



BACK HEALTH

Current Concepts in the Surgical Treatment of the Degenerative Spine

ABSTRACT

Degenerative conditions of the spine are a major cause of disability, and represent a large economic burden on the health care system. In this review, we have described some of the most common degenerative pathologies of the lumbar spine—low back pain, spinal stenosis, degenerative spondylolisthesis, lumbar disc herniation and cauda equina syndrome—and the diagnostic approach and immediate management from the perspective of the primary care physician. We have emphasized clinical pearls seen in these conditions and specific indications for surgical referral, as well as red flags that should prompt urgent referral for life-threatening entities, such as malignancy and infection.

KEYWORDS: degenerative spine, surgery, lumbar disc herniation, spinal stenosis, spondylolisthesis, radiculopathy



CME

Pre-test Quiz



In this article, we provide an update on current surgical indications for degenerative conditions of the lumbar spine including important clinical pearls of diagnosis. There are many physician specialists that treat spinal pathologies, such as physiatrists, rheumatologists, pain specialists, and surgeons to name a few. This educational update will provide context regarding current surgical indications that may be helpful to primary care physicians when considering a referral to a spinal specialist for either non-surgical care or surgical management. Spinal conditions that will be discussed include: back pain, spinal stenosis and neurogenic claudication, lumbar disc herniation, spondylolisthesis, and cauda equina syndrome.



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Low Back Pain

Depending upon the study, low back pain is the second to fifth most common reason for all physician visits in North America.^{1,2} Acute back pain is defined as occurring within the last 4 weeks, while subacute back pain is within 3 months.¹ Approximately 25% of North American adults have reported acute low back pain lasting at least a day and it is estimated that low back pain directly incurs approximately \$26 billion dollars annually in the U.S. in health care costs.² The majority of patients who report low back pain have short, self-limited episodes. Of those who sought medical attention, the majority typically improve within the first 6 weeks, rapidly returning to work.¹ Of the patients who report an acute episode of back pain, up to one third will report continued back pain one year after the acute episode. It is estimated that 75% of the cost associated with low back pain is attributed to less than 5% of people with back pain disability. Several studies have shown significant variation in the use of diagnostic tests and management plans, with similar outcomes in the low back pain patient populations.¹

Clinicians should ensure that a focused history and a thorough physical examination is performed to help place patients with low back pain into several key categories: (a) nonspecific low back pain

(Pattern I or II), (b) back pain potentially associated with radiculopathy leg symptoms (Pattern III) or leg claudication from structural spinal stenosis (Pattern IV), or (c) back pain potentially associated with another specific spinal cause (i.e. red flags). The history should also include assessment of psychosocial risk factors, which predict risk for chronic disabling back pain.³

In his landmark publications, Dr. Hall described a classification for low back pain (Back Dominant—Patterns I and II; Leg dominant—Pattern III (sciatica) and IV (claudication)).^{4,5} Patients may have both back and leg pain symptoms and it remains critically important to determine if the symptoms are back dominant (i.e. nonsurgical treatment for most) or leg dominant (i.e. surgery may be helpful in those not improving with non-op treatment).

In approximately 85% of low back pain patients, no anatomic cause can be elucidated. Red flag symptoms or signs, suggesting a non-degenerative etiology for back pain should be ruled out. To elucidate the risk factors for cancer, prospective data have demonstrated four key questions for patient (Table 1).

In patients with a history of cancer, the likelihood of cancer underlying a presentation of back pain increases from approximately 0.7% to 9%. Spinal infection



Table 1: Factors That May Indicate the Likelihood of Cancer as the Cause of Back Pain^{6,7}

Cancer related questions	Positive likelihood ratio	Sensitivity	Specificity
A history of cancer	14.7	0.31	0.98
Unexplained weight loss	2.7	0.15	0.94
Failure to improve after 1 month	3.0	0.31	0.94
Age older than 50 years	2.7	0.77	0.71

should be considered in patients presenting with a history of fever, intravenous drug use, the presence of prior infection or the presence of constitutional symptoms such as night sweats and chills. Risk factors for vertebral compression fractures include older age, history of osteoporosis, and steroid use. Ankylosing spondylitis is suspected in patients who are younger, have morning stiffness, pain improves with exercise, alternating buttock pain, and awakening due to back pain.³

