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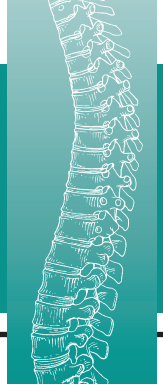

Management of Sacroiliac Joint Dysfunction

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LEARNING OBJECTIVES: After participating in this CME activity, the spine surgeon should be better able to:

1. Assess patients with sacroiliac (SI) joint dysfunction.
2. Distinguish SI joint dysfunction on imaging studies.
3. Select appropriate treatment for patients with SI joint dysfunction.

Sacroiliac (SI) joint pain is a difficult problem that is increasingly recognized for its contribution to chronic pain. In specific circumstances, it may present independently. However, in many scenarios, the SI joint represents one of the many factors contributing to the onset of axial back pain and its various referral patterns. Despite this, there remains no clear solution for SI joint-mediated pain.

Low back pain remains a significant burden on the healthcare system and is the source of approximately 12 million physician office visits per year in the United States. It is among the leading causes of disability, accounting for expenditures in excess of $50 billion every year.[1,2] Surgical management of back pain may involve fusion. Although nearly 1 million spinal fusions are performed annually, outcomes measures have demonstrated success rates anywhere from 35% to 89%.[3,4] Therefore, it can be concluded that the etiology of back pain is complex and often multifactorial. Studies have shown that SI pathology may present in association with or contribute directly to the cause of back pain in greater than 30% of cases.[4-7] Despite this, the SI joint is often overlooked as a contributing source of back pain.

Maintaining an understanding of the anatomy, biomechanics, and clinical presentation of SI joint-mediated pain may allow the physician greater understanding regarding the constellation of symptoms that manifest as low back pain. This may further allow for more critical diagnostic capacity and help to develop an appropriate and more efficient treatment algorithm.

EPIDEMIOLOGY

Successful management of low back pain is predicated on recognizing and then appropriately managing the pain source. Studies have shown that low back pain may not only have variable lumbar origins, it also may be a manifestation of hip or SI pathology. In a review of more than 1200 cases, Bernard and Kirkaldy-Willis[5] documented that 44% of individuals presenting with low back pain had findings consistent with lesser-recognized diagnoses such as SI joint dysfunction and posterior facet syndromes. An additional 33% of patients in their cohort had concordant SI joint symptoms with lumbar stenosis or spondylolisthesis. Further work has shown that of patients presenting to spine clinics for back pain, only 65% have a singular pain generator localized to the spine, and up to 25% have pain that involves the SI joint to some degree.[7,8]

The rate of SI joint degeneration is even greater in the subset of patients with low back pain who have undergone spinal fusion. Instrumented lumbar or lumbosacral fusion is used for a variety of indications, and the phenomenon of adjacent segment disease has been well documented in the literature. In their prospective cohort, Ha et al[6] demonstrated that the rate of SI joint degeneration was nearly double in patients who had undergone posterior spinal fusion compared with age-matched controls observed during a 5-year period. Ivanov et al[9] performed finite elemental analysis to simulate the effects of lumbar fusion on the forces transmitted across the SI joint and also showed that angular motion and stress were increased along the

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articular surface with fusion. It is unknown whether the amount of SI joint degeneration is related to the number of levels involved in the fusion segment.

ANATOMY

The SI joint is the largest axial joint in the human body, with an average surface area of approximately 17.5 cm^2.[10,11] It is characterized as a true synovial joint, despite the fact that more than 70% of its surface area comprises capsular and ligamentous structures, owing to its tremendous stability. Significant morphologic changes occur throughout life. Development is finalized by early adulthood with formation of an auricular or C-shaped joint, whose final anatomic orientation is variable in nature. Degenerative changes are common over the course of adulthood and have a predilection for the iliac side of the joint first, followed by sacral involvement.

