Spine Osteoarthritis

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Abstract: Osteoarthritis of the spine develops as a consequence of the natural aging process and is associated with significant morbidity and health care expenditures. Effective diagnosis and treatment of the resultant pathologic conditions can be clinically challenging. Recent evidence has emerged to aid the investigating clinician in formulating an accurate diagnosis and in implementing a successful treatment algorithm. This article details the degenerative cascade that results in the osteoarthritic spine, reviews prevalence data for common painful spinal disorders, and discusses evidence-based treatment options for management of zygapophysial and sacroiliac joint arthritis.

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INTRODUCTION

Painful degenerative spine disorders are widespread and account for significant morbidity, disability, and health care expenditures. Consequently, such conditions are a source for significant concern among treating health care professionals, employers, payers, and affected individuals [1-6]. Low back pain is the second most common cause of disability in U.S. adults, with a lifetime prevalence approaching 84% [7,8]. Evaluation and treatment for mechanical low back pain accounted for approximately 45 million visits to U.S. physicians in 2006 and remains one of the leading causes for patients to seek physician evaluation [9-11]. The majority of acute low back pain episodes are self-limited and resolve within a few months after onset, regardless of treatment [12]. However, the proportion of individuals who go on to develop chronic low back pain account for 80%-90% of the associated health care and socioeconomic expenditures [13].

Related to this concern has been the often-repeated idea that, in a majority of low back pain cases, a definitive pathoanatomical diagnosis cannot be made, thus minimizing the value of interventional spine procedures [14,15]. However, there is evidence that demonstrates that use of interventional diagnostic procedures with adherence to strict operational criteria can reveal the structural source of chronic low back pain in 90% of patients and the source of chronic neck pain in 80% of patients [16-24]. Sequentially, the most common causes of chronic low back pain are internal disk disruption, zygapophysial (facet or z-joint) joint arthritis, and sacroiliac joint (SIJ) arthritis, with prevalence rates of 39%-42%, 15%-32%, and 13%-18.5%, respectively [18-24]. Because osteoarthritis (OA) is a disorder of synovial joints, in the spine, OA affects the z-joints and SIJs. OA does not account for all causes of z-joint or SIJ pain, but the relative percentage of painful joints due to OA increases with age.

The spine functions biomechanically to sustain load bearing, to permit mobility, and to provide protection for the neural elements. There are 3 primary subsystems that contribute to stability: the passive subsystem (osteoligamentous spine and disk), the active subsystem (muscles and tendons), and the neural subsystem (central nervous system and mechanoreceptors) [25]. Spondylotic changes that occur over time include and contribute to disk degeneration, z-joint arthropathy, spinal stenosis, and SIJ arthropathy. The description by Kirkaldy-Willis et al [26] of the degenerative spine cascade is a well-accepted theory that recoups the complex interaction between anterior and posterior spinal elements, and the subsequent development of progressive spondylotic changes. In this cascade, the progression of z-joint degeneration is from synovitis and stiffness, to widening and instability, and ultimately hypertrophy and arthritis [27,28]. Similarly, and in parallel, the intervertebral disk also degenerates, which leads to various potential clinical presentations. A salient point...
is that, at any given time, one structure (ie, disk or joint) produces clinically relevant symptoms [21, 29].

One-year prevalence estimates for cervical spine–related pain range from 30% to 50%, with a lifetime prevalence of 70%, although disability due to neck pain is less common [30, 31]. The most common anatomic structure responsible for chronic cervical pain is the z-joint, with prevalence estimates between 36%-60% and approaching 74% in individuals injured in high-velocity motor vehicle accidents [16, 17, 32, 33]. The degenerative process in the cervical spine is distinguished by intradiskal tears, synovial joint cartilage loss, and later by paraligament and facet joint osteophytes and end-plate irregularities [34]. The prevalence of thoracic spine pain in the general population has been estimated at 15%, with z-joint–mediated pain accounting for 42% of cases with chronic thoracic spinal pain [35, 36]. Similar to peripheral joints with OA, radiographic imaging does not correlate well with pain because the degenerative process is initiated years before morphologic abnormalities are detected on imaging, and, furthermore, the presence of radiographic abnormalities is not a reliable identifier of a painful joint [37].

