Advanced concepts in interventional spine care

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This review of interventional treatment of the spine emphasizes the need for aggressive pain control as a means of preventing persistent pain. The use and application of lumbar epidural injections, facet blocks/denervation, lysis of epidural adhesions, thermal annuloplasty, radiofrequency neurotomy, and nucleoplasty are the treatment options described. These descriptions are not all-inclusive of advanced treatment options for patients with spine pain.

(Key words: disk disruption, disk herniation, facet syndrome, failed back surgery syndrome, leg pain, lysis of adhesions, nonsteroidal anti-inflammatory drugs [NSAIDs], nucleoplasty coablation, radiofrequency neurotomy, spin pain, thermal annuloplasty)

Care of the individual with painful spine conditions has evolved over many years. The founder, Andrew Taylor Still, MD, DO, and the early practitioners of osteopathic medicine realized that the spine represented an interwoven structure with a dynamic relationship between spinal components. They understood how abnormal preexisting structural conditions can be exacerbated by injury, leading to further structural dysfunction. As osteopathic physicians and diagnosticians, our skill lies in identifying the primary spine diagnosis as well as secondary diagnoses that may be caused by the primary process. Tertiary diagnostic categories will present themselves as a result of chronicity of primary and secondary processes. Overall, our goal is to limit pain and promote functional restoration.

Low back pain remains one of the most common ailments, responsible for more than 5 million sufferers of pain at any given time. Although it is true that 60% to 90% of that number have self-limiting or short-term pain, 1-year follow-up will show that up to 50% will report recurrence. A recent study showed that 13% to 50% will have moderate to severe chronic pain and, importantly, 31% of patients with chronic back pain have had spine surgery. The long-term functional sequela of persistent spinal pain is related to the cumulative effects of mechanical dysfunction, chronic inflammatory mediators, and central pain mechanisms.

The lumbar spine undergoes universal degenerative changes. This degeneration occurs over time, even without obvious insult or injury. Etiologic factors are complex but interrelated. The spine segment that is composed of a three-joint complex, including the two facet joints and the intervertebral disk, is prone to interrelated degenerative changes. These changes occur regardless of which region suffers initially. For example, synovial injury in the facet joint can lead to facet capsular laxity and instability that causes additional stress on the intervertebral disk. This stress results in radial annular tears and internal disk disruption (IDD).
This cascading process generally results in bony enlargement of the articular processes and osteophytes at the vertebral bodies (ie, spinal stenosis). This process is greatly accelerated in the face of spinal pain syndromes with their resultant persistent inflammatory mediators. Further, chronic spinal inflammatory conditions following disk herniation, spine surgery, or trauma can lead to epidural fibrosis, adhesions, and scar formation. The resultant irritability of the nerve root contributes to persistent pain states.

It is useful to characterize back pain into either radicular (nerve irritation) syndromes (Figure), accounting for 5% to 15% of cases of spinal pain, or nonradicular (without nerve compression) syndromes (Figure), accounting for the remaining 85% to 95% of such patients. Specific spinal conditions may fit into this classification, and their respective interventional treatment protocols serve to illustrate use of advanced treatment techniques.

**Disk herniation**
The pathophysiology of leg pain after disk herniation involves large amounts of inflammatory mediators that are released on disruption of the disk. These inflammatory mediators increase the sensitivity and firing of the dorsal root ganglion. In addition, the inflamed nerve root is painful when pressed or stretched.

**Illustrative case study**
A 35-year-old man, after lifting, has pain primarily into his legs, associated with numbness, tingling, and worsening with bending and lifting. Physical examination revealed positive straight leg raising with restricted flexion of the lumbar spine, decreased sensation in the S1 distribution. The magnetic resonance imaging (MRI) study confirmed disk herniation at L5-S1.

Conservative treatment includes short-term bed rest (ie, less than 2 to 3 days), along with nonsteroidal anti-inflammatory drugs (NSAIDs) and pain medicine as needed. Physical therapy can be initiated to restore range of motion, reduce muscle spasm, and maintain mobility and muscle strength.