The anterior aspect of the joint consists of a thin capsule and overlying ligament that are confluent with the iliolumbar ligament. The strong posterior tension band is formed by the interosseous ligament and accessory ligamentous structures, including the posterior SI, sacrospinous and sacrotuberous ligaments. Additional support is provided by the dynamic function of gluteus maximus and medius, erector spinae, biceps femoris, psoas, and piriformis muscles, and the lumbodorsal fascia.[11] These structures allow indirect transfer of regional muscle forces to the SI joint and in many cases have expansions that invest with the posterior SI ligament structures. The structural integrity of the capsular and ligamentous structures is at least partly sex-specific, with hormonally induced increased laxity in women allowing for necessary motion during parturition.

Innervation of the SI joint is both complex and ambiguous. Studies have characterized nerve supply to the posterior joint as either originating from L4 to S3 root dorsal rami branches or independent contributions from the L3 and S4 nerve roots.[8,12] The anterior joint similarly has significant variability with innervation supplied by the ventral rami from L2–S2 roots.[10] Additional animal studies have evaluated the various pain thresholds of the nociceptive fields involving innervations of the lumbar facet articulations, SI joints, and lumbar disc. Pain sensitivity measured as mechanical threshold was 70 g for the SI joint, which was significantly lower than that for the lumbar facet (6 g) and higher than that for the lumbar disc (241 g).[13,14]

Relevant surrounding neurologic anatomy consists of the L5 ventral ramus and lumbosacral plexus, which cross the cephalad portion of the SI joint approximately 2 cm distal to the pelvic brim.[15] The L5 root then courses along the anterior aspect of the sacral ala. The S1 ventral ramus crosses the SI joint more caudal near the inferior aspect of the joint.

PATHOMECHANICS

The sacrum is considered the keystone of the pelvis. It is the most caudal component of the vertebral column, and it provides the transition from the spinal axis to the pelvis. It is critical in the transfer of load from the lower extremities and innominate bone to the lumbar spine. The SI joint is 6 times stronger in compression than the lumbar spine, but it fails at 1/20th the axial load and half the shear force.[11] Forces from the upper extremities and vertebral column are similarly imparted to the pelvis. SI joint motion occurs around all 3 axes, and it may be influenced by sex and age. Brunner et al[16] determined that men have greater translational motion, whereas in women, maximum motion is rotational. Motion

This continuing education activity is intended for orthopaedic and neurologic surgeons and other physicians with an interest in spine surgery.

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involving the SI joint is small and difficult to measure, but on average is less than 4 degrees of rotation and 1.5 mm of translation. Cadaveric studies have shown that the posterior interosseous ligament tension band is most critical in maintaining SI joint stability. Sectioning the accessory ligamentous pelvic structures such as the sacrotuberous and sacrospinous ligaments, and the pubic symphysis anteriorly, has no significant impact on stability.[17] This is especially relevant when evaluating SI joint integrity in trauma situations.

SI joint dysfunction is commonly idiopathic in nature but may have numerous etiologies. Sources of nociception may result from capsular or synovial disruption, ligamentous tension, altered joint mobility and stress, microfracture, and disruption in the myofascial kinetic chain. Pathology may be categorized as either intra- or extra-articular. Common causes of intra-articular pathology include infection, inflammation, and degenerative arthritis. The most common infectious organisms include *Staphylococcus, Pseudomonas*, *Cryptococcus,* and *Mycobacterium,* and these should be suspected in IV drug use, endocarditis, or posttraumatic situations.[11] Degenerative changes occur over the course of decades and are related to repeated microtrauma, ultimately presenting as a progression of joint sclerosis on imaging studies (Figure 1). Unilateral or bilateral sacroiliitis is an early symptom in seronegative and HLA-B27-associated spondyloarthropathy, occurring in all individuals diagnosed with ankylosing spondylitis (AS). There is a strong male predilection for inflammatory spondyloarthropathy, and the association with HLA-B27 supports an immune-mediated etiology that is characterized by more erosive changes on radiographs. Recent work by O'Shea et al[18] involved prospective evaluation of a primary back pain cohort and demonstrated that of the 23% of patients with SI joint pathology, 24% had degenerative abnormalities and 8% had inflammatory changes. Women were more likely to have degenerative changes (68%), and men represented the majority of those with inflammatory involvement (63%). Other forms of inflammatory arthritis include rheumatoid arthritis, Reiter syndrome, Crohn disease, and ulcerative colitis.