SYMPTOMATIC FACET JOINT OA

Nomenclature

The term “arthrosis” comes from the Greek root word arthros, which means “a joint,” and is used to describe a chronic, degenerative disorder of a joint, whereas, arthropathy refers to any disease that affects a joint. Arthritis denotes joint inflammation. OA indicates arthritis characterized by erosions of articular cartilage, which mainly affect weight-bearing joints. Z-joints are a synovial joint formed by the superior articular process of 1 vertebra and the corresponding inferior articular process of the vertebra above, with facet that indicates a small, smooth area on a bone or other firm structure and with zygapophyseal being synonymous with the articular process.

Functional Anatomy

The z-joints are small, paired joints composed of the superior articular process of the vertebra below and the inferior articular process of the vertebra above. The concave surface of the superior articular process is oriented posteromedially, with the smaller inferior articular process facing anteromedially. These 2 bony prominences converge to form a true synovial joint, which contains a hyaline cartilage surface and a synovial lining encompassed by a posterior fibrous external capsule, which is not present anteromedially [38, 39]. The capsule predominantly contains collagenous fibers arranged transversally, which function to resist flexion [40, 41]. Synovial-lined anterior and posterior synovial recesses exist, which contain embedded fibroadipose-containing menisci formed by synovial reflections [42, 43]. The capsule is imbued with a rich network of substance P, which contains nociceptive nerve fibers and implicates this structure as a potential source for pain [44-47]. Each z-joint receives dual innervation from the medial branch of the posterior primary rami at the corresponding level and 1 level above [48, 49]. An exception exists regarding the innervation of the L5-S1 z-joint, in which the L4 medial branch and the L5 dorsal ramus provide primary innervation [50, 51].

Biomechanics

The z-joints function biomechanically to support and stabilize the spine and to resist multidimensional planar movements under complex loading. This inherent quality is dependent upon the geometric orientation of the z-joints. Z-joints that are parallel with the sagittal plane are resistant to torsional strains at the expense of anterior-posterior shearing forces, whereas the opposite is true with z-joints oriented coronally [52]. The articular surfaces in the cervical and upper thoracic spine are positioned horizontally to support coupling of lateral bending and axial rotation to allow for enhanced motion [53]. When proceeding from a cephalad to a caudal direction along the thoracolumbar spine, an angular metamorphosis occurs as the z-joint orientation is altered from a relatively sagittal position, from T12-L2, to a more coronal direction, from L2-S1 [54-59]. With aging, the z-joints may assume a more asymmetric sagittal orientation in 20%-40% of individuals, a phenomenon known as tropism [52, 60]. Results of a number of studies have demonstrated a positive correlation between more sagittally oriented z-joints and the presence of degenerative OA changes [57, 58, 61]. As with peripheral joints, trauma is also an important source that influences z-joint pathology, including subchondral fractures, joint-space hemorrhage, capsular tears, and avulsion [62-68].

Pathophysiology

Intervertebral disk degeneration and loss of inherent structural integrity can predispose the lumbar z-joints to degenerative changes [26, 69, 70]. Fujiwara et al [71, 72] established that degenerative changes of the intervertebral disk predominantly occur before the onset of z-joint spondylosis, potentially by as many as 20 years. The lumbar z-joints may normally carry up to 33% of the total compressive load [73, 74], which increases to 47% in the presence of z-joint spondylosis and up to 70% in the presence of a degenerated intervertebral disk [75, 76]. The increase in the total compressive load-bearing percentage on the posterior elements contributes to degenerative changes by propagating an increase in facet joint subchondral bone density and osteophyte formation [77-79]. Synovial hypertrophy ensues, with the impending cascade of full-thickness cartilage necrosis, ulceration, fibrillation, eburnation, abnor-
nal joint motion, instability, and bony hypertrophy, which may result in spinal stenosis [26,80]. Degenerative changes are advanced by cartilage and extracellular matrix degrada-
tion in excess of their synthesis. The extracellular matrix consists largely of water and proteoglycans; the latter is composed of a glycosaminoglycan-hyaluronic acid complex en-
veloped in a collagenous-fibrillary framework [81]. The viscoelastic properties of synovial fluid and its inherent func-
tion as a lubricant and shock absorber are largely attributable to hyaluronic acid [82]. The viscoelasticity of intra-articular synovial fluid is diminished as the concentration and mole-
cular weight of hyaluronic acid are assuaged in the degenera-
tive state, propagating further joint destruction [82]. The L4-5 and L5-S1 levels, in which both load bearing and mobility are the greatest, account for the highest incidence of OA [83-86].

