

Degenerative Spondylolisthesis: Diagnosis and Treatment

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Abstract

Degenerative spondylolisthesis is most often seen at the L4-5 level. The most common complaint is back pain, but the advent of leg symptoms, such as claudication and restless legs syndrome, is often the reason for seeking specialized medical attention. Conservative treatment usually suffices; extended bed rest is of little value. The 15% of patients who are surgical candidates are those with clinical signs and symptoms of cauda equina abnormality, progressive muscular weakness, or progressive incapacitating radicular pain or claudication. The author advocates pedicle-to-pedicle decompression with preservation of the articular facets as the essential operation. The indications for fusion have been debated, but recent prospective studies show improved outcomes after fusion. The risk of significant morbidity associated with laminectomy and fusion increases as a function of age and magnitude of operation; therefore, careful patient selection for surgical intervention is vital.

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Spinal stenosis is thought to be a growing, potentially major health problem for the elderly population. In this age group, degenerative spondylolisthesis may be the most common cause of spinal stenosis. Although the structural defect was first recognized over a century ago in anatomic specimen, the associated clinical syndrome was not described until Macnab's classic article,¹ in which he correlated the symptoms, signs, radiographic findings, and treatment. His proposed nomenclature was "spondylolisthesis with an intact neural arch," but soon thereafter "degenerative spondylolisthesis" became the preferred term.

Degenerative spondylolisthesis can be found in classifications of spondylolisthesis, spinal stenosis, and segmental instability, indicating that the clinical presentation is varied. The basic structural deformity involves forward displacement of a

lumbar vertebra (usually L-4 on L-5) (Fig. 1).

The symptoms of lumbar spinal stenosis, particularly a complaint of neural claudication, serve as the common operative indication. Because the appearance of a significant deformity or neural claudication often is antedated by significant and recurring episodes of low back pain, the condition is sometimes considered a prototype for segmental instability. However, the radiographic abnormality may occur without current or prior symptoms.

Valkenburg and Haanen² found an age-related increased prevalence of degenerative spondylolisthesis in women over the age of 60 years; 10% had the deformity, but many reported that they had never had back or leg pain. This finding is extremely important, and emphasizes that the obvious radiographic deformity cannot be assumed to be

causative of symptoms until a complete clinical and imaging evaluation has been performed.

Epidemiology and Etiology

All clinical and epidemiologic analyses have shown the most common site of structural deformity to be at the L4-5 level. Women are more commonly affected than men, and the prevalence of the condition increases with age. In contrast, ischemic spondylolisthesis usually occurs at L5-S1 and is more common in men; furthermore, the clinical symptoms often improve rather than worsen with age.

Radiographic surveys show that degenerative spondylolisthesis is more common in patients with hemisacralization. This finding is thought to have etiologic significance because the immobility of the L5-S1 level shifts mechanical stresses to the adjacent L4-5 level.

Diabetic patients and women who have undergone oophorectomy are also at significantly greater risk. These observations have clinical rel-

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evance because the orthopaedist faced with a patient with degenerative spondylolisthesis, diabetes, and leg pain often has to determine whether diabetic neuropathy or spinal stenosis is the cause of leg pain. The relationship to oophorectomy suggests the possibility that estrogen replacement might prevent or slow the onset of the deformity and symptoms.

Pathophysiology

The most important requisite for degenerative spondylolisthesis is relative immobility of the lumbar segment below the lesion. The immobility is most commonly due to hemisacralization but can also result from advanced disk degeneration at the L5-S1 level (Fig. 1). An iatrogenic cause for immobility is spinal fusion. The forward slip occurs many years after the original fusion; surpris-

ingly, many patients are asymptomatic despite the deformity² (Fig. 2).

There is substantially more controversy about other possible pathoanatomic causes. The higher prevalence in diabetic persons is thought to be due to weakened collagen cross-linking. Other mechanical theories suggest, but do not prove, that congenital or acquired abnormalities in the orientation of the facets predispose to the forward displacement. Unfortunately, the various pathoanatomic theories have no utility for designing specific prevention strategies.