Fig. 1 *Anteroposterior pelvic radiograph of a 47-year-old woman with left-sided buttock pain. Mild to moderate degeneration of the left SI joint is noted relative to the right side.*

Extra-articular pathology, often posttraumatic, may be attributable to ligamentous injury, myofascial pain, and fractures. The underlying causes are almost endless, ranging from leg-length discrepancy, gait abnormalities, prolonged exercise, athletic injuries, and prolonged lifting and bending.[10] In a retrospective study, Chou et al[19] evaluated 54 patients with injection-confirmed SI joint pain and documented that trauma was the cause in 44% of cases, 35% were idiopathic, and 21% were because of repeated stress. The most common traumatic events were categorized as motor vehicle accidents, followed by falls. In young adults, major trauma resulting in SI joint disruption is most common, with lateral compression injuries more likely to result in later development of SI joint dysfunction.[20] Cumulative microtrauma from overzealous activity and repetitive loading, microfracture, and ligamentous or capsular injuries may also commonly cause insidious onset of SI joint pain.

Other, less common causes of SI joint pathology may arise from iatrogenic injury during overaggressive iliac crest graft harvest that violates the SI joint. Hormonal changes during the final trimester of pregnancy may induce hypermobility of the SI joint, which predisposes it and surrounding ligaments to additional injury. There is conflicting evidence as to whether a history of lumbar fusion contributes to biomechanical and anatomic alteration of the SI joint. Metabolic diseases such as calcium pyrophosphate crystal deposition disease, gout, hyperparathyroidism, and renal osteodystrophy may potentiate early inflammation and degeneration.[11] Although primary SI tumors are rare, bony metastasis to the pelvis ranks second only behind spinal metastasis and must be ruled out.

PAIN PATTERNS

Perhaps the most critical factor in making a diagnosis of SI dysfunction is suspicion that the SI joint may act as a pain generator. SI joint pain, like posterior facet syndrome, manifests as a referred pain pattern, which is mediated by type C fibers and typically involves a sclerotomal or myotomal pattern a limited distance from the site of irritation.[5] The referral area associated with SI joint pathology is inferior to the ipsilateral posterior superior iliac spine (PSIS) and measures approximately 3 $\times$ 10 cm.[21-23] This area is also common to many other pain sources, but in more than 90% of patients with SI pain, there is rarely any pain cephalad to the L5 root level. Ambiguity often exists in attempting to discriminate

between referred pain and the radicular pain patterns that are typical with root impingement. Referred pain syndromes such as SI joint dysfunction may cause radiation below the knee as well, with pain reported in the lower limb and foot in 28% and 12% of patients, respectively.[23]

PHYSICAL EXAMINATION

Examination may assist in diagnosing SI joint pathology, but is often neither specific nor sensitive. Examination findings are critical in excluding other sources of pain, including a radiculopathy or tumor. A false-positive straight-leg raise at 60 degrees is often appreciated in patients with SI joint pathology; this is thought to be due to dural irritation and therefore must be distinguished from a true radicular pattern.[5] Other possible sources of referred pain, such as hip and lumbar spine pathology, should be evaluated. The Fortin finger test is highly sensitive but not very specific and is often used to exclude SI joint pathology when negative. The finger test result is positive all of the following criteria are met: the patient can localize the pain with one finger; the area pointed to is immediately inferomedial to the PSIS within 1 cm; and the patient consistently points to the same area over at least 2 trials. Another test that is also heavily used is the flexion abduction external rotation (FABER) test or Patrick test. In this test, the hip is flexed, abducted, and externally rotated. This test is positive if it recreates the patient's pain and the patient localizes it to the SI joint. A variety of other tests have been described for identifying SI joint-mediated pathology, although most have shown questionable scientific validity. Motion and alignment tests are largely ineffective in their predictive value of SI joint pain.