Furthermore, inflammatory chemical mediators, such as leukotrienes and prostaglandins, have been shown to exist in z-joint tissue, which suggests a role for these mediators in inflammation and pain generation [87,88]. As inflammation ensues, fluid and polymophonuclear leukocyte infiltration, vasodilation, and venous congestion occur within the joint space, which results in pain-provoking capsular distention and neuronal sensitization of substance-P immunoreactive nerve fibers [80,89]. If nociceptive input persists, then the development of peripheral and central sensitization and neuroplasticity can occur, which contributes to chronic z-joint pain [90].

**TREATMENTS**

As will be discussed, there are unique aspects to the treat-
ment of spine OA, including radiofrequency (RF) neuro-
tomy; however, most of the literature on acute or chronic neck and back pain does specifically address z-joint OA. Even studies that evaluate the z-joints do not exclude non-OA causes of pain. In general, oral medications for spine OA are the same as those commonly used in peripheral joint OA, including nonsteroidal anti-inflammatory drugs, acetami-
phon, and opioid analgesics. One notable exception is that skeletal muscle relaxants are commonly prescribed for all causes of low back pain, including OA. Skeletal muscle relaxants have been shown to be beneficial over placebo to decrease muscle spasm and to provide pain relief in patients with acute low back pain, regardless of etiology. However, there is no evidence to support chronic use of muscle relax-
ants [91]. Although medications are typically used for pain relief, formal spine-focused flexion-biased physical therapy that addresses lumbar stabilization, in conjunction with a sustained home-based exercise regimen, remains a corner-
stone for the treatment and restoration of neurophysiologic function in patients with spinal pain. A 2004 Cochrane systematic review included 61 randomized controlled trials (RCT) that analyzed all forms of exercise on adult nonspecific acute, subacute, and chronic low back pain. Exercise therapy was found to be effective in reducing pain and improving function in adults with chronic low back pain [92]. A more recent review, of 37 RCTs, that investigated the effectiveness of exercise therapy on adult nonspecific chronic low back pain, drew similar conclusions, with a benefit also incurred by individuals with chronic low back pain [93]. Spinal man-
ipulative therapy (SMT) is widely practiced to theoretically restore range of motion and to reinnstitute spinal symmetry to decrease pain. A Cochrane Review in 2004 of 39 RCTs of SMT in patients with acute low back pain showed that SMT was superior to sham manipulation, massage, diathermy, traction, corset, home care, bed rest, and topical gel in providing short-term benefit in both pain and physical functioning [94]. SMT, however, was not more effective than other standard therapies, such as analgesics, general prac-
titioner care, or exercise [94]. A recent systematic review of 26 RCTs for the use of SMT in chronic low back pain demonstrated a small, short-term effect on pain relief, and func-
tional status, which was significant but not clinically relevant in comparison with other interventions [95]. Traction therapy is also commonly used for painful spine disorders. It involves the use of mechanical force to separate the vertebral segments along the vertical axis of the spine, theoretically altering spine biomechanics to decrease pain. A Cochrane Review from 2007 included 25 RCTs that examined the use of traction for patients with acute, subacute, and chronic low back pain [96], and found it no more effective than placebo or sham as a single treatment. The results should be interpreted with caution, however, because the review lacked high-quality studies and had significant symptom heteroge-
ainty among included subjects.

**Percutaneous Treatments**

Collectively, interventions directed at the z-joint are among the most commonly used procedure code in interventional spine centers throughout the United States [97]. The foundation upon which successful percutaneous treatment of z-joint pain is predicated upon an accurate and specific diagnosis. Importantly, the existence of z-joint OA on imaging, including radiographs, magnetic resonance imaging, and computed tomography, lacks predictive value for corre-
spanding painful z-joint arthropathy [98-100]. When compared with image-guided diagnostic blocks, clinical features and physical examination maneuvers also have been shown to lack predictive value for z-joint pain [101]. Fluoroscopically guided diagnostic blocks, therefore, remain the criterion standard for diagnosing z-joint–mediated low back and neck pain [102,103].