Unless there are red flag symptoms or signs, routine imaging or other diagnostic tests in patients with acute nonspecific low back pain is not required.³

The majority of patients will improve within one month of initial presentation. Thus, in patients with nonspecific back pain and the absence of red flags it is reasonable to reassess in one month's time.^{4,8} Routine plain radiographs are unnecessary for nonspecific

low back pain and run the risk of cumulative radiation over time. A single chest radiograph has a radiation dose of 0.1mSv, equivalent to 10 days of environmental background radiation. A standard 2-view lumbar spine series has a radiation dose of 3.0 mSv, equivalent to one whole year of background radiation, or about 40 chest radiographs; a significant radiation exposure, particularly for young women of reproductive age due to the amount of ovarian radiation. For adults younger than 50 years of age, in the absence of signs or symptoms of systemic disease, one can forego imaging. For patients 50 years or older and in whom findings suggest systemic disease, plain radiograph and simple laboratory tests can almost completely rule out underlying systemic diseases. Advanced imaging should be reserved for patients when there is consideration for surgery or those in whom systemic disease is strongly suspected.⁸



Diagnostic imaging and special investigations in patients with low back pain in the presence of severe or progressive neurologic deficits or when serious underlying conditions are suspected on the basis of history and physical examination.

Examples of serious underlying conditions include cancer, osteoporotic fracture and infection. Severe neurological deficits that indicate cauda equina syndrome (urinary retention, fecal incontinence, diminished perineal sensation, bilateral lower limb weakness) or spinal cord compression (presence of upper motor neuron signs such as hyper-reflexia, positive Hoffman's reflex, clonus, and increased tone) should prompt early work up with MRI or CT imaging.³

Surgery can be helpful for patients with leg dominant symptoms (sciatica/radiculopathy, Pattern III) or leg claudication from spinal stenosis (Pattern IV). There is a limited role for surgery for back pain dominant symptoms in the absence of specific structural correlative pathology (i.e. Pattern I or II).³

See Table 2.

Spinal Stenosis

Spinal stenosis is defined as a narrowing of the spinal canal with encroachment of the neural elements by surrounding bone and soft tissue. It is a radiographic finding and not a clinical diagnosis. Degeneration of the intervertebral

discs results in the initial relative instability of the facet joints. This leads to progressive hypertrophy of the facet joints, in particular the superior articular process, resulting in reduced canal size. Any ensuing venous congestion and hypertension around the nerve roots produces the characteristic neurogenic claudication and/or radicular leg pain. The clinical diagnosis of neurogenic claudication (Pattern IV) is defined as pain in the buttock or legs on walking or standing for a period of time that is relieved by sitting or lumbar flexion.⁹

The most common type of spinal stenosis is caused by degenerative arthritis of the spine, although it can be caused by a variety of congenital and acquired conditions, such as spondylolisthesis, spondylolytic stenosis, post traumatic stenosis, metabolic stenosis (i.e. Paget's disease) and iatrogenic stenosis (i.e. post laminectomy stenosis). Nerve root compression may occur within the lateral recess, the foramina or it may be extra-foraminal. The most common roots involved are the fifth lumbar root (75%), followed by the fourth root (15%), and the third root (5.3%). For patients over the age of 65, the symptoms associated with lumbar stenosis are the most common reason for lumbar spinal surgery.⁹

Diagnosis is made on the clinical evaluation and confirmed by imaging. The most common form of degenerative stenosis is usually