Provocative maneuvers have improved diagnostic capability but they lack diagnostic utility. Large forces are needed to stress the SI joint, causing false-negative results; when forces are applied incorrectly, they may provoke neighboring pain generators, causing false-positive results.[21] Furthermore, Dreyfuss et al[22] documented that routine SI joint provocation was positive in 20% of individuals who were otherwise asymptomatic with regard to SI joint pathology. Positive predictive value was determined to be greatest in the setting of localization of pain to either the PSIS or sacral sulcus in association with pain below the L5 root level. Various studies, including a meta-analysis by Szadek et al,[24] have documented that sensitivity and specificity improve significantly with 3 or more positive provocative stress tests, demonstrating discriminative power for diagnosis of SI joint pathology.

RADIOGRAPHIC FINDINGS

Imaging studies are largely ineffective in their ability to reliably identify or diagnose SI joint pathology. The primary use of imaging modalities is to exclude other causes of pain. Plain radiographs of the pelvis remain a component of the modified New York criteria for the diagnosis and classification of AS and are useful in ruling screening for bony abnormalities such as tumor. High inter- and intraobserver reliability limit the utility of radiographs in early or acute cases of sacroiliitis (Figure 1), which may lead to delay in diagnosis and possible treatment.[25] Radionuclide bone scanning has been shown to have approximately 90% specificity; however, work by Maigne et al[26] and Slipman et al[27] has shown sensitivities of 13% and 40%, respectively, making it a poor screening test. CT has demonstrated sensitivity and specificity approximating 60% compared with diagnostic injection, also making it a less than ideal modality. MRI provides excellent visualization of soft tissues, which allows for evaluation of other pain sources including spinal stenosis. In addition, it may provide enhanced visualization of chondrolysis or inflammatory joint changes in the early stages of sacroiliitis to assist in earlier diagnosis and treatment initiation.[27]

DIAGNOSTIC INJECTION

Resolution of a fluoroscopically-guided (Figure 2) or CT-guided diagnostic block is a criteria for the diagnosis of SI joint-mediated pain is. This procedure is necessary largely because of the inability of history, physical, and imaging studies to reliably diagnose SI joint pathology. From a technical standpoint, studies of asymptomatic individuals showed SI joint volumes of 1.6 mL; therefore, maximum quantity of injectate rarely exceeds 2 mL.[25] Injection should be performed under image guidance, especially in light of the work by Rosenberg et al,[29] which demonstrated that successful intra-articular injection was achieved in only 22% of subjects, with sacral foraminal spread in 44% and extension into the epidural space in nearly 24%. In another study with CT guidance, successful injection into the SI joint was achieved 90% of the time. So, one of the problems in diagnosing SI joint pain with SI joint injections is

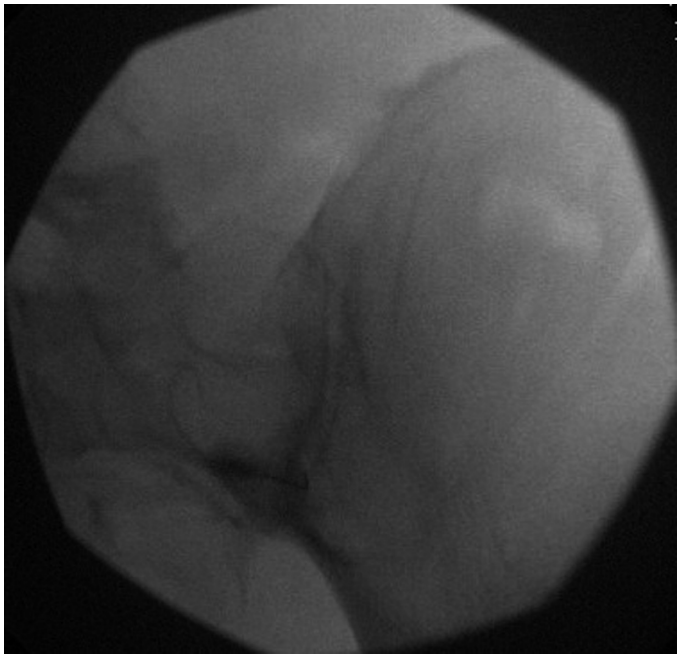

Fig. 2 *Fluoroscopic view of a successful left SI joint injection. Note the contrast in the joint but also how some of the contrast extravasates to the surrounding soft tissue.*