There are 2 main image-guided options available to diag-
nose z-joint pain: intra-articular injection of anesthetic and diagnostic blocks of the medial branches that innervate the z-joint. Intra-articular injection of anesthetic as a diagnostic
block has never been validated for z-joint pain, which is in contrast to the medial branch block and which has been repeatedly validated for z-joint pain [104]. However, single diagnostic blocks have been shown to have a weak positive predictive value and to achieve only weak diagnostic confidence [105]. Likely due to the placebo effect, single blocks also have a known false-positive rate between 25% and 41% [105]; this led to the use of dual comparative anesthetic blocks, in which the patient undergoes the same block on 2 separate occasions with a different local anesthetic at each setting. A positive response is one in which the patient has a longer duration of relief with the longer-acting anesthetic. This rigorous technique has been validated as for the diagnosis of z-joint pain [104]. Even more importantly, this technique has been shown to accurately predict which patients respond favorably to more advanced treatments such as RF ablation of the medial branches [106]. A randomized multi-center study by Cohen et al [106] tried to ascertain the ideal diagnostic algorithm for patients undergoing RF ablation. The investigators randomized 151 subjects to have no, one, or dual comparative medial branch blocks to determine the appropriateness for an RF ablation [106]. They then performed a cost analysis and evaluated the percentage of patients with successful outcomes at 3 months, as defined by a greater than 50% reduction in pain coupled with a positive global perceived effect. They found that the RF ablation success rate at 3 months was 33% for patients with no diagnostic blocks, 39% for those with one positive block, and 64% for those who underwent dual comparative blocks. Although the cost per successful RF ablation was lowest in the group that had no diagnostic blocks, the total costs were lowest with the dual comparative block group due to fewer subjects needing the more expensive RF ablation. Another area of debate is what degree of pain relief must be experienced for a block to be successful. Varying degrees of pain relief have been postulated to declare a successful block, which ranged from 50% to 100% pain reduction. Although opinions are strong on this subject, it has been shown that more stringent inclusion criteria result in a higher percentage of patients having a positive response to an RF ablation [106]. Although strong outcome data are limited, it is clear that fewer patients undergo RF ablation, with more strict diagnostic criteria. Similar to diagnostic options, there are several postulated percutaneous treatment options for z-joint pain, including intra-articular corticosteroid injections, medial branch RF neurotomy, and intra-articular viscosupplement injections [107,108].

Fluoroscopically guided intra-articular injections of corticosteroids have been used as an interventional treatment strategy for patients with z-joint–mediated spinal pain. This is an appealing option, given that corticosteroids are frequently used in peripheral joint OA for pain relief via interruption of inflammatory pathways and stabilization of neural membranes. Unfortunately, thus far studies have had mixed results regarding the efficacy of intra-articular corticosteroids, with results of studies showing efficacy rates that ranged from 18% to 63% [109]. This is in part due to suboptimal study designs, with the literature consisting mostly of uncontrolled trials that did not use rigorous inclusion criteria to correctly identify the pain generator. In fact, no studies to date have evaluated corticosteroids in dual comparative medial branch block–confirmed z-joint pain. Instead, most studies to date have relied on intra-articular injections or single diagnostic medial branch blocks to identify those patients with z-joint pain. Because the literature is so scarce, several researchers discourage the continued use of this intervention [101,110]. However a systematic review from 2007 that investigated the utility of therapeutic intra-articular z-joint injections reported moderate evidence for lumbar pain for short- and long-term pain relief [111]. In the cervical spine, use of intra-articular z-joint injections for the treatment of headaches that emanated from the C2-C3 facet joint has been shown to be an effective intervention [112]. A more rigorous multicenter, double-blind, randomized clinical trial that compared saline solution with triamcinolone in patients with lumbar z-joint OA and pain, as diagnosed with more than 80% pain relief with fluoroscopically guided dual comparative medial branch blocks, is underway by Kennedy, Stout, et al, with funding from the International Spine Intervention Society.