Differential Diagnosis

The epidemiologic studies suggest that degenerative spondylolisthesis is often an asymptomatic radiographic finding. This fact is of enormous importance because there is a natural tendency for clinicians to

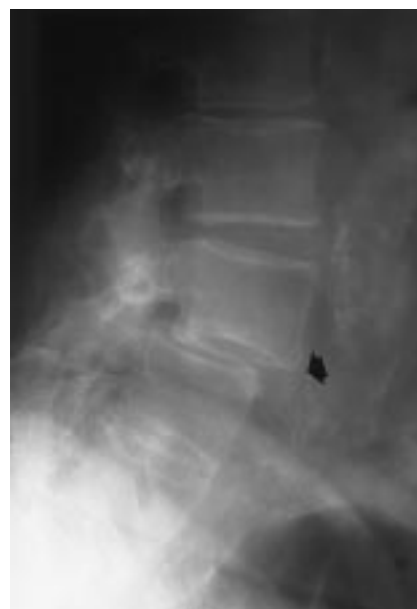


Fig. 2 Lateral radiograph of a 70-year-old woman who underwent successful fusion from L-4 to the sacrum 18 years previously. Current presenting symptom was neurologic claudication with pain, localized primarily to the anterior thigh. Displacement of L-3 on L-4 above the solid fusion is demonstrated (arrow).



A



B

Fig. 1 Radiographs of a 72-year-old woman followed up for 10 years. **A**, She originally presented with mild recurrent back pain and a minimal slip at L4-5. **B**, Six years later the displacement had progressed, the disk space had narrowed, and she experienced claudication after walking 1 mile. The L5-S1 space is very narrowed as well.

ascribe symptoms to an obvious structural lesion. A variety of other conditions can cause back or leg symptoms easily confused with the symptoms of degenerative spondylolisthesis.

Osteoarthritis of the hip occurs in 11% to 17% of patients with degenerative spondylolisthesis, and can mimic the anterior thigh pain of an L-4 root entrapment.³ Therefore, the hip needs to be carefully examined for an alternative cause for symptoms of leg pain.

Degenerative scoliosis is often an associated spinal deformity, and some believe that degenerative spondylolisthesis is a common antecedent for degenerative scoliosis in the elderly. In these patients the neurologic complaints may be more diffuse, consistent with multi-level involvement. Treatment of this

subset of patients may also raise substantially greater issues, such as the extent of decompression and fusion.

A less common coexistent condition is diffuse idiopathic skeletal hyperostosis. This condition is characterized by multilevel bridging osteophytes and commonly affects middle-aged and older men, who frequently are diabetic and hyperuricemic. If surgery is required, these patients can be far more challenging than those with standard degenerative spondylolisthesis.

The other possible causes for symptoms confused with degenerative spondylolisthesis include cervical spinal stenosis, intrinsic neurologic disorders, primary or metastatic tumors, and peripheral vascular disease. Peripheral vascular disease is of particular importance since it produces vascular claudication easily confused with neurologic claudication. A useful differentiation is that patients with a spinal cause usually are relieved of symptoms only by cessation of walking and sitting down or flexing the spine. In contrast, patients with a vascular cause have only to stop walking and symptoms disappear in the normal upright standing position.

Because of the age group affected and the substantial differential diagnosis, it is important to perform a current and complete medical evaluation before proceeding with definitive treatment of the spinal disorder.

Clinical Signs and Symptoms

The most common complaint of patients with degenerative spondylolisthesis is back pain. Often the pain has been episodic and recurrent for many years. Few patients can recall a specific traumatic event. As is the case with all mechanical back pain, patients usually report that

their symptoms vary as a function of mechanical loads imposed, and pain frequently worsens over the course of the day. Radiation into the posterolateral thighs is also common and is independent of neurologic signs and symptoms.

