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CURRENT OPINION

Sacroiliac Joint Pain and Dysfunction

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The purpose of this current opinion on sacroiliac joint pain and dysfunction is to assist interventional pain physicians to apply appropriate treatment decisions and rationale to their patients in pain. Discussion of relevant scientific data and controversial positions will be provided.

This review is intended to help characterize the sacroiliac joint as a pain generator, and explore its contribution to the differential diagnosis of low back pain. Historical, technical, and current treatment practice will be characterized against current evidence. Discussion will provoke support or criticism of the relevant scientific data, and general recommendations for interventional pain management physicians should be considered within the context of the individual practitioners skill and practice patterns. Current Opinion is not intended to provide a standard of care.

Keywords: Sacroiliac joint, sacroiliac joint pain and dysfunction, sacroiliac joint syndrome, low back pain, controlled comparative local anesthetic blocks, radiofrequency thermoneurolysis

The confusion and lack of awareness of the sacroiliac joint as a pain generator throughout the past century has, in many ways, contributed to the lack of diagnostic uncertainty and lent to few available treatment options to address this joint. Belief in the sacroiliac joint as a source of low back pain waxed and waned throughout the twentieth century (1). Arguments for and against this belief, however, were based solely on assertion and opposition. Objective evidence was not available until 1990s.

Chronic spinal pain is a multifactorial disorder with many possible etiologies. The structures responsible for pain originating in the spine and afflicting the low back and lower extremity include sacroiliac joints, intervertebral discs, nerve roots, facet joints, vertebrae, spinal cord, ligaments, and muscles (2). However, vertebrae, muscles and ligaments have not been proven to be common sources of low back and lower extremity pain. In contrast, sacroiliac joint pain, facet joint pain, and discogenic pain have been proven to be common causes of pain with proven diagnostic techniques (3, 4). Two separate studies (5, 6), either by application of spinal pain mapping with a sequence of well-organized nerve block procedures or evaluating the relative contributions of various structures in patients with chronic low back pain who have failed to respond to conservative modalities of treatments and with lack of radiological evidence to indicate disc protrusion or radiculopathy, utilizing precision diagnostic injections, evaluated the sacroiliac joint. These studies showed that sacroiliac joint contributed to low back and lower extremity pain in 2% to 10% of the patients. Studies evaluating prevalence of sacroiliac joint pain in select population showed its presence in the order of 13% (± 7%) (7) or 19% (± 10%) (8), i.e., about 15% (1). Now, the sacroiliac joint is accepted as a potential source of low back and/or buttock pain with or without lower extremity pain.

Pain of spinal origin is a major component of any chronic pain practice, and a complex diagnostic challenge. The interspecialty variation, treatment, and lack of guidelines, guarantees spinal pain among the most costly dilemmas in American society (2). Lacking are evidence-based, scientific approaches necessary to provide reproducible and effective means of addressing spinal pain. Recent efforts of the evidence-based literature by spinal interventionalists provides a proactive first step to rationally apply literature support and peer reviewed assessment to outcome predictive value (2). Furthermore, disability and impairment impose a tangible decline in societal productivity, and low back pain remains a leading cause. Unfortunately, diagnostic and therapeutic treatment of back and hip pain has evolved into an industry devoid of predictable positive patient experiences and outcome, often driven by interspecialty bias and occasionally financial incentive.

Pain of spinal origin remains a complex diagnostic challenge by its complex anatomic nature. Innervation and biomechanical interrelationships of multiple dynamic structures add a level of inherent neurological, anatomical, and physiologic uncertainty that stimulate the researcher and clinician to press for reliable treatment paradigms, often leaving more diagnostic questions than answers (2).

The very premise of the sacroiliac joint as a pain generator has been challenged in the literature. The constellation of symptoms associated with the sacroiliac joint, as well as various diagnostic tests commonly used to define structural dysfunction questions validity and reproducibility of the sacroiliac joint as a pain generator.