RF medial branch neurotomy (RF) is a technique in which a thermal probe is placed parallel to the medial branches that innervate the z-joints and is heated to effectively coagulate the nerves that innervate the joint. Although a detailed explanation of technique is beyond the scope of this article, it should be noted that there are various techniques described, some of which have been demonstrated to be not anatomically accurate. Results of studies that did use appropriate technique and patient selection uniformly showed RF to be an effective intervention for both short- and long-term pain relief, reduced medication use, and improved function [108,113]. In a descriptive study with correct RF technique, and strict inclusion criteria of greater than 80% pain reduction with dual comparative medial branch blocks, showed that 80% of patients had 60% relief of pain and 60% of patients had 80% relief that lasted for at least 12 months [115]. Similar outcomes were corroborated by another descriptive study [116] of 174 patients, with at least 70% pain relief with dual blocks. The researchers showed that 68% of patients maintained at least 50% relief of their pain for 6-24 months and had an associated improvement in functional activities and decreased consumption of oral analgesics [116]. There also is evidence that demonstrates that those patients selected by intra-articular injections or treated with nonvalidated RF techniques tend not to have successful outcomes [104]. Likewise, the use of cervical RF neurotomy in the treatment of cervical facet–mediated pain warrants merit for imparting persistent, clinically significant pain relief
in carefully selected patients [114]. Results of some studies demonstrated a minimum expected duration of relief between 6 and 12 months in properly selected patients [113,115]. The potential for nerve regeneration and return of symptoms does exist; in such instances, the procedure can reinstate long-term pain relief when repeating the procedure in a technically sound manner [117].

The use of intra-articular viscosupplements has been explored by several researchers, with a recent pilot study that demonstrated a significant improvement in low back pain, disability, function, range of motion, and sitting tolerance at 6-month follow-up [118]. More rigorous studies are required to investigate the role of viscosupplements in the management of facet-mediated low back pain. No studies currently exist that have investigated the efficacy of viscosupplementation in proven cervical facet joint-mediated pain.

PAINFUL SIJ ARTHRITIS

Pathophysiology

The SIJ is a wedge-shaped diarthrodial joint composed of 2 parts: an inferior cartilaginous joint that contains a joint capsule, synovial lining, and synovial fluid; and an upper fibrous articulation [119,120]. The joint surface is lined with hyaline cartilage and is formed by the articulation between the lateral sacrum and the medial ilium. The exact innervation of the SIJ anteriorly has yet to be clearly elucidated but is believed to be supplied primarily by the ventral rami of the L4-S2 nerve roots, potentially with contributions as cephalad as L2 [121-123]. The posterior segment receives innervation via the lateral branches of the S1-S3 dorsal rami with contribution from the L5 dorsal rami [119,124-126]. The existence of mechanoreceptors, nerves, and nerve fascicles in human SIJ periarticular tissues has been confirmed [127]. The SIJ functions to transmit axial forces generated through the spinal column caudally to the lower limb [128]. It also provides a bony anchor for the attachment of a multitude of ligamentous and tendinous structures. As aging occurs, degenerative changes impede the capacity of the SIJ as a force transmitter, as the joint space becomes filled with debris [129]. SIJ fusion does not occur with aging in a nonhematologic spine [130].

Biomechanical Factors

SIJ pain also may occur due to nondegenerative conditions such as trauma, pregnancy, spondyloarthropathies, infection, and malignancy. The SIJ surface is flat and is oriented nearly parallel to the plane of maximal load [131]. The irregular surface of the sacrum, coupled with an inherent shock-absorbing capability allow for an effective locking mechanism with the ilium during axial loading [132,133]. This self-locking mechanism occurs via form and force closure, terms used to describe the inherent stability of a structure with closely fit contacts coupled with external compressive forces, and, in addition, is supported by the surrounding musculoligamentous and fascial matrix [134]. SIJ motion is complex and is likely permitted about 3 axes, limited to no more than 2°-3° in the transverse or longitudinal plane [135-137]. Age-related morphologic changes occur in both iliac and sacral cartilaginous surfaces but are more pronounced in the iliac cartilage and resemble OA changes, whereas sacral articular cartilage remains relatively unaltered until advanced age [130]. A stringent perpendicular load significantly mitigates the extent of degeneration of the sacral articular cartilage, in stark contrast to the additional shearing forces experienced by the iliac articular facet and accelerates early-onset degenerative changes, which may be appreciated as early as puberty [130,138].

Degenerative arthritis of the SIJ may commence at an early age and may predominantly affect the iliac cartilage to a greater extent than the sacral cartilage. This is due to the sacral cartilage being richly imbued with acidic glycosaminoglycans and being 2-3 times thicker than the fibrocartilaginous structure of the iliac cartilage [130,139-141]. Examination of the pubescent iliac articular facet reveals a reduced cell count in the upper cartilaginous layer, with accompanying deep fissures [130]. The corresponding mid zone contains clefts with fibrillation of extracellular matrix near the subchondral bone without complementary structural alterations of the sacral articular surface [130]. Blood vessels penetrate the subchondral bone plate of both the iliac and sacral articular facets and pass in close proximity to the overlying articular cartilage, which may explain the high incidence of SIJ involvement encountered in systemic inflammatory diseases [130].