The advent of leg symptoms is the most common reason why patients and referring physicians become truly concerned and seek specialized medical attention. Monoradiculopathy is the less common type of leg pain; when present, it is the result of entrapment of the L-5 root in the lateral recess. The more common pain presentation is that of neurologic claudication. The pain may be diffuse in the lower extremities, involving the L-5 and/or L-4 roots unilaterally or bilaterally. These symptoms of spinal stenosis are reported by 42% to 82% of patients who seek help from orthopaedists.⁴ Typically, the leg pain is accentuated by walking and relieved by forward flexion of the spine. Additional complaints include cold feet, altered gait, and "drop episodes," wherein the patient unexpectedly falls while walking.

With extreme stenosis, interference with bladder and bowel control can occur, as was reported by Kostuik et al⁵ in 3% of their patients. Unlike the acute and often devastating bladder and bowel symptoms of cauda equina syndrome in lumbar disk herniation, spinal stenosis often has an insidious and subtle presentation. The unwary examiner is at risk of attributing these complaints to age-related conditions, such as cystocele in women and prostatism in men.

Stenotic symptoms are the result of mechanical and vascular factors. As the slip progresses, facet hypertrophy, buckling of the ligamentum flavum, and diffuse disk bulging contribute with the forward displacement to compression of the cauda equina (Fig. 3). As in all stenotic conditions, the relief of

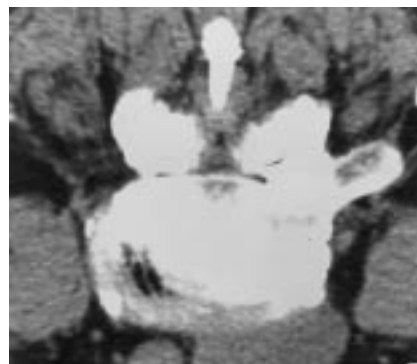


Fig. 3 Computed tomographic scan demonstrates the relationship of the caudal sac and nerve roots and the very substantial facet degeneration. Note the marked narrowing of the lateral recesses.

symptoms that follows forward spinal flexion is thought to be related to the increase in the anteroposterior dimensions of the spinal canal that occurs in that posture. At the extreme, patients may report the need to sleep in the fetal position to relieve leg symptoms.

The significant vascular component in complaints of leg pain may lead to another manifestation, restless legs syndrome, sometimes called "vespers curse."⁶ In this condition, patients are awakened by aching pain in the calves, restlessness, an irresistible urge to move the legs, and fasciculations. This syndrome is reported to be exacerbated by congestive heart failure, which, in turn, may increase pressure in the arteriovenous anastomoses that characterize the lumbar nerve-root microcirculation. Accordingly, if the patient reports increasing night cramps, it is worthwhile to obtain a thorough cardiovascular examination. Other associated neurologic symptoms, such as numbness and weakness, are variably present.

As already noted, some patients present with degenerative spondylolisthesis above a spinal fusion (Fig. 2). A long symptom-free interval is

followed by the onset of nerve-root symptoms and stenosis emanating from the level above their previous fusion.⁷

Physical Examination

As in most patients with lumbar spinal stenosis, the clinical examination findings are often nonspecific. Inspection usually reveals loss of lumbar lordosis if the patient is experiencing significant spine or neurologic symptoms. When stenotic symptoms are severe, a fixed forward-flexed posture, sometimes accompanied by hip-flexion contractures, can be observed. Except in very thin patients, the step deformity usually is not palpable.

One of the surprising features of degenerative spondylolisthesis is the retention of normal spinal mobility or, in some instances, hypermobility. It has been suggested that patients with this condition have generalized ligamentous laxity, which might have etiologic significance.

The neurologic examination may be quite useful when the patient has an isolated unilateral radiculopathy. The knee-jerk reflex may be reduced or absent when the L-4 root is involved. Unilateral dorsiflexion or quadriceps weakness and the pattern of sensory loss are important findings. However, a positive nerve-root tension sign is uncommon, particularly in the older population. More commonly, the neurologic findings are nonspecific and may include bilaterally absent reflexes, spotty sensory losses, and muscle atrophy without frank weakness.

