting root pain (several weeks).

Decreased reflex or dermatomal sensory signs or symptoms are not sufficient grounds for surgery. Of all acute lumbar disk lesions, 80% can be successfully managed conservatively. After 2 weeks of bed rest, medications are gradually reduced and ambulation is increased. Corset is often useful for 2 to 4 weeks in some patients, especially obese or elderly. Chronic corseting is deleterious because it serves to weaken back and abdominal muscles. When fully ambulatory, patient should follow regimen described in Box 19-11 (most suggestions are designed to decrease load on lumbar spine).

Unfortunately, reinjury and prolonged low back symptoms often produce chronic condition. Conservative management with each attack is preferable, but if chronic root pain or root symptoms persist and are not relieved by rest and medication, electromyography (not abnormal until three weeks after acute lesions) and spinal MRI scan should be obtained. Back pain alone is not reason enough to undertake surgery; root disease is, if symptoms persist. Significant percentage of patients with chronic root complaints are helped with surgery, but selection of surgical candidates must be careful and includes patients with evidence of persistent radiculopathy. In patients with back pain and radiculopathy, which interferes with patient's
functioning and which is not improving, surgery should be considered. Patient should be told that leg symptoms (due to nerve root compression) are more likely to improve and low back pain may improve but may be more persistent. Spinal surgery including discectomy and laminectomy are to remove pressure on nerve root and spinal fusion is carried yet when there is congenital spinal abnormality and instability.

Chronic low back pain from repeated lumbosacral strain has many ramifications. After 9 to 12 weeks of low back pain, 5 to 10% have persistent symptoms. It is this group of patients who consume 80 to 90% of costs due to low back pain. Careful neuro-imaging and rheumatological tests should be done to be certain structural lesion was not missed on initial evaluation; however, psychological mechanisms of pain should be explored. Over time, facet joints hypertrophy and degenerative disks develop spurs along their edges. This process of degeneration can lead to spinal (lumbar) stenosis. Such patients develop lumbar claudication (paresthesias and weakness when walking) and progressive often bilateral radiculopathy L4, L5, and S1. Plantar extension and flexion of feet is decreased, reflexes are reduced, and distal sensory loss is seen.

Chronic low back pain can be disabling to person who does physical labor. Frequently patient must change jobs to function. Disability claims and legal considerations become complicating aspect of syndrome, and all too often, patient and employer or insurance company enter into adversarial relationship rather than sympathetic one. Back pain, as with any chronic pain, have strong psychologic component from frank malingering to minimal psychologic overlay on the real problem. Depression, reversals in personal life, financial hardship, and pending litigation all complicate resolution of problem. It is important to monitor pain medication carefully because of potential for drug addiction. Occasionally personality test such as the Minnesota Multiphasic Personality Inventory is useful in assessing this aspect, but it can only serve as part of overall evaluation. Each physician must learn to deal with this problem; there are no easy answers or dogmatic rules. Be sympathetic with the patient, but be aware of multiple facets that can be present in each case.

**SUMMARY**

Disease of spine includes spinal cord, nerve roots, and supporting bony and soft tissues. Many clinical syndromes involve spine, and most can be easily diagnosed by history and physical examination. Judicious use of newer imaging techniques, particularly MRI, have made it possible to diagnose such conditions as intervertebral disk disease and spinal cord tumor much more accurately and with less morbidity. Spine injury remains common and frequently disabling symptom for which definitive treatment is lacking. Because cost of low back pain and neck pain is so high in terms of lost work productivity and compensation payments, preventive strategies have been initiated to reduce cost of these injuries.
SUGGESTED READING

Cervical Spine Conditions

Lumbar Abnormalities
Mixter WJ, Barr JS: Rupture of the intervertebral disc with involvement of the spinal canal, 211:210, 1934.

