Degenerative conditions of the spine

Current diagnostic procedures and treatment modalities

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Degenerative conditions relating to the spine can be divided primarily into those which lead to symptoms of back pain and those with leg pain (isolated leg pain or leg pain greater than back pain). The majority of the causes of low back pain are not completely understood.[6, 38] The primary pain focus for most clinicians, clinical researchers, and basic scientists, has been directed at the disc. Degenerative conditions are observed in 95% of the population by age 55, though most are asymptomatic occurrences related to aging.[16, 18, 25, 26, 37, 40, 44, 76, 90, 96, 86, 116] They may, however, lead to many of the back and leg related symptoms and signs encountered. Muscles, ligaments, facet joints, and other connective tissues may cause some of the symptoms, but these too are not understood, or well defined by currently available diagnostic tools. Increasingly however, attention is being focused on these areas as sources of back pain (e.g. facet syndrome, sclero-therapy for ligaments/muscles, etc.).[7, 8, 13, 15, 20, 33, 36, 41, 45, 83–85, 73, 74, 91, 92, 102, 103, 111, 120, 124, 125, 129, 130]

Non-tumorous, non-infectious conditions that are known to lead to back related pains include degenerative discs, internal disc disruption, disc protrusions, degenerative spondylolisthesis, and isthmic spondylolisthesis.

Normal degenerative changes of a disc include dehydration and progressive chemical (decrease in proteoglycams and changes in collagen content) and mechanical alterations with loss of disc space height, disc protrusion, ligament thickening, osteophyte development and occasionally motion segment incompetence or instability. These normal changes may lead to low back pain, although an exact correlation between disc degeneration and pain has not been established.

Low back pain related to disc degeneration

Diagnostic procedures

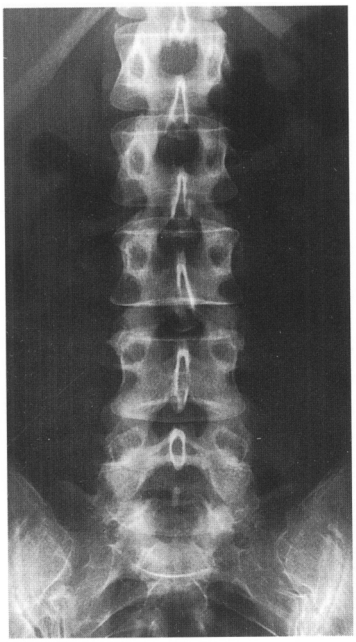
The first component in obtaining the diagnosis is the history and physical examination.[30, 119] Patients with back pain related to tumors or infections tend to have progressive symptoms with escalating pain during all activities, often worse at night. There may be systemic signs such as fever, chills, weight loss, or other associated medical conditions, for example cancer, IV drug abuse, diabetes, etc.

Patients with degenerative conditions of the back frequently have intermittent low back pain, or episodic acute flare-ups. They often describe a gradual onset, though specific injury or sudden pain following lifting, bending, coughing, sneezing, etc. may be noted. The back pain tends to be worse in the morning on awakening, decreases after 30–60 minutes, is often tolerable during the day and then increases again at night. It may interfere with getting to sleep, but usually does not awaken the patient.

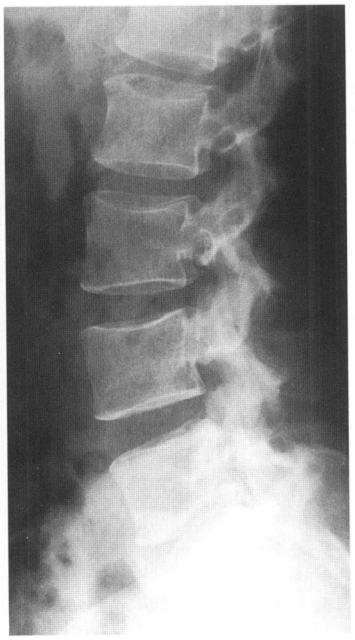
In the majority of individuals the physical examination is non-diagnostic. Percussion and palpation of the spine are usually unremarkable. With tumors or infection severe pain may be noted. Flexion and extension may or may not be limited. The neurologic exam is almost always normal and symmetric.