If epidural steroid injections (ESIs) are to be considered, there are three major routes. The translamellar approach is widely used. Medications, however, are preferentially distributed in the dorsal aspect of the spinal canal away from inflammatory reactions occurring in ventral aspects of the canal. In addition, much of the medication will flow cranially and may miss the primary site of inflammation.

Many pain practitioners believe that the causal technique is the initial epidural injection of choice. It remains quite safe and preferentially affects the epidural space around L5-S1, but may also allow anti-inflammatory effect as high up as L3-4. If an initial caudal epidural or translaminar epidural method is not successful after one or two injections, a transforaminal epidural injection should be strongly considered. This approach requires image guidance using fluoroscopy with improved target specificity over other ESIs. It will also provide diagnostic information because of its selectivity. In addition to image guidance, contrast is mandatory to verify that the epidural injection spreads ventrally and ensure that the injection is not intravascular.

Using a combination of exercise stabilization program and ESIs, Saal et al had 45 of 52 patients responding with good to excellent outcomes. Further, serial MRIs demonstrated significant resolution of the disk herniation at 1 year.

Adverse effects of ESIs can include headache (especially if there is dural damage), as well as infection, bleeding, a 7- to 10-day increase in blood sugar (from use of cortisone), hypertension, pedal edema, and congestive heart failure.

**Lumbar stenosis**
The second radicular syndrome involves lumbar canal stenosis and often affects elderly individuals. It is characterized by pain during walking with relief during rest, and it must be distinguished from vascular claudication.

The pathophysiology of spinal stenosis is best understood in terms of the degenerative cascade. Chronic stress and injury to the facet joints and intervertebral disk lead to combined lesions that produce simultaneous central and lateral spinal stenosis. There is often loss of disk height. The superior facet of the lower vertebrae moves upward and forward on the inferior facet of the upper vertebrae, thereby narrowing the intervertebral foramen and causing radicular symptoms.

Physical therapy is used to maintain flexibility; assistive devices are used for safe ambulation. Response to ESIs, especially via the caudal approach, may be good, particularly early in the clinical course. Surgical treatment is by decompressive laminectomy.

**Failed back surgery syndrome**
Failed back surgery syndrome typically involves radicular symptoms that are observed after failed back surgery; epidural adhesions are present. Even after successful back surgery, several related effects to the surgery itself occur, including perineural fibrosis, some degree of persistent chemical irritation, and often venous congestion with reduced nutrient delivery to neural structures. These side effects, often related to the appearance of scars and adhesions, may be of low clinical importance or may cause severe radicular pain. In the event of significant radicular pain after spine surgery, an interventional treatment may include lysis of adhesions procedures.

There are several treatment techniques described in the literature. One common method includes introduction of a flexible catheter through a caudal approach via an introducer needle. This procedure is done under image guidance, allowing the flexible catheter to be directed toward regions of clinical relevance and scar formation. Contrast may be used to see regions where scar tissue appears. These regions,
when approached with the catheter, can be infiltrated by relatively large volumes of fluid, including saline solution, cortisone, and anesthetic agents.

Hyaluronidase, an enzyme useful in reducing adhesiveness of scar tissue, may be added before instillation of fluid. Overall, the process seems to reduce fibrosis and inflammation and increase neural mobility. This process is enhanced by the use of specific stretching exercises given to patients after the procedure.

Two types of nonradicular (or axial) back pain include facet syndrome (15% of those presenting with axial spine pain), and IDD (accounting for 39% of cases).12

Facet syndrome
The facet syndrome is associated with posttraumatic facet synovitis. Physical findings include back pain, worsened with extension. Pain radiates locally, generally across the back and often into the proximal aspect of the thigh, groin, and upper lumbar region. This important cause for axial spine pain is difficult to determine radiologically. Often, diagnostic medial branch or facet joint blocks can be done under image guidance.13

Resolution of symptoms after introduction of a local anesthetic such as bupivacaine hydrochloride to the facet joint or its nerve is diagnostic. This pain can resolve, albeit temporarily, after medial branch blocks or injections into the facet joints.14 A more definitive treatment modality includes radiofrequency neurotomy of the nerve to the facet joint.15 An electrode is placed along the medial branch nerve under fluoroscopic guidance. Radiofrequency current is then applied to the distal tip of the probe, causing an increase in temperature that denervates the nerve for up to 6 months. Internal disk disruption accounts for a large percentage of individuals with nonradicular pain syndromes, ie, pain without nerve compression.