Table 2: Glossary of Common Spinal Terms

Term	Definition
Acute low back pain	Low back pain present for fewer than 4 weeks, sometimes grouped with subacute low back pain as symptoms present for fewer than 3 months.
Cauda equina syndrome	Compression on nerve roots from the lower cord segments, usually due to a massive, centrally herniated disc, which can result in urinary retention or incontinence from loss of sphincter function, bilateral motor weakness of the lower extremities, and saddle (perineal) anesthesia
Chronic low back pain	Low back pain present for more than 3 months
Herniated disc	Herniation of the nucleus pulposus of an intervertebral disc through its fibrous outer covering (annulus), which can result in compression of adjacent nerve
Neurogenic claudication	Symptoms of leg pain (and occasionally weakness) on walking or standing, relieved by sitting or spinal flexion, usually associated with spinal stenosis
Nonspecific low back pain	Pain occurring primarily in the back with no signs of a serious underlying condition (such as cancer, infection, or cauda equina syndrome), spinal stenosis or radiculopathy, or another specific spinal cause (such as vertebral compression fracture or ankylosing spondylitis). Degenerative changes on lumbar imaging are usually considered nonspecific, as they correlate poorly with symptoms
Radiculopathy	Dysfunction of a nerve root associated with pain, sensory impairment, weakness, or diminished deep tendon reflexes in a nerve root distribution.
Sciatica	Pain radiating down the leg in the distribution of the sciatic nerve, suggesting nerve root compromise due to mechanical pressure and inflammation. Sciatica is the most common symptom of lumbar radiculopathy.
Spinal stenosis	A radiographic finding of narrowing of the spinal canal that may result in bony constriction of the cauda equina and the emerging nerve roots.
Straight-leg-raise test	A procedure in which the hip is flexed with the knee extended in order to passively stretch the sciatic nerve and elicit symptoms suggesting nerve root tension. A positive test is reproduction of the patient’s typical leg dominant pain when the leg is raised. Reproduction of the patient’s sciatica when the unaffected leg is lifted is referred to as a positive “well leg lift” test and indicates a high level of irritability. “Cross-over” is leg pain felt in the unaffected as well as the affected leg (bilateral sciatica) and suggests a possible Cauda Equina Syndrome from a central disc herniation.



Table 3: Distinguishing Features Between Vascular and Neurogenic Claudication

Evaluation	Vascular	Neurogenic
Walking distance	Fixed	Variable
Relieving factor	Standing	Sitting/bending
Provocative factor	Walking	Walking/standing
Walking uphill	Painful	Painless
Bicycle test	Positive (painful)	Negative
Pulse	Absent	Present
Skin	Loss of hair; shiny	—
Weakness	Rarely	Occasionally
Back pain	Occasionally	Commonly
Back motion	—	Limited
Pain character	Cramping—distal to proximal	Numbness, aching -proximal to distal
Muscle Atrophy	Uncommon	Occasionally

symptomatic during the seventh decade, and more common in women. In 91% of patients, a history of claudication is present, while a history of back pain and sciatica occurs in 95% of patients. The pain improves with lumbar flexion, sitting, stooping down or lying, and is aggravated by prolonged standing, walking or lumbar extension. As the condition becomes more advanced, sitting or lying down become less palliating. The family doctor should elicit a thorough bowel and bladder history. In central stenosis, symptoms involve bilateral buttocks and posterior thighs in a classically non-dermatomal distribution. With lateral recess stenosis, however, the symptoms of pain and numbness

are usually dermatomal because specific nerves are being compressed. With regards to the neurological examination, it is essentially normal at rest, inclusive of the straight leg raising test.

Approximately 15% of patients with lumbar spinal stenosis will have concurrent cervical or thoracic canal stenosis. One must screen for the presence of upper motor neuron signs and symptoms. Degenerative lumbar stenosis always presents without upper motor findings but may occasionally have focal root compression signs.

Differentiation between neurogenic and vascular claudication is one that every family doctor should be cognisant of. (Table 3)



CT or MRI of the lumbar spine will demonstrate the degree of stenosis and the specific location of neural element compression. MRI can also evaluate for foraminal stenosis, degree of disc degeneration, and far lateral stenosis on axial images. Abnormal findings are present in roughly 67% of asymptomatic patients, thus it is critical that the MRI findings should be correlated with the clinical history and physical examination. A mismatch of imaging and symptoms portends a worsened surgical outcome.^{9,10}

In order to recommend surgical management one must understand the natural progression of the disease. In one study where 27 patients were followed with untreated spinal stenosis, 70% remained unchanged at the end of 4 years. 15 % deteriorated and 15 % had some improvement. Despite the small sample size, it can be observed that the majority remain unchanged.¹¹ Conservative management is the recommended initial treatment and best suited for patients with mild to moderate pain. Conservative measures include bed rest, NSAID's, acetaminophen, core strength training, exercise program to keep active, aerobic fitness and epidural steroid injections. Surgery is proposed for those patients with severe symptoms and in whom there is strong correlation between the

imaging and symptomatology. Patients with severe pain, persistent neurological symptoms (Pattern IV), significant reduction in quality of life due to claudication or reduced ambulatory capacity, and those who fail conservative management can be offered surgical intervention.