Historical Considerations

The sacroiliac joint as a painful entity was first described in 1905 by Goldwaite and Osgood (9). During the first third of the 1900's, the sacroiliac joint was felt to be the primary source of pain in the low back, with little attention given to other biomechanical structures of the

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spine (10). Mixter and Barr (11) implicated low back pain attributed to herniation of the vertebral disc in 1934, and the sacroiliac joint became a less prominent consideration. In 1938, Haldeman and Soto-Hall (12) were the first to inject the sacroiliac joint with procaine, and this was followed by the first fluoroscopic guided procedure by Norman and May in 1956 (13). The suggestion that provocation may be an important diagnostic and therapeutic tool of sacroiliac joint dysfunction was the consideration that led to Hendrix et al (14) in 1979 to fluoroscopically inject the sacroiliac joint for therapeutic purposes. Aspiration of an infected joint under fluoroscopic observation was first described by Miskew et al in 1979 (15).

Fortin et al (16, 17) described referral patterns of SI joint provocation or irritation. Schwarzer et al (7) were the first to estimate prevalence of sacroiliac joint dysfunction, based on controlled local anesthetic blocks. Maigne et al (8) further validated the concept by evaluating false-positive rate of controlled diagnostic blocks, by implementing comparative local anesthetic blocks.

Anatomic Considerations

The sacroiliac joint is a synovial (diarthrodial) joint with a capsule, and synovial fluid. Hyalin cartilage is found on the sacral side of the joint, and fibrocartilage on the iliac contribution of the joint. Embryologically, the joint presents itself at the 10th week of gestation, and is firmly established by the 16th week (18-20). Anteriorly, the sacroiliac joint is well-defined. Posteriorly, the joint is suspended by multiple ligaments.

The sacrum is a large triangular bone that comprises five fused vertebra wedged between the two pelvic bones. A hyaline cartilage of 1-3 mm covers the sacroiliac joint. A small amount of synovial fluid is produced at the anterior joint. The sacroiliac nerves exit the bony foramen anteriorly and posteriorly. The sacroiliac joint is the union of the sacrum and iliac wings (innominate bones) attaching on either side. Three joints result, the pubic symphysis anterior midline, and the right and left sacroiliac joints posteriorly. The sacrum, situated at the base of the vertebral column, is between the right and left iliac bones, resulting in a union of the three joints, forming the sacroiliac joint.

The sacroiliac joint shares all muscles with the hip joint and is subject to shear (10). The hip joints approximate with the femoral head at the acetabular socket at the innominate bone. The hips, therefore, are directly related by force and weight-bearing to the sacroiliac joint. The lordotic curve is contiguous with the sacral curve, but does not have a significant effect on the sacroiliac joint. Ligamentous attachments to the sacroiliac joint limit motion, although hormonal influences may be important in joint laxity in the female. Muscular attachments further contribute to pelvic stability of the sacroiliac joint. As a result of the placement of the sacroiliac joint, longitudinal forces from the lumbar spine are transferred to the sacrum and the lower lumbar segments.

The sacral side of the joint is lined with hyaline cartilage and the iliac side with fibrocartilage. The average surface area of the joint is 1.5 cm at birth, 7 cm at puberty and 17.5 cm in the adult (21, 22). On the sacral side, the cartilage is 2 to 3 times thicker (23-25). The sacroiliac joint is described as an auricular shaped joint with two arms. The short arm is positioned posteriorly and cephalic in contrast to the long arm which is oriented posterolaterally and caudally (26). However, it has been described that the morphology of the sacroiliac joint is significantly variable between individuals based on patient's size, etc., with respect to size, shape and contour of the joint (22).

The sacroiliac joint while mainly a bony structure is supported by ligaments and the muscles. Consequently, the fibers of the sacroiliac joint capsule blend anteriorly and posteriorly with numerous ligaments. While the posterior capsule of the sacroiliac joint frequently possesses multiple vents and tears, the anterior capsule is well formed and uniformed (22). Multiple ligaments implicated to act in concert with the sacroiliac joint capsule include not only the anterior and posterior sacroiliac ligaments but also iliolumbar ligament, interosseous ligament, sacrotuberous ligament, and sacrospinous ligament (27-29). Further, multiple structures that have connections or an intimate relationship with various ligaments described above include thoracodorsal fascia, piriformis, biceps femoris, gluteus maximus, gluteus minimus, quadratus lumborum, erector spinae, and latissimus dorsa. The sacroiliac joint also has the distinction that the interosseous ligament of the sacroiliac joint is the strongest ligament not only supporting the sacroiliac joint, but in the body (22, 30-33).

The sacroiliac joint in the first ten years of life enlarges its surfaces, remains flat, and the anterior capsule thickens (34-36). As the individual ages, connective tissue and bones become more fibrous with commonly observed osteophytic formation by the 5th and 6th decades of life. The 8th decade typically reveals large osteophytes and fibrous adhesions.