Illustrative case study
A 42-year-old male attorney with a history of low back pain off and on for 5 years has a severe episode of pain 1 week before the office visit. He presents with minimal leg pain, localized back pain, and significant intolerance to sitting more than 15 minutes. Lying down lessens his pain. The MRI study shows a picture of a degenerative disk and often a high-intensity zone, which correlates with annular rupture and disk degeneration. Often, however, MRI is nondiagnostic with minimal findings.

This patient has IDD, which is differentiated from disk herniation by the lack of findings on MRI. Intolerance to sitting and lack of significant findings on MRI (other than loss of height) make one suspect IDD. A definitive diagnosis, however, requires diskography.12

The pathophysiology of painful IDD involves innervation of the outer annulus; this region is densely innervated, and disrupted portions of the disk become infiltrated with neurovascular bundles. Inflammatory mediators heighten nociception and sensitize the nerve endings. Pressurizing the disk, vis-à-vis sitting or lifting, will provoke pain.

The use of diskography can be quite helpful in diagnosing IDD.17 Indications include equivocal disk disease on MRI or computed tomography (CT) scans, multiple-level disk disease, postsurgical spine with pain, and painful disk in conjunction with posterior fusion. Diskography is also used as a preliminary test for spinal fusion to evaluate disks above and below the contemplated fusion region.18

During diskography, needles are placed under image guidance into each disk under study and then pressurized to provoke pain. Familiar or concordant pain is highly correlated with a significant pain-generating disk. Postdiskography CT scans, as well as plain film x-ray studies, will demonstrate annular tears within the disk.18 Recording disk pressure during the test can be helpful in classifying IDD. Medical histories of IDD have been evaluated in several studies. In one such investigation, after 1-year follow-up, 14 of 17 patients with IDD had worsened pain if no interventions were offered.12

If individuals have undergone conservative treatment for several months and have failed to improve, other options must be considered. Minimally invasive procedures include thermal annuloplasty utilizing radiofrequency. Other thermal annuloplasty techniques include resistive heating such as intradiskal electrothermography.19

Candidates for thermal annuloplasty include patients who have a diskogenic pathologic process clearly established by diskography and who have had a failed response to at least 6 months of conservative therapy and are facing surgery as the sole therapeutic option. Additional criteria include largely preserved disk height, back pain greater than leg pain, intolerance of sitting, good tolerance of standing, posterior annular deficit, high motivation with no significant psychiatric history, and no demonstrable facet disease.20

Proposed mechanisms for thermal annuloplasty include thermal modification of collagen, thermocoagulation of annular nociceptors, and volume contraction of the disk itself. Postprocedure care includes 6 weeks with no significant bending, twisting, or lifting; wearing a corset for the first 2 weeks; and aggressive stabilization exercises beginning week 3 or 4.

For patients whose leg pain is greater than that of the back but who have minimal disk herniation on MRI and who have had a failed response to 6 months of conservative treatment, an additional percutaneous mode of therapy is available. Nucleoplasty coagulation uses radiofrequency technology to ablate and coagulate soft tissue within the nucleus of the involved disk. This procedure acts to decompress contained herniated disk material percutaneously. Postprocedure therapy is similar to that for thermal annuloplasty.

Comment
Preventing the disabling sequelae of persistent low back pain is of great importance. An organized approach is helpful, particularly when many therapeutic options are included. This article by no means accounts for all advanced treatment options but may serve as a resource for both patient and practitioner.

References
of internal disc disruption in patients with chronic G, Bogduk N. The prevalence and clinical features

Zygapophyseal joint injection techniques in the

facet joint nerve blocks in chronic low back pain:

selective nerve root blocks in the management of

Lester J, Lagattula F. Epidural procedures in spine

Orthopedic Procedures and Clinical Practice.

Beyer CD, Damron KS. Role of one day epidural

Olmarker K, Rydevik B. Pathophysiology of sciatica.