Spinal Injuries

Spinal Cord Neoplasm
BOX 19-1.
1. Back pain (myofascial syndromes)
2. Nerve root symptoms (radiculopathy)
3. Spinal cord symptoms (myelopathy)

BOX 19-2. History
1. Presence of trauma (see Spinal Trauma)
2. Character of onset and course
3. Location
4. Relief or exacerbation of pain with change in position
5. Radiation of pain around body or into limbs
6. Associated neurologic symptoms (e.g., weakness and paresthesias) or bladder dysfunction
7. Previous back surgery
8. History of cancer, AIDS or other infections
9. Medical disease such as heart disease, ulcer, renal, or pelvic disease; all can produce referred pain to the back
10. Intermittent claudication (i.e., neurologic claudication: neurologic symptoms such as weakness and paresthesias that come on after walking a short distance)
11. Recent infection, particularly tuberculosis or pelvic inflammatory disease
12. Corticosteroid use or metabolic disease that can lead to osteoporosis with possible compression fracture
BOX 19-3. Physical Examination

1. Inspection of the back
   a. Spasm in paraspinous muscles
   b. Alignment (scoliosis, loss of normal lordosis cervical or lumbar)
   c. Dimples, sinus, or hair patch in lumbar area (might indicate underlying closure defect such as spina bifida with or without intraspinal tumor)

2. Palpation to identify spasm and tenderness

3. Percussion of spinous processes (start gently because percussion of an infected or damaged vertebra can be extremely painful)

4. Observation of movement of spine in all four directions and with rotation; note restrictions or production of pain or spasm

5. Neurologic examination with careful attention to spinal cord and nerve root signs

6. Maneuvers to evaluate low back pain:
   a. Patrick's maneuver. With patient supine and leg flexed, leg is allowed to abduct fully until knee lies on bed laterally (frog-legged). Flexion of leg relieves stretch on the root; therefore, pain elicited during this maneuver usually indicates hip joint disease.
   b. Straight leg raising. With patient supine, examiner places hand under one heel and slowly raise leg to the 80- or 90-degree position. If there is root impingement, this maneuver will stretch and irritate root and reproduce radiating pain at 30- to 60-degree position. If pain is present but equivocal, the examiner should dorsiflex the foot. This further stretches nerve and should increase pain if root pathology is present. This test is positive in high percentage of acute disk herniations, particularly in young persons (under age 30); in fact, a negative straight leg-raising test almost eliminates possibility of disk lesion in that population.
   c. Pyriformis syndrome. The pyriformis muscle can develop spasms and trap sciatic nerve, causing back and leg pain. To test for these, have patient lie supine with leg flexed, then adduct leg and force knee over opposite leg. Sciatic pain is suggestive of pyriformis syndrome.
   d. Test for sciatic notch tenderness.
   e. Observation for pelvic tilt. The pelvis can ride higher on symptomatic side because this is attempt to reduce pressure on this such that weight is absorbed by nonsymptomatic side.

7. Foraminal closure test for cervical root impingement Have patient extend neck and tilt head to the side. This will tend to close the neural foramen and produce root pain and paresthesias in a compromised root.

8. Abdominal examination

9. Rectal and pelvic examination (low back pain)

10. Peripheral pulses
BOX 19-4. Differential Diagnosis (Excluding Trauma)

1. Congenital abnormalities of the spine
   a. Fusion of vertebrae. This commonly occurs in neck and can involve several levels of fusion.
      These en bloc vertebrae or Klippel-Feil deformities reduce neck mobility and can cause pain.
      There are often associated anomalies such as hemivertebrae and scoliosis. Short neck and reduced
      neck motion are common.
   b. Hemivertebrae. Fusion of part of fifth lumbar vertebra to sacrum (sacralization of L5) can lead to
      tilt of spine with compensatory scoliosis and pain,
   c. Spondylolisthesis. This is congenital defect in inter-articular process of superior facet of L5 that
      causes the L5 vertebral bodies to slip forward over S1. This slippage usually occurs in mid teens
      and is characterized by back pain, muscle spasm, pain on straight leg raising, and often hamstring
      spasm with associated short stride gait. Sacral roots can be involved in severe cases. Surgery is
      necessary.
   d. Absent odontoid with instability of atlantoaxial joint. This can give neck pain and neurologic
      symptoms if subluxation occurs.
   e. Basilar impression. Base of the skull is flattened and cervical spine is literally pushed upward.
      This can cause neck pain, cord compression, and lower cranial nerve abnormalities.
   f. Scoliosis Scoliosis can be seen in association with spine abnormalities such as collapse or
      malformation of vertebral body; spinal tumors, particularly those associated with
      neurofibromatosis; spino cerebellar degenerations; syringomyelia; and neuromuscular disease.
      The most common, however, is idiopathic progressive variety, which can occur both in infancy or
      in juveniles. The problem is much more common in females and is usually thoracic in location.
      The deformity can be very marked, and surgery is necessary.