Surgery for spinal stenosis may consist of either decompression alone, or decompression with spinal fusion. Decompression by laminectomy is considered the standard treatment for central or lateral recess stenosis. Fusion is required if foraminal stenosis is present and thus a wider decompression is necessary, which in turn may compromise spinal stability.

The Spine Patient Outcome Research Trial (SPORT) compared the outcomes of conservative management versus surgery. This study was conducted in 13 centres, across 11 states. A total of 654 patients were enrolled, 365 of which were in the observational cohort, and 289 were in the randomized cohort. Of the randomized subjects, 138 patients underwent surgery and 151 had conservative management. During the study there was substantial cross-over from surgical and non-surgical arms. Patient outcomes were measured in terms of pain and quality of life. On the as-treated analysis, the surgical patients had significantly better outcomes at 3 months and at two years.¹²



Degenerative Spondylolisthesis

Degenerative spondylolisthesis is the slipping forward of one lumbar vertebra over the other due to a failure of the facet joints. Unlike a spondylolytic spondylolisthesis the slipping vertebra has an intact neural arch. It rarely occurs before the age of 50, has a strong female preponderance of 6:1 and typically occurs at the L4-L5 level. The prevalence varies in the literature but is estimated to be between 6-8% in the general population.¹³ The Wiltse classification system subdivides spondylolisthesis into five etiological categories: isthmic, dysplastic, degenerative, traumatic, and pathological. The degenerative form predominates. The isthmic causes are most common in patients less than 50 years old and commonly affect L5-S1.¹⁴ In isthmic spondylolisthesis, bilateral spondylolysis (pars interarticularis defects from acquired stress fractures) allows the forward slippage of the superior vertebrae over the inferior one.

While the majority of degenerative lumbar spondylolisthesis patients are asymptomatic, symptomatic patients will present with either have neurogenic claudication and/or radiculopathy, with or without back pain. Appropriate investigations include plain upright radiographs, with flexion/extension views to assess for dynamic instability. Finding 3-5 mm of translation, or greater than 11

degrees of kyphosis warrants a consultation with a spine surgeon.¹³

Treatment of spondylolisthesis is similar to spinal stenosis and an initial trial at conservative measures may be helpful. The SPORT study published in New England Journal of Medicine in 2007 enrolled 307 patients in the randomized cohort for either surgical or non-surgical management. The as-treated analysis demonstrated that surgically-treated subjects fared better in terms of quality of life and pain scores, at three months. This statistically significant difference was sustained at two years of follow up.¹⁵