that the lidocaine or corticosteroid is injected into the SI joint reliably only 90% of the time, even with CT guidance.[30]

In 2007, Boswell et al[31] performed a systematic review of the literature to provide a guideline for all interventional procedures. After a thorough review of the literature, the group determined that there was only moderate evidence for the use of diagnostic injection to diagnose SI pain. Relief with intra-articular injections was considered short-term if it lasted less than 6 weeks and long-term if it lasted 6 weeks or longer. However, there were no criteria regarding how much pain was necessary for the test to be considered successful. Many consider at least 50% pain relief to be a postive test. But, is 50% pain reduction necessary for the test to be considered positive, or should it be 100%? Because of these issues, diagnostic injections remain a useful test for diagnosing SI joint pain, but a diagnostic gold standard for SI joint pain remains elusive.

MANAGEMENT

Treatment of SI joint pain is extremely challenging and is limited in many ways by a lack of prospective randomized controlled trials. Options range from conservative measures and medical management to more invasive methods such as image-guided injection and radiofrequency (RF) ablation. When all other modalities have failed to resolve the pain, surgical management in the form of arthrodesis may be required.

Noninterventional management of SI joint pathology uses basic principles of medical pain management and consists of nonsteroidal anti-inflammatory drugs and nonopiate analgesics. Newer agents, including immunomodulators and protease inhibitors, have shown success in management of inflammatory spondyloarthropathy. The goal of noninvasive management involves targeting the underlying pathology. Shoe lifts are often used for leg-length discrepancy, but they should be prescribed with care because of the multiple sites of potential biomechanical compensation. Physical therapy and chiropractic are used for functional stabilization often in coordination with a manual therapy or manipulation program over a course of 4 to 6 weeks. Bracing, in the form of pelvic belts, has also been described as a possibility for nonsurgical stabilization. External stabilization can provide proprioceptive feedback and may also reduce SI joint motion by approximately 30%.[32]

Diagnostic injection should be performed after persistence of symptoms after a 4-week course of noninvasive management. Injections have the capacity to be both diagnostic and therapeutic related to the anesthetic and corticosteroid phases of relief, and patients should be provided a pain log to document quality of symptoms accordingly. When performed for appropriate indications, some studies have demonstrated good to excellent pain relief from intra-articular injections lasting from 6 months to 1 year. Intra-articular viscosupplementation has not demonstrated reproducible positive results.

RF denervation has also been employed to provide pain relief through denervation of the SI joint. Although nearly 66% of patients have reported significant relief after this procedure, the major shortcoming is that the ventral aspect of the joint cannot be addressed. Schwarzer et al[8] demonstrated that the majority of CT-imaged joint pathology involves the anterior 60% of the joint and ventral capsular structures. Furthermore, because of the complex innervation patterns, many of the nerves ablated during these procedures target other surrounding structures, whereas those nerves actually innervating the SI joint are usually preserved owing to their relative inaccessibility.

SURGICAL MANAGEMENT

When all other treatments have failed, surgical management in the form of arthrodesis may be considered as a final option. Fusion performed solely for pain and in the absence of evidence of joint degeneration, destruction, or instability is controversial and not recommended. However, in those patients with disabling pain confirmed by diagnostic intra-articular block and with no associated lumbar pathology, surgical intervention may be considered after all conservative measures have been attempted. Buchowski et al[33] conducted a retrospective review of 20 patients who underwent SI joint fusion for intractable pain localized to the SI joint. Successful fusion was noted in 85% of the cases with significant clinical improvement. However, Schütz and Grob[34] performed a retrospective review of 17 patients. The authors reported a reoperation rate of 65% and clinical failure in 82% of patients. Hence, surgery remains an option for patients with intractable pain, but the evidence supporting surgery for SI joint pain remains limited.