2. Diseases of the viscera that can produce back pain
   a. Posterior wall cardiac ischemia or infarction.
   b. Ulcer in posterior wall of stomach. Pain in right posterior chest wall.
   c. Gallbladder, biliary tree, and pancreatic disease.
   d. Retroperitoneal masses or hemorrhage. Nerve root symptoms are often present at level of lesion.
   e. Aortic or abdominal aneurysm (can give acute back pain with dissection),
   f. Pelvic disease. Tumor, mass, or inflammation can cause low back pain. The retroflexed uterus,
      however, probably does not.

3. Osteoporosis (bone softening)
   This is common problem in elderly but is seen in patients on chronic corticosteroid medication or with
   hormonal or neoplastic diseases that produce imbalance between calcium absorption from bone and
   calcium deposition. Back pain is due to vertebral collapse or fracture; onset is often acute.

4. Infectious disease
   Vertebral osteomyelitis is somewhat uncommon and predominantly affects adult diabetics. The major
   symptom is localized back pain. It is progressive, unremitting, and worse at night. Movement intensifies
   pain, and paravertebral muscle spasm with spinal rigidity is common. The affected vertebrae can be
   extremely sensitive to percussion. Pain radiates around chest if there has been some vertebral collapse and
   root impingement. Spinal cord findings can be present if vertebrae are collapsed and subluxed. The white
   blood cell count and erythrocyte sedimentation rate are elevated, but temperature can be normal.
   Tuberculosis of spine (Pott's disease) is most common in immunocomprised patients such as HIV positive
   patients. The disease has more indolent course and less dramatic symptomatology than is seen with
   pyogenic infection. Long-term antimicrobial therapy is required in all types of osteomyelitis.
   Epidural spinal abscess can also appear with back pain. The origin of infection is usually pelvic
   inflammatory disease. Signs of generalized infection and spinal cord findings are often early features.
BOX 19-4. Differential Diagnosis (Excluding Trauma)- continued

5. Neoplasm
As with infection, principal symptom is progressive, unremitting pain that is unrelieved by position change. Cramps of pain are common, and sudden exacerbations of the pain will occur with vertebral collapse. Scoliosis is often present. In young patients with back pain and scoliosis, tumor must always be ruled out. Fortunately, if discovered, most tumors are benign in young patients.

a. Multiple myeloma (plasmacytoma). This is common spine tumor. It is usually seen in males past age of 50. There is often evidence of constitutional symptoms such as malaise and weight loss. Erythrocyte sedimentation rate is often increased, as are calcium, alkaline phosphatase, and uric acid. Bence Jones (light-chain) protein is seen in urine: on immunoelectrophoresis, serum electrophoresis often shows increased globulin with "M" spike, and immunoelectrophoresis shows increase in light chain immunoglobulins.

b. Metastatic. Spine is most common site for skeletal metastasis. Roentgenographic findings are late because 30% of vertebral mass must be destroyed before it is evident on plain roentgenography. Bone scan and MRI are more effective diagnostic tests. Metastatic disease can be osteolytic (hypernephroma, thyroid, and large bowel) or osteoblastic (prostate, lung, breast).

c. Intradural extramedullary tumors, These tumors can also present with back pain (e.g., neurofibroma/schwannoma or meningioma).

6. Collagen disease
Ankylosing spondylitis and rheumatoid arthritis are both known to produce considerable back pain. Ankylosing spondylitis (predominantly males) commonly starts in sacroiliac joints and is cause of low back pain. Rheumatoid disease (predominantly females) has its most serious complications in cervical spine where atlantoaxial dislocation can occur. Inflammatory pannus formation anterior to cervical cord can simulate a mass lesion.

7. Degenerative disk disease and arthritis of facet joints
Degenerative disease of spine, both cervical and lumbar, is major cause of back pain. This degeneration is often due to repeated trauma. Pain from disks and facets is not always midline or paraspinous; it can be referred to hip (medial and lateral) and even to anterior thigh.

8. Hip or bursa pain
If pain is much worse when patient is lying on one side and radiates into thigh and calf, the clinician should carefully examine the hip; the patient may have a trochanteric bursitis. Also, if pain is much worse when walking, there is possibility of primary hip joint disease.