Numerous publications attempt to define innervation of the anterior and posterior elements of the sacroiliac joint, but the actual nerve supply to the joint remains unclear. Most agree that the posterior aspect of the joint is innervated by posterior rami of L4-S3 (37-42). However, the S1 level may be most important to the sacroiliac joint. Hilton's law states a joint may receive innervation from a nerve that crosses over the joint, and therefore L4-S3 should be contributory innervation as their branches pass over the joint. Obtained histologic samples of capsule ligamentous tissue reveal that the synovial joint is innervated, and most likely derived from the dorsal rami of S1-3 (42). The poor characterization of innervation a likely source of confusion during the examination and is responsible for the varied referred pain patterns.

Fortin et al (42) based on an anatomic study on adult cadavers, concluded that the sacroiliac joint is predominantly, if not entirely, innervated by sacral dorsal rami. Grob et al (37) found that the human sacroiliac joint receives myelinated and unmyelinated axons derived from the dorsal rami of the first four sacral nerves. Ikeda (38), in histologic studies of the innervation of the sacroiliac joint, showed that the upper ventral portion of the joint is mainly innervated by the ventral ramus of the fifth lumbar nerve, the lower ventral portion of the joint was mainly supplied by the ramus of the second sacral nerve or branches of the sacral plexus. Further, the upper dorsal portion of the joint was innervated by the lateral branches of the dorsal ramus of the fifth lumbar nerve, and the lower dorsal portion was innervated by nerves arising from a plexus composed of lateral branches of the dorsal rami of the sacral nerves. Murata et al (41) evaluating the innervation in the rats showed that rat sacroiliac joint innervation is different on the ventral and dorsal side. They also illustrated that the sensory nerve fibers to the dorsal side of the sacroiliac joint were derived from the dorsal root ganglions of the lower lumbar and sacral levels (from L4 to S2) and those to the ventral side from the DRGs of the upper lumbar, lower lumbar and sacral levels (from L1 to S2). Vilensky et al (39) demonstrated the presence of nerve fibers and mechanoreceptors in the sacroiliac ligament.

Etiological Considerations

Sacroiliac joint pain and dysfunction may be either secondary to acute trauma involving sudden heavy lifting, prolonged lifting and bending, torsional strain, fall onto a buttock, or rear-end motor vehicle accidents (43-50). In addition, sacroiliac joint pain and dysfunction may occur from chronic repetitive shear or torsional forces to the sacroiliac joint associated with figure skating, golf, bowling, constant sitting or lying on the affected side (10, 43, 47). It also has been described that pain in the sacroiliac joint may be aggravated by sitting (22, 43), lying on the affected side (43, 47), weight bearing on the affected side with standing or walking (43), forward flexion in the standing position with knees fully extended (51) and finally, Valsalva maneuver (43).

Pain Patterns

The sacroiliac joint is an accepted source of low back and/or buttock pain with or without lower extremity pain. Until recently, the evidence for the sacroiliac joint as a pain generator had been only empirical and was derived from successful treatment of patients with sacroiliac joint pain with certain clinical symptoms and physical findings (52). Anatomically and biomechanically, the sacroiliac joint shares all its muscles with the hip joint (10). Thus, the sacroiliac joint is unable to function in isolation. The sacroiliac joint is subject to unidirectional pelvic shear, repetitive and torsional forces, which can contribute to sacroiliac joint pain as described under etiology (10).

The constellation of symptoms and a plethora of literature describing the numerous pain referral patterns, attributed to sacroiliac joint dysfunction was mainly dependent on patient's history and physical examination (10). These referral patterns described included lumbar region, buttock, greater trochanteric area, groin, thigh, abdomen, and finally, calf.

Early published referral patterns of sacroiliac joint provocation or irritation, were based on patients' complaints and physical examination (10). Fortin et al (16) successfully generated a pain referral map using provocative injections into the right sacroiliac joint in asymptomatic volunteers. These pain referral patterns extended approximately 10 cm caudally and 3 cm laterally from the posterior superior iliac spine. Fortin et al (17) also evaluated the applicability of a pain referral map as a screening tool for sacroiliac joint dysfunction. Based on the referral maps, they successfully screened for sacroiliac joint dysfunction. Slipman et al (53) also demonstrated sacroiliac joint pain referral zones with 94% of the patients describing buttock pain, 72% describing lower lumbar region pain, 50% describing lower extremity pain and 14% describing groin pain. Fig. 1, illustrates various pain referral patterns observed.