As aging progresses, exposed areas of enlarged collagen fibrils surface in the iliac cartilage, with staining of the extra-cellular matrix that exhibits inhomogeneity [130]. Chondrocytes, embedded within the exposed collagen fibers, are arranged in clusters, with deep fissures visible in the fibrillated iliac cartilage surface [130]. On histologic examination, with advancing age, the once fibrocartilaginous composition of the iliac articular cartilage is replaced by large areas of hyaline cartilage [130]. The cell density in the superficial zone of the iliac articular cartilage is reduced, with underlying clustered chondrocytes immersed in stromelysin synthesis, an enzyme instrumental in proteoglycan degradation [130,142]. Enhanced expression of aggrecan–proteoglycan–messenger RNA around cell clusters in the mid cartilage zone results in insufficient increased synthesis of proteoglycans with low expression in the superficial zone of OA articular cartilage [143]. Morphologic changes of the sacral articular cartilage are much more limited in comparison and may consist only of a thin fibrous tissue with reduced cell density overlying the articular surface [130]. Chondrocytes of OA articular cartilage have expressed alterations in collagen metabolism. Synthesis of cartilage-specific type II collagen is
reduced in favor of increased synthesis of type 1 collagen, normally synthesized by fibroblasts [144]. The altered composition of the iliac articular cartilage extracellular matrix impedes its biomechanical function and subjects it to progressive OA destruction with advancing age [150]. The development of bridging osteophytes may result in para-articular bony ankylosis and focal cartilaginous fusions [145].

**TREATMENTS**

SMT is a commonly used manual treatment aimed at restoring physiologic SIJ motion, reducing pain, and improving overall function. One randomized, single-blinded clinical trial that evaluated SMT for SIJ syndrome found statistically significant improvements on both the visual analogue scale and the Oswestry Disability Index. This study was limited due to the lack of control, and the diagnosis was arrived at by a combination of physical examination maneuvers that lacked appropriate sensitivity and specificity for SIJ pain when compared with fluoroscopically guided diagnostic intra-articular injections [146].

Current percutaneous treatment options for identified SIJ-mediated pain include intra-articular steroid injections and RF neurotomy of the sacral lateral sensory branches. The installation of steroid into the SIJ under fluoroscopic guidance has been shown to be a reasonable intervention in well-selected patients in reducing pain and improving function, with 1 study that demonstrated a significant improvement in low back pain and disability at a mean of 20.6 months' follow-up [147-149]. Further rigorous clinical trials are required to determine long-term effectiveness.

In patients with SIJ pain confirmed by diagnostic SIJ injections who remain refractory to other conservative interventions, SIJ RF denervation may be a feasible treatment option, although strict operational criteria have yet to be established because a variety of techniques persist [150]. Because of the complexities inherent in formulating a diagnosis of SIJ pain, limiting the use of this procedure to highly selected patients is paramount in achieving optimal therapeutic outcomes.

The use of viscosupplementation in the treatment of SIJ arthropathy is being studied as a viable therapeutic strategy for these patients. In a small cohort of 4 patients with SIJ pain diagnosed via fluoroscopically guided intra-articular anesthetic block, all patients underwent 3 injections of hyaluronic acid in the SIJs 2 weeks apart [151]. A 40%-67% reduction in pain on the visual analogue scale was reported by all 4 patients at 12-16 weeks [151].

**SUMMARY**

The functional complexity of the spinal column and the subsequent stresses inherently encountered result in an ensuing intricate, degenerative spinal cascade that can lead to painful spinal conditions that contribute to significant morbidity and health care expenditures. Although spinal OA may simultaneously affect multiple structures identifiable on imaging, unfortunately this finding alone is insufficient to yield a pertinent diagnosis, as often degenerative changes are present in asymptomatic individuals. The emerging evidence in spine care has provided a compass for health care professionals who diagnose and treat painful spinal disorders to navigate through these often complex clinical presentations and to secure an accurate diagnosis. Remaining attuned to this evidence while collecting a careful patient history, performing a focused, pertinent physical examination, and using evidence-based interventional spine procedures in the appropriate setting is necessary to achieve optimal treatment outcomes, to maximize patient satisfaction, and to minimize health care expenditures.

**REFERENCES**