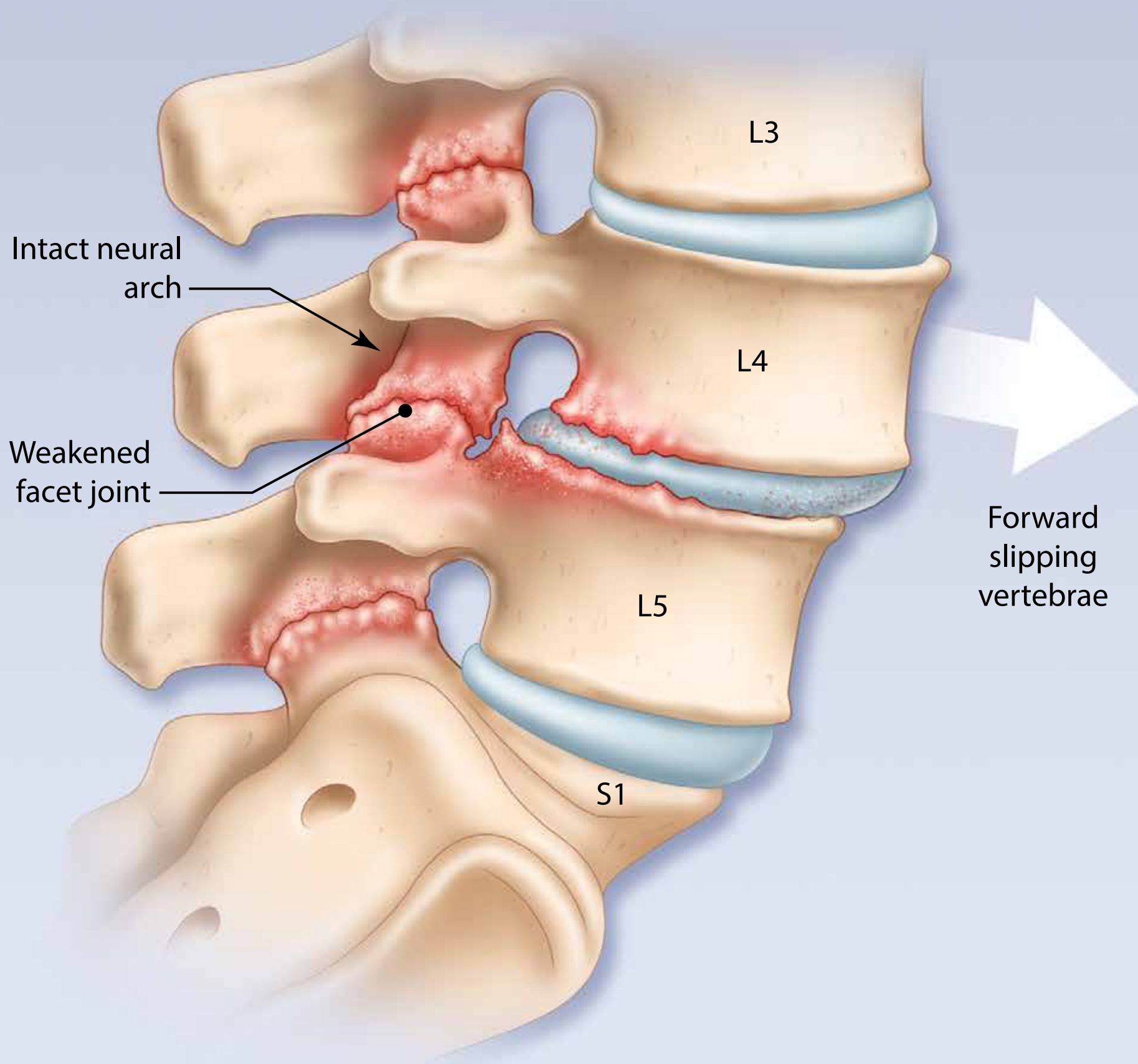
Lumbar disc herniation

Lumbar disc herniation is defined as the localised displacement of disc material beyond the margins of the intervertebral disc space. The highest prevalence is among 30-50 year olds with a 2:1 male to female ratio.¹⁶