When bladder symptoms are reported, sensory loss may be present in the perineal area, accompanied by a decrease in rectal sphincter tone. However, these genitourinary findings are often subtle; therefore, patients with these complaints should undergo urologic evaluation.

Imaging Studies

The plain radiographic features (Fig. 1) include the essential finding of forward displacement of L-4 on L-5 or, more rarely, L-5 on S-1 or L-3 on L-4 in the presence of an intact neural arch. The only lesion that can mimic these radiographic findings is the far less common L4-5 ischemic spondylolisthesis (Fig. 4). Patients with that condition are quite likely to have neurologic symptoms and to be younger. Unlike L5-S1 ischemic spondylolisthesis, the slip increases over time, and fusion is often necessary.

The remaining radiologic findings are consistent with a long-standing degenerative process and include disk-space narrowing, vacuum sign, endplate sclerosis, peridiskal osteophytes, and facet sclerosis and hypertrophy. The anteroposterior radiograph often, but not always, demonstrates the accompanying hemisacralization of L-5.



Fig. 4 Radiograph of a man with L4-5 ischemic spondylolisthesis with an advanced slip. Note the defect in the pars.

Dynamic flexion-extension radiographs are used by some experts to evaluate for instability. Today, the criterion for instability in flexion-extension is displacement exceeding 5 mm. The alternative approach of using traction-compression radiographs has been described by Friberg.⁸ In this technique, a lateral lumbar radiograph is taken first after the application of a standard axial load and then after traction. The difference in displacement between these two views is correlated with back pain and instability, and is considered by Friberg to have prognostic significance.

Additional imaging studies may be warranted depending on the patient's presentation and the clinical findings. The choice of how soon these studies are performed is a matter of clinical judgment. Factors that speak to the need for further imaging include significant and progressing neurologic claudication or radiculopathies and the clinical suspicion that another condition, such as metastatic disease, may be causative. An absolute indication is the presence of bladder or bowel complaints.

The imaging alternatives include computed tomography (CT), myelography, contrast material-enhanced CT, and magnetic resonance (MR) imaging. Currently, MR imaging is favored by many experts because of its noninvasive nature. Others continue to believe that the contrast material-enhanced CT scan gives the most information about the caudal sac. The pragmatic approach is to choose that imaging study with which you and the radiologist have the most experience and for which you have the best equipment.

Regardless of the imaging study chosen, the typical findings are a significant constriction of the cauda equina (Fig. 5) associated with a diminished cross-sectional area and diameter, facet degeneration and

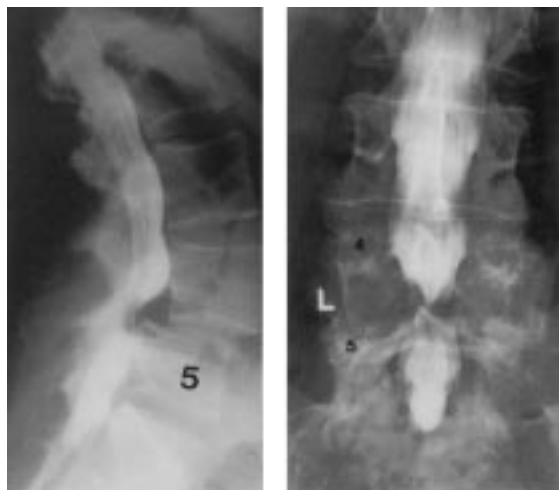


Fig. 5 Typical lateral (**left**) and anteroposterior (**right**) myelographic appearance of degenerative spondylolisthesis. Note the significant constriction of the caudal sac at L4-5.

hypertrophy with subarticular entrapment of the L-5 nerve roots, apparent thickening and buckling of the ligamentum flavum, and diffuse disk bulging. All of these factors contribute to the symptoms of spinal stenosis.