If the symptoms do not improve in a reasonable period of time (4–6 weeks),[6] or if there is a history suggestive of significant injury, tumor, or infection, the first diagnostic study to order is anterior-posterior (A-P) and lateral radiographs (Figure 1), possibly with the inclusion of flexion/extension lateral films.[37, 40] The radiographs should be evaluated for tumor or infection, subluxation or instability that may suggest the cause of the pain (Figure 2), disc space narrowing (inappropriate for age), osteoporotic fractures, etc. In the majority of individuals with primary low back pain magnetic resonance imaging (MRI), computed tomography (CT), and/or myelography offer little

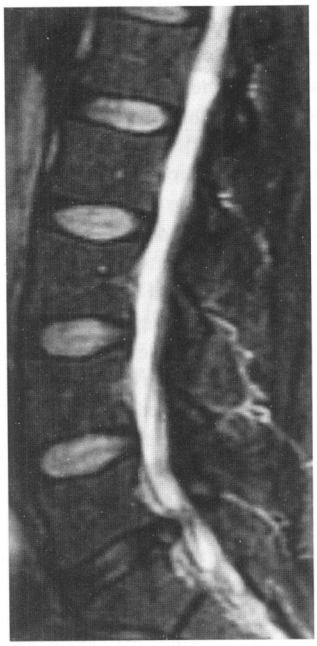
Figure 1. 38-year-old man has a three-month history of severe radiating right leg pain. He has been treated with short term rest, anti-inflammatories, epidural steroids, and therapy without relief. Surgery was considered and a MRI scan obtained.



AP radiograph demonstrates slight increased sclerosis at the L5–S1 endplates.



Lateral radiograph with disc space narrowing at L5–S1.



Sagittal MRI demonstrates a large disc herniation L5–S1.

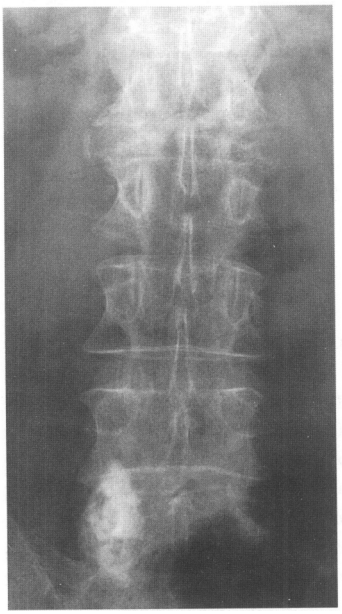
Cross section MRI through the L5–S1 disc space demonstrates the large disc herniation off center to the right. The white oval is the cauda equina. Anterior to it (dark oval) is the herniated disc.

useful information, unless a concern is raised related to the possibility of tumor or infection. Occasionally, in individuals under 40–45 years of age, with primary low back pain related to disc degeneration, where a fusion is being considered, an MRI is useful to define the levels of disc degeneration. The MRI is also a useful screening tool for tumor or infection. A CT scan is better than MRI for depicting bony architecture. Bone scintigraphy may be helpful to diagnose acute pars inter-articularis fractures (particularly in an adolescent) or demonstrate an area of abnormal uptake which would allow focusing a CT scan or other imaging studies to better diagnose a small bone tumor (e.g. osteoid osteoma), infection, or other localized disorders involving a portion of a vertebra.

Discography can be used in a patient with chronic low back pain to help diagnose a degenerative disc that may be a cause of pain.[14, 49, 59, 68, 107, 121] This is a controversial study, particularly related to interpreting and using the results. The discographer should assess the degree of resistance to the injection, the volume of fluid accepted by the disc, dye flow, and most importantly the patients pain response. It should be followed by a CT scan to evaluate the dye pattern and extrusion. This may help identify annular fissures or tears, which may be causes of low back pain.