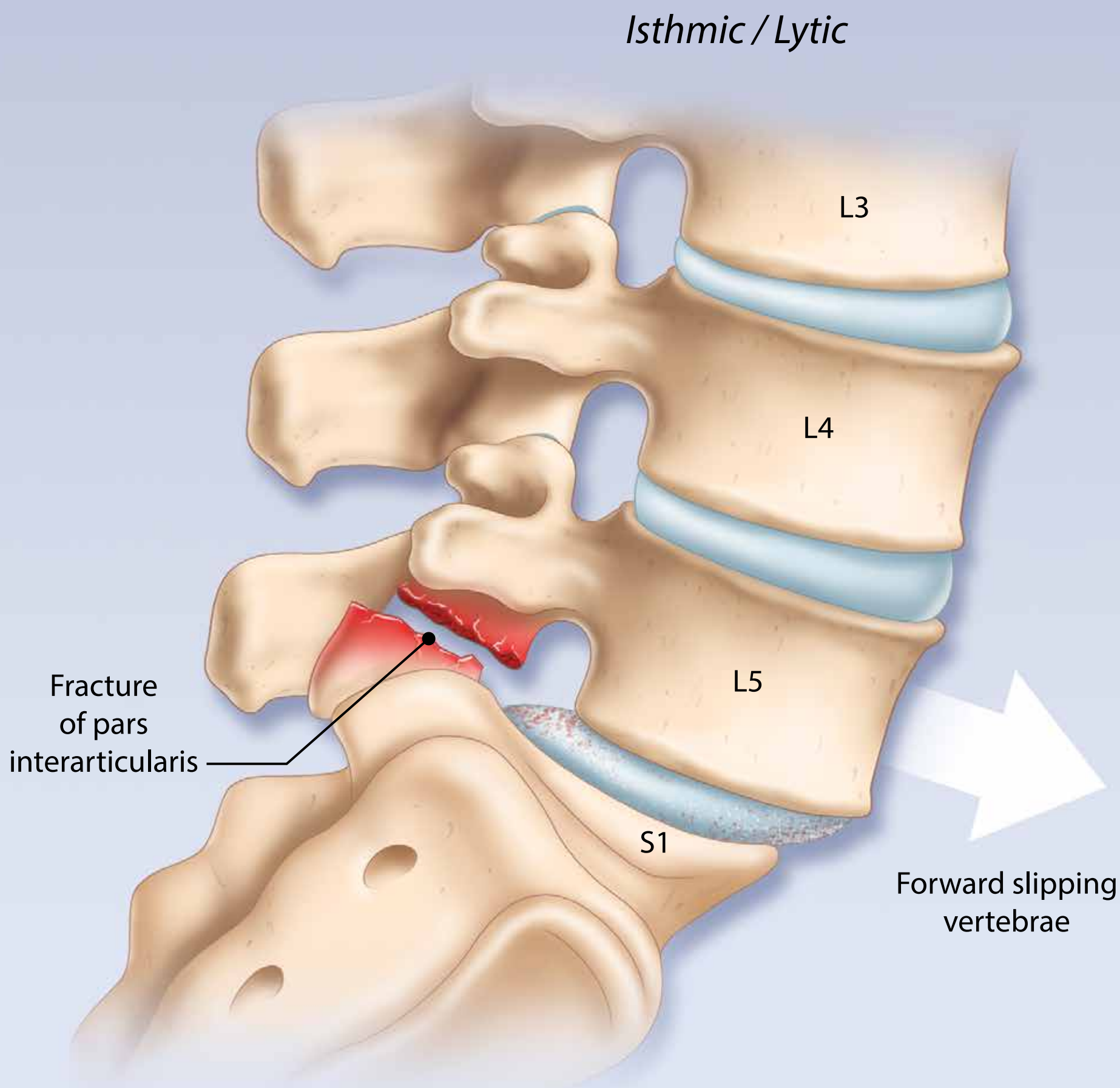
The vast majority of disc herniations occur at L4-L5 or L5-S1 and are either asymptomatic or produce back dominant pain. If there is irritation of an adjacent nerve root the patient can experience typical radicular pain (sciatica symptoms, Pattern III pain). Nerve impingement at these levels can lead to characteristic signs. L5 nerve root compression (at the L4 – L5 level) can cause weakness in extension of the big toe and potentially in dorsiflexion of the ankle (foot

A Comparison of Types of Spondylolisthesis

Degenerative



A Comparison of Types of Spondylolisthesis





SUMMARY OF KEY POINTS

1. Evaluate for hip and knee joint pathology, and vascular pathology, especially in older patients presenting with unilateral radiating leg symptoms.
2. Spine surgery is more successful in treating leg dominant pain symptoms than back dominant mechanical pain symptoms.
3. Screen every patient presenting with a lumbar spine complaint for concomitant cervical and thoracic stenosis, in particular looking for evidence of cord compression (i.e. myelopathy). Be suspicious in patients with bilateral leg symptoms.

drop). Numbness and pain can be felt on the dorsum of the foot, and the pain may also radiate into the buttock region. S1 nerve impingement (at the L5 – S1 level) from a herniated disc may cause loss of the ankle reflex and/or weakness in plantar flexion. Numbness and pain can radiate down to the sole or the lateral aspect of the foot.