SUMMARY

SI joint dysfunction is a common cause of axial or referred back pain, and in many cases presents in the setting of degenerative lumbar disease. Although it is a relatively common occurrence, reliable diagnostic findings often make it difficult to recognize. Perhaps most critical during clinical evaluation is for the physician to maintain clinical suspicion. Because of the ambiguity of examination findings, the presence of SI pathology is confirmed with image-guided injection, which is both diagnostic and potentially therapeutic. Once SI joint pain is confirmed, there are multiple treatment options. Conservative management with physical therapy and bracing is determined to be effective in up to 50% of patients. For those who remain symptomatic, more invasive treatment in the form of injections is available. SI arthrodesis is a surgical option for refractory SI pain, but it should be used selectively, taking into account patient age, sex, and social factors.

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1. What percentage of patients presenting to spine clinics have some degree of SI joint pain?
- A. less than 1
- B. less than 5
- C. about 10
- D. up to 25

2. Which one of the following ligaments is the most critical in providing strength to the SI joint?
- A. Anterior interosseus ligament
- B. Posterior interosseus ligament
- C. Sacrotuberous
- D. Sacrospinous

3. A 45-year-old man reports nonspecific right-sided low back pain. The pain is slightly below the posterior superior iliac crest. There is no history of trauma, but he works as a heavy equipment operator. Which one of the following options describes the most appropriate next step in management?
- A. Perform a physical examination, including provocative tests specific for SI joint dysfunction
- B. Order an HLA-B27 test
- C. Order lumbar and pelvic radiographs
- D. Order an MRI scan of the pelvis

4. Which one of the following is the most appropriate imaging modality to diagnose SI joint dysfunction?
- A. Radiography
- B. Bone scanning
- C. CT
- D. MRI
- E. None of the above, as imaging studies are ineffective in reliably identifying or diagnosing SI joint pathology

5. A 42-year-old administrative assistant presents with a 3-month history of progressive nonspecific right-sided low back pain. Physical examination reveals tenderness to palpation over the right SI joint. Which one of the following options describes the most appropriate next step in management?
- A. Send the patient to physical therapy for flexion exercises
- B. Continued observation
- C. Order an SI joint injection
- D. Consider for SI joint fusion

6. For an SI joint injection to be considered diagnostic, pain relief should be at least
- A. 25%
- B. 50%
- C. 75%
- D. 100%

7. Which one of the following is the main drawback of RF ablation in treating patients with SI joint pain?
- A. Lack of effectiveness
- B. Inability to address the anterior SI joint
- C. Cost
- D. Lack of people trained to perform the procedure

8. A 50-year-old airline pilot has a 1-year history of progressive left-sided back pain that now prevents him from flying. There is no history of trauma. Physical examination does not reveal any neurologic deficits. Palpation demonstrates tenderness over the left SI joint. Radiographs are normal, and MRI shows a normal lumbar spine and moderate left SI joint degeneration. An SI joint injection completely relieves his pain for 4 weeks. He has since tried physical therapy and more injections. However, the injections are providing shorter periods of pain relief. Which one of the following options describes the most appropriate next step in management?
- A. Continued observation
- B. More physical therapy
- C. Lumbar epidural injections to rule out spinal pathology
- D. Discussion with the patient regarding arthrodesis of the SI joint

9. What percentage of patients with SI joint pain can expect to improve with physical therapy and bracing?
- A. 10
- B. 25
- C. 50
- D. 75
- E. 100

10. With traditional open SI joint fusion, the expected rate of arthrodesis is
- A. 50%
- B. 60%
- C. 70%
- D. 85%