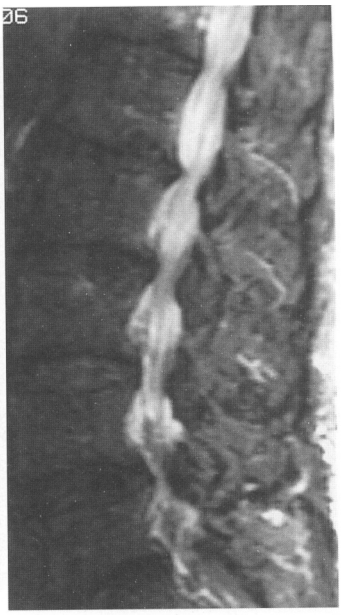
Electromyography (EMG), somatosensory evoked potentials (SSEP) and dermatosensory evoked potentials (DSEP) have little proven diagnostic value in isolated low back pain, though are ordered frequently.[6] Thermography has not been shown to be of particular benefit in the diagnosis or treatment of individuals with low back pain.[6]

Figure 2. 76 year-old woman with leg pain greater than back pain. Bilaterally absent ankle reflexes and symmetric knee reflexes. She has weakness in her right EHL and anterior tibialis on the right. She has a positive Trendelenburg on the right.



AP radiograph demonstrates marked narrowing of the inter-laminar spaces at L3–4, L4–5, and L5–S1. There is benign sclerosis at the L5–S1 joint.

A lateral radiograph demonstrating anterolisthesis of L4 on 5. There is L5–S1 disc space narrowing with osteophytes. Osteoporosis is evident. There is a calcified aorta which is not clinically significant.



The MRI scan demonstrates diffuse lumbar stenosis, greatest at L4–5 at the level of degenerative spondylolisthesis. Narrowing is observed at L3–4, L2–3, and also L1–2.

Treatment

Treatment, initially, is symptomatic as many patients with low back pain (60–70%) improve over a 4–6 week period of time—almost regardless of treatment.[117] However, that does not imply that physicians should assume that low back pain complaints do not warrant, or need, treatment. The physician should be familiar with the natural history of low back pain, what can be diagnosed and treated, and the efficacy and safety of available treatment options. Treatment for patients with acute or sub-acute low back pain include time, activity alteration, short term bed rest (2–5 days), reassurance, and pain relief. The latter includes narcotic or non-narcotic analgesics, non-steroidal anti-inflammatories and appropriate physical therapy measures that may help decrease pain.[22, 29, 35, 48, 53, 75, 78, 87, 100, 117] Commonly used muscle relaxants may calm the patient and provide some relief of pain, but do not have any proven effect on the paravertebral muscles.[22] Physical therapy modalities including heat, cold, massage, ultrasound, stretching, specific exercises, manipulation, etc. may have beneficial effects, but convincing scientific documentation is lacking.[50, 70, 71]

Other treatments that have some strong proponents, but have not been scientifically validated, or invalidated, for long term improvement include oral steroids, colchicine, anti-depressants, transcutaneous electrical nerve stimulation (TENS), corsets, traction, facet joint injections, trigger point injections, and sclerosing agents, though there are some controlled studies regarding the latter which show some benefits beyond normal saline controls.[3, 6, 31, 104] Acupuncture, chiropractic manipulation, and variations on conventional physical therapy and exercises all have proponents with large groups of patients who have done well following these regimens.[1, 50, 52, 77] However, controlled, scientifically validated, reproducible studies, separating out which individuals improve and which do not by specific diagnosis, are not available. Many of the above treatments have proven to be useful in the early phase of pain. However, some of these interventions may also be taking advantage of the natural history of the condition which is to improve within 4–6 weeks. Facet injections may help localize pain to facet joints, however at this time they have not been useful in directing treatment.[81] There have been reports of short-term relief of back pain with lumbar

rhizotomies. However, long term relief following denervation of the dorsal primary ramus nerves to the facet joints is not convincing.

Chronic conditions may benefit from psychological interventions.[4, 5, 109, 118, 119] For intractable pain morphine pumps or other types of chronic long term pain management may be considered.