9. Psychogenic back pain
This diagnosis is suggested if there are no mechanical or neurologic (radiculopathy, myelopathy) signs. This is a complex problem and usually is associated with trauma.
**BOX 19-5.**

1. Spine roentgenograms
2. Bone scan, especially in nontraumatic progressive pain
3. Erythrocyte sedimentation rate, collagen evaluation and rheumatoid factor, alkaline phosphatase, acid phosphatase (male), phosphate, calcium ions, fasting blood sugar, uric acid, serum electrophoresis, and immunoelectrophoresis
4. Urinalysis with immunoelectrophoresis if in an older patient
5. Selected cardiac, gastrointestinal, or pelvic studies as indicated
6. CT/MRI scan of spine
7. Myelogram with CT

**BOX 19-6.**

Careful physical examination
Specific tests to determine which root is involved and the cause
Spine roentgenograms
Electromyogram
CT/MRI of spine
Myelography with postmyelogram CT scan
BOX 19-7.

1. Important symptoms to elicit during the history of patients suspected of having spinal cord disease:
   a. *Speed of development of symptoms.* Rapidly progressing cord lesion (hours to days) is true emergency. If cord function, particularly bowel and bladder control, is severely compromised for more than 24 hours from pressure, functional recovery is poor.
   b. Level of dysfunction above which there are no symptoms but below which bilateral symptoms are present. Sensory symptoms are often vague and changing.
   c. *Bowel, bladder, and sexual dysfunction.* Bladder is often "spastic" with low capacity and frequent spontaneous emptying. Clinically this can first appear as frequency and urgency, but soon incontinence is experienced.
   d. *Back pain.*
   e. *Root symptoms.*
   f. *Absence of cranial nerve symptoms.*
   g. *Family history of spinal cord disease.*
   h. *General medical history:* Diabetes, stomach disease or surgery (possible vitamin B₁₂ deficiency), atherosclerotic vascular disease, collagen disease, sarcoid, cancer, AIDS.
   i. *Previous or recent trauma.*

2. Examination to establish both presence and level of spinal cord involvement:
   a. *Cranial nerve examination.* This should be normal in isolated cord disease. In amyotrophic lateral sclerosis patient can demonstrate spinal cord (anterior horn cell/motor neuron) signs plus cranial motor signs.
   b. *Motor examination.* This should show decreased motor control, spastic gait, and hyperreflexia below the lesion (if a cervical cord lesion is suspected, check jaw jerk; if this is hyperactive the lesion can be above the pons) with clonus and pathologic reflexes.
   c. *Sensory level.* Carefully examine for a sensory level (not always present, especially with intrinsic [intramedullary] tumors).
   d. *Anal tone.*
   e. *Inspection of back.* Examine back for tenderness, spasm, scoliosis, birthmarks, midline dimples, or hair patches.
Figure 19-1. Cross-section of spine.
Figure 19-2. Lateral view of lumbosacral region. Note proximity of exiting nerve roots to both the facet joints and the disk. Disease in either the disk of facets can easily damage the roots.
Figure 19-3. Posterior view of lumbosacral region with transverse processes and spines removed to expose the filum terminale. Note relationship between exiting nerve root and intervertebral disk; rupture of the disk (e.g. L4-L5) can damage the L4 root above but often only affects the L5 root, which is passing the disk to exit below.
Figure 19-4. Lateral MRI of cervical spine demonstrating a herniated disk (arrow)
Figure 19-5. Lumbar myelogram demonstrating a marinated lumbar disk (arrow).

Figure 19-6. Anterposterior view of cervical myelogram demonstrating cervical spondylosis. The impingement on the roots laterally (arrow) is demonstrated. The lack of contrast shadow in the center of the white contrast column indicates pressure from the disk anteriorly.
Figure 19-7. Lateral view of cervical myelogram demonstrating cervical spondylosis. The posterior protrusion of the calcified disk (*arrows*) is shown.
Figure 19-8. Superior view of a lower lumbar vertebral body at the level of the cauda equina. The facet at the left is normal, but the one on the right shows evidence of severe hypertrophic degenerative change. Note how this traps the nerve root exiting at that level. The disk below also shows evidence of degeneration and is encroaching on the spinal canal anteriorly.