Treatment options include conservative and surgical treatment. Conservative measures for back pain include activity modification, exercise, weight loss and core strengthening. If there are associated radicular symptoms, epidural steroid injections may be used. Surgeons will monitor patients with motor weakness. Generally however, conservative measures are successful and approximately 85% of patients, even those with a motor deficit will improve. Surgery is recommended when there is unrelenting radicular pain, failure of conservative management and the imaging matches the clinical

presentation. Operative intervention may also be indicated if there is progressive neurological loss beyond the first week of onset. Surgery has the best results for improvement of leg, radicular, pain.¹⁶ Improvement in the back pain and recovery of a motor deficit are less predictable but may occur.

In the SPORT trial, 501 patients were randomised into either surgical or non-surgical arms of a lumbar herniated disc sub-trial. In the intention-to-treat and the as-treated analysis, the surgical group fared better at both 2 and 4 years. The surgical patients had greater improvement in pain, function, satisfaction, and self-rated progress over the 4-year period compared to patients treated non-operatively. It is generally recognized that surgery improves the time course of recovery for patients with sciatica symptoms but does not significantly change the long term prognosis. That final outcome depends on the interplay between genetic, envi-



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ronmental, and mechanical factors. The risk for a recurrent disc herniation following a lumbar discectomy is estimated to range from 15-20%.^{17,18}

Cauda Equina Syndrome

Cauda Equina Syndrome (CES) is an uncommon clinical entity that results from compression of the sacral nerve roots (lumbar roots may be collaterally involved) distal to the conus medullaris. That can occur in a number of ways but is most commonly secondary to a large central lumbar disc

herniation. Other causes of CES include extreme spinal stenosis, tumor, epidural hematoma, epidural abscess, iatrogenic injury and other even rarer causes. This compression results in variable sensorimotor deficiencies of the lower extremities, decreased reflexes, saddle anesthesia and some degree of bowel and bladder dysfunction. In fact, some degree of sphincter dysfunction must be present to make a diagnosis of CES. The true prevalence of CES is unknown; however, the literature shows that 1-6% of patients undergoing lum-



CLINICAL PEARLS

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bar discectomies have an associated diagnosis of CES.^{19,20}

Patients with CES may present with a variety of complaints including low back pain, groin/perineal/buttock pain, radicular symptoms, sensory abnormalities, lower extremity weakness, saddle anesthesia and variable degrees of bowel and bladder dysfunction.²¹ The time course that the patient describes may be acute, as in the case of a large disc herniation or trauma, or it may be slowly evolving and insidious, as would be the case in spinal stenosis or compression secondary to neoplastic growth. Ask the patient about altered sensation in the groin or around the genitals or anus. Ask the patient if it feels normal when wiping with toilet paper following a bathroom visit. Distinguish true incontinence (not being aware of the need to void and ‘wet’ themselves) versus other forms of incontinence (stress incontinence following sneezing or coughing / urgency to get to the bathroom and failed to make it in time).

A careful neurologic examination should be performed including motor function, sensation, and reflexes. Testing of perineal sensation is mandatory; diminished perianal sensation in the region innervated by S2-S4 is typical of CES. One must test light touch or pin prick in the left and right side of the perianal region and to contrast that to sensation outside the region.

A post-void residual or bladder scan can be helpful in diagnosis. MRI is indicated to assess cauda equina compression. If the clinical evaluation is suspicious for CES, emergent MRI should be performed in anticipation for emergency operative intervention. Findings will include pronounced compression of the lumbar nerve roots distal to the conus medullaris.

A diagnosis of CES merits emergent transfer to the care of a spine surgeon, with the intention of urgent surgical decompression. Early decompression is essential for an optimum chance of recovery. Results of surgery are worse if surgery is performed more than 48 hours following from the onset of CES.^{20,22} The surgery is usually a generous decompression of the neural elements—laminectomy and discectomy. Particularly if there is a delay in the operative intervention CES patients can be left with residual extremity weakness, bladder, bowel and sexual dysfunction.

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