Surgery is rarely indicated for individuals with acute low back pain related to degenerative conditions. In some patients with chronic low back pain, fusion may be considered to help relieve the pain. [24, 34, 39, 42, 69, 115, 126, 127, 133] This is true for an adolescent or young adult with spondylolisthesis, in a patient with degenerative spondylolisthesis, or in an individual under 40 with one or at most two degenerative discs and concordant pain (which absolutely reproduces the patient's symptoms) on discography. Interbody fusions may be useful (70% success) for the latter, while posterior transverse process fusion or interbody fusions have been successful (80%) for spondylolisthesis.

Lumbar radiculopathy related to degenerative discs

Diagnostic procedured

Frequently encountered causes for lumbar radiculopathy include disc herniation, spinal stenosis, degenerative spondylolisthesis, and isthmic spondylolisthesis. These conditions are usually diagnosed by the history, physical exam, and non-invasive imaging studies. There are other etiologies such as piriformis syndrome, lumbar plexopathy, etc. that are often difficult to diagnose—except by excluding the primary ones. Lumbar radiculopathy from a spinal nerve root compression tends to radiate in a dermatomal, or radicular, reproducible, fashion. The pain tends to increase with activity and decreases somewhat with the hips and knees flexed. Sitting, driving, bending, overhead reaching, coughing, sneezing, etc. tend to aggravate the leg pain.

The leg symptoms can include pain, numbness, and/or weakness. There may be a sudden or gradual onset that may or may not be associated with back pain, with or without a specific injury. Loss of bladder or bowel function is rare, but significant and is an indication for early surgical intervention.

The physical examination for patients with herniated discs is often reproducible. There may be a loss or diminution of deep tendon reflexes. There may be weakness in specific lumbar nerve root related motor functions. Tension signs, such as leg pain with straight leg raising, are often positive.

With isthmic spondylolisthesis, degenerative spondylolisthesis, and spinal stenosis the history and physical findings are often less specific than with disc herniation. The symptoms may vary from leg to leg and include pain, numbness, pins and needles, tingling and/or vague descriptions of weakness or dysfunction. The neurologic exam may be normal or have isolated specific motor group weakness with strength decreasing following ambulation, and returning to normal when the patient is at rest.

Imaging studies are often the first studies ordered for the diagnostic work-up. Flexion-extension lateral films may demonstrate instability.[12, 54] Facet sclerosis and/or degenerative changes across disc spaces may be noted. However, for the most part, particularly in disc herniation, the studies are unremarkable. If non-operative treatment fails to relieve the symptoms and surgery is considered, a MRI, CT, or myelo-CT should be obtained to demonstrate the root(s) compressed (Figure 1 and 2). If this is consistent with the symptoms, surgery may be considered. However, one third of asymptomatic individuals have evidence of disc herniation and compressed nerve roots on imaging studies.[9-11, 58, 60, 61, 62, 64, 128, 131] Therefore, the imaging study must correlate with the symptoms and signs.

Electrophysiologic studies such as EMG and nerve conduction velocities (NCV) are useful to obtain in individuals who have primary weakness without pain, the symptoms and signs suggest peripheral neuropathy (such as with diabetes or other neuromotor disorders), and/or the diagnosis is unclear from the history and physical or from the imaging studies.

Discography followed by a CT scan may have a role in diagnosing leg pain if there is a small bulging or lateral disc or the pain is from a chemical radiculitis and disc disruption that is not clearly identified on the MRI or myelo-CT. Disco-CT may be diagnostic in subtle cases if there is pain reproduction and the CT demonstrates the dye leaking out to the nerve.

Nerve root injection under fluoroscopic or CT guidance may also be helpful in isolating the symptomatic nerve root. This is particularly useful in cases with degenerative scoliosis, in an attempt to limit surgery to one or two levels, rather than the entire lumbar spine involved in the scoliotic curve.