Additional studies that may be selected include technetium bone scanning, particularly when a metastatic tumor is suspected, and electrodiagnostic studies if a systemic neurologic disorder is a possibility.

Local anesthetic injections may be useful in specific cases. The best indication is concomitant degenerative spondylolisthesis and hip osteoarthritis. Relief of symptoms following an intra-articular hip injection suggests that the hip is the most probable origin for the symptoms.

Conservative Treatment

There are no prospective, randomized clinical trials that establish a preferred method of nonoperative treatment. However, there is recent evidence that the natural history of degenerative spinal stenosis and degenerative spondylolisthesis may

be more favorable than previously thought. Johnsson et al⁹ followed up 32 patients with clinical symptoms and myelographically confirmed stenosis for an average of 49 months. No patient had significant deterioration, and surprisingly many patients improved.

In the absence of definitive clinical trials, treatment currently is non-specific and consistent with the conservative care of most degenerative lumbar spinal disorders. The alternatives include (1) nonsteroidal anti-inflammatory drugs (in the elderly, there should be careful monitoring for gastrointestinal complaints and melena); (2) encouragement of aerobic conditioning, on the premise that this exercise may improve arterial circulation to the cauda equina (because walking often aggravates symptoms, a stationary bicycle is a good alternative, particularly if the handlebars and seat are set up to allow the forward-flexed posture); (3) weight reduction, although this strategy often minimally affects neurologic complaints; and (4) careful management of osteoporosis.

Additional strategies include the judicious use of braces, other exer-

cise regimens, and epidural blocks, but again there are no well-established clinical trials. Extended bed rest appears to be of little value and carries a significant risk of morbidity in the elderly. Likewise, there is no information to support the use of manipulative therapy; that treatment may be contraindicated, particularly in the osteoporotic patient.

Operative Treatment

Because the natural history of degenerative spondylolisthesis is still relatively uncertain, it is difficult to establish what percentage of patients respond to conservative management and who requires surgical intervention. However, it is estimated that no more than 10% to 15% of patients are surgical candidates. Today the indications in order of relative importance are (1) clinical symptoms and signs of cauda equina dysfunction, accompanied by evidence of a complete block at the affected level; (2) progressive muscular weakness of functional significance, such as a dropped foot or quadriceps dysfunction; and (3) progressive and incapacitating radicular pain or claudication, particularly when it causes sleep disturbance. Back pain per se is a relatively uncertain indication.

When a patient fulfills any one of these criteria, the essential operative intervention is decompressive laminectomy. Although the extent of laminectomy required has been debated, I and others¹⁰ advocate a pedicle-to-pedicle decompression with preservation of the articular facets (Fig. 6). Many experts believe that the disk should not be excised unless it is frankly ruptured. It is thought that excising the disk increases the risk of later instability. Following decompression, the patency of the dural sac is established