Treatment

The initial treatment options are similar to those for low back pain. Most of the non-operative modalities prove useful in many individuals, though reproducibility and scientifically valid studies for, or against, many treatments are not available. Since a significant component of the radicular pain is related to inflammation, and not just compression, anti-inflammato-

ries, oral steroids, epidural steroids (60% effective in decreasing leg pain), and other modalities to reduce inflammation may have a more useful role in reducing leg pain, than primary back pain.[19, 51, 98, 99, 123]

If nonoperative treatment is not effective in reducing the leg pain, if there is progressive or debilitating weakness, or if there is associated loss or diminution of bowel and/or bladder function, surgery may be considered. For a disc herniation the conventional procedure is a laminotomy and discectomy, performed with magnification. It has 90–95% success rate in non-workers compensation cases.[23, 32, 39, 51, 56, 88, 89, 94, 97, 105, 112–114] For symptoms of spinal stenosis without degenerative spondylolisthesis, laminectomy and foraminotomies are often the surgical treatment of choice. 85–90% of appropriately selected and treated patients improve.[65, 67, 72, 95, 101, 108] If there is evident instability (spondylolisthesis and/or degenerative scoliosis) concurrent fusion with or without instrumentation may be chosen.[17, 46, 47, 55, 79, 80, 93, 106, 115, 132] Fusion following laminectomy for stenosis, when there is associated instability, improves the success rate from 70% for laminectomy to 85% or better with laminectomy and fusion. Alternatives to a formal open procedure, particularly for disc herniations, include a number of percutaneous techniques (nucleotomes, laser, endoscopically directed, etc.) which either remove material through the disc space or from within the canal. These techniques, however, have not proven to be as successful (30–70% depending on the technique used) as the results for an open procedure (85–90%) for relieving leg pain in properly selected patients.[2, 21, 57, 66, 97, 134] At this time, percutaneous procedures have limited to no utility in the treatment of spinal stenosis or low back pain. The results for chemonucleolyis are approximately 85% successful when used to treat leg pain related to a protruding disc. For any other indications the success decreases.[27, 43, 63, 82, 110]

Future perspectives

Future diagnostic and treatment modalities should help separate the various causes of low back pain. Better imaging to assess muscle injuries, ligament disruptions or sprains, and facet arthritis/arthropathy should be developed and/or improved. Additionally, measures to better assess a disc as a cause of back pain and the effect of interventions at the disc level should be developed. The more information that can be obtained non-invasively, visually, objectively, and reproducibly will be helpful in planning treatment—surgically and non-surgically. Treatment needs to be directed towards the diagnosis. At this time since the diagnosis is vague often the treatment options are non-specific and equally vague. Medications that specifically neutralize or decrease intrinsic chemical mediators and pain enhancers (substance, P VIP, etc.) would be useful and better than the current general approach of anti-inflammatories, muscle relaxants, and analgesics. Better outcome studies and measurement tools, providing the ability to monitor and define treatments that are effective, separating them from those that take advantage of time and/or a placebo effect should be developed. At this time there is a paucity of evidence based outcome studies for these conditions. Sound clinical trials and outcome analysis with adequate patients and follow-up are difficult to perform, because so many patients improve spontaneously. Therefore, it is necessary to study a large number of individuals with varying demographics, over wide geographic areas. This involves a significant amount of research dollars, time and energy commitments, as well as requiring the ability to follow large numbers of patients. All of these components (money, time, energy, patients) are not often available at the same time.

Frequently, in many centers, fusions for low back pain are not performed on a regular basis. However, fusions in patients undergoing laminectomies for stenosis are increasingly performed. One may speculate that surgery for low back pain is under utilized, since we often do not know who to fuse, while fusions for patients with spinal stenosis and spondylolisthesis are over utilized, since it is not clear at this time who not to fuse. This information must be acquired in the future.

Endoscopic means to decompress nerve roots, study arterial flow and or ischemia around the roots or within the thecal sac would be helpful to establish a diagnosis, as well as treat individuals with radicular pain. Endoscopic techniques for the spine, at least as currently used, have limited use compared to other areas. Their capabilities need to be amplified.

Low cost, virtual reality based systems for imaging of the spine, simulating reconstructive procedures, surgical guidance, in vivo analyses, and other uses need to be developed.

Ultimately, future directions in diagnosis and treatment depend on elucidating the cause of back related pain, who improves symptomatically, and why. We critically need better understanding of the degenerative process, as well as how to slow or reverse it, and separate pathologic conditions from normal senescence.

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