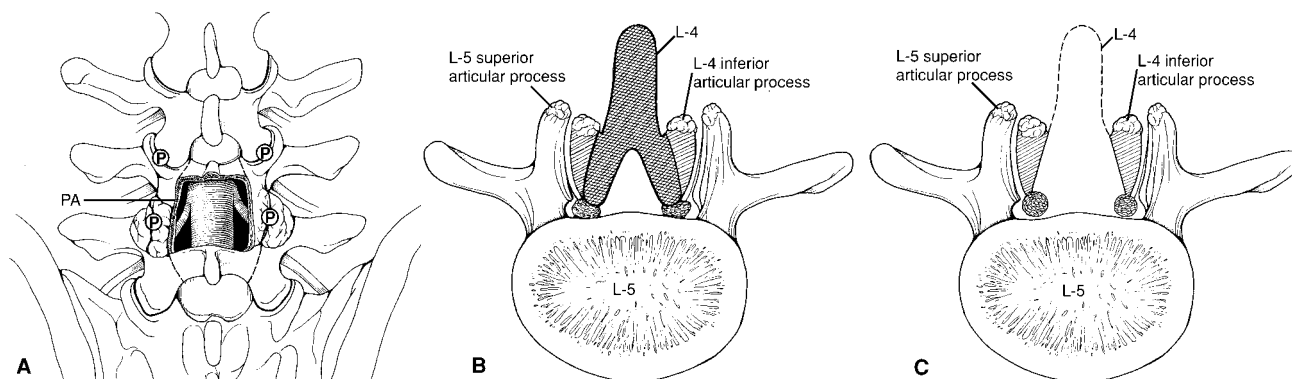


Fig. 6 Principles of surgical decompression. **A**, Anatomic relationships of the nerve roots and the extent of decompression required. PA = pars interarticularis; P = pedicle. **B**, Area to be removed by undercutting the facets. **C**, Final decompression.

by the presence of dural pulsations and the absence of nerve-root tension.

Fusion

The indications for fusion have been hotly debated, except when adequate decompression requires sacrifice of more than 50% of the facets or when the pars has been breached. Herkowitz and Kurz¹¹ performed a controlled prospective study that demonstrated significantly improved results in patients who had an accompanying L4-5 intertransverse ("floating") fusion (Fig. 7). Their data are sufficiently compelling for one to consider fusion, except in those patients with significant accompanying systemic diseases and in the elderly, in whom the systemic and local complication rates rise significantly. I believe it is unnecessary to extend the fusion to the L5-S1 level in most patients, because that level is usually stabilized by bone abnormalities or marked disk degeneration.

Which fusion technique should be chosen ultimately depends on the method with which the surgeon is most comfortable. Transverse-process fusion remains the most common technique, although poste-

rior interbody fusions and even anterior interbody fusions have been advocated. Whether internal fixation improves the rate of fusion in degenerative spondylolisthesis remains undetermined. There is now some evidence that the rate of fusion or lumbar degenerative disease is enhanced by the addition of fixation devices. A variety of choices exist now, most selected from the growing menu of pedicle-fixation devices. However, all of these devices have significant risks, including pedicle

perforation and neurologic injury. This is particularly true in the osteoporotic patient, and the risks of neural injury increase when methylmethacrylate is used to enhance screw fixation.

Results

Most studies report surgical success rates for treatment of radiculopathy or claudication in the range of 70% to 85%. The relief of low back pain is less predictable. A longer-term follow-up study performed by Katz et al.¹² demonstrated that the results deteriorated over time and were less favorable than those reported in previous studies. The predictors of failure were increased age, associated comorbidities (e.g., cardiac disease), and a longer duration of surveillance. Their findings are consistent with the results reported by Nakai et al.¹³ However, the latter investigators thought instability was the most common cause of failure.

The significant morbidity associated with laminectomy and with laminectomy and fusion has been detailed by Deyo et al.¹⁴ They report that the risks increase as a function of increasing age and the magnitude of operation undertaken. Their data are a sobering compilation of local

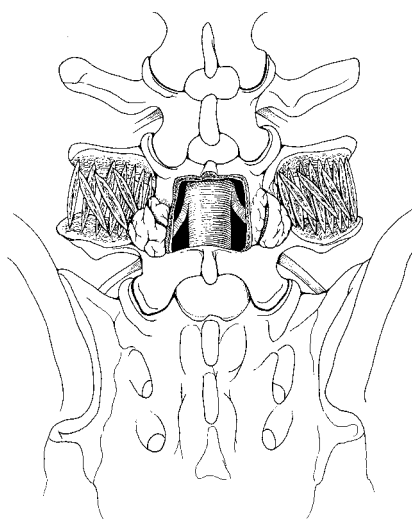


Fig. 7 Floating intertransverse fusion.

and systemic problems that can affect as many as 20% of elderly patients. Perhaps the most impor-

tant message to be derived from that study is the importance of careful patient selection and adherence to

strict indications when selecting surgical intervention for degenerative spondylolisthesis.

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