Other studies which showed symptom relief following a diagnostic intraarticular injection of sacroiliac joint identified symptoms in the posterior superior iliac spine (43), upper and lower lumbar regions (7, 16, 22, 26, 28, 29, 53-59), buttock (7, 16, 22, 26, 28, 29, 53, 66, 61), greater trochanter (26, 61), thigh (62), groin (22, 26, 62), calf (22, 26, 61, 62), ankle (53), plantar and dorsal foot (7, 16, 53). Finally, the diffuseness of sacroiliac joint pain referral patterns may arise for a multitude of reasons, including the joint's innervation, which is highly variable and complex, primary nociceptors may be located in the ligaments, facet joints, intervertebral discs, piriformis muscle, or pain may be generated either from sciatic nerve or L5 nerve root (63-65). In addition, pain referral patterns may be dependent on the distinct locations of injury within the sacroiliac joint (65).

Assessment

The difficulties in examination are compounded by the extensive innervation and structural interrelationships of the sacroiliac joint, spine, and supporting architecture. Freburger and Riddle (66-68) evaluated published evidence of examination of the SI joint, and concluded that data does not support symmetry or movement. Broadhurst (69) concluded radiographic studies of motion is considered too small to support descriptions of dysfunction in the SI joint, suggesting that most historical data is not useful in diagnosing sacroiliac joint dysfunction. Also reported is pain perceived in the area of the posterior superior iliac spine or groin is not a useful diagnostic indicator of sacroiliac joint dysfunction.

Symptoms and Signs

Table 1, illustrates results of multiple evaluations studying to identify dysfunction in the sacroiliac joint region. Fortin et al (70), however, argue that pain over the posterior superior iliac spine by digital palpation revealed a positive test of sacroiliac joint pain and dysfunction in 10 of 16 patients. As noted by Slipman et al (71) predictive value of sacroiliac joint pain in patients with three positive provocative maneuvers is 60%, which leaves 40% of patients with suspected sacroiliac joint presentations ill defined. Maigne et al (8) and Dreyfuss et al (7) showed that sacroiliac pain provocation tests do not definitely demonstrate the presence of sacroiliac joint pain. However, Broadhurst and Bond (69) reported a sensitivity range of 77% to 87% when three provocative sacroiliac joint maneuvers are positive. Thus, multiple sacroiliac joint provocation tests enter into the differential diagnosis of sacroiliac joint dysfunction even though they are not specific for diagnosis. Dreyfuss et al (72, 73) showed lack of value of medical history and physical examination in diag-

Figure 1. Illustration of pain referral patterns of sacroiliac joint

Table 1. Illustration of results of various provocative tests employed in identifying sacroiliac joint dysfunction

Reference	Subjects	Examination	Findings
Slipman et al (71)	50 patients with pain in the sacral sulcus region, a positive Patrick's test, and pain over the ipsilateral sacral sulcus	Sacroiliac joint block	60% of the patients were found to have dysfunction of the sacroiliac joint region
Dreyfuss et al (72)	85 patients with suspected dysfunction in the SIJ region	Anesthetic block of the sacroiliac joint	Pain in the area of the PSIS or groin does not indicate a dysfunction in the sacroiliac joint region.
Broadhurst and Bond (69)	Patients with pain reported from Patrick's test, the posterior shear test, and resisted hip abduction test.	normal saline or local anesthetic injection	Most patients who received the local anesthetic had less pain. No change in pain for saline injections.
Maigne et al (8)	54 patients with unilateral pain over the area of the PSIS region, tenderness over the sacroiliac joint, and no pain in the lumbar spine.	short-acting anesthetic block, 7 pain provocation tests, and an anesthetic block 1 week later for patients who responded positively.	No relationships between the pain provocation tests and dysfunction of the sacroiliac joint region.
Fortin et al (70)	16 patients with pain near the PSIS	Anesthetic block of the sacroiliac joint on the painful side	Pain in the area of the PSIS may be a useful diagnostic indicator for dysfunction in the sacroiliac joint region.

nosing sacroiliac joint pain. A corroborative history and physical examination while cannot make a definitive diagnosis of sacroiliac joint dysfunction, may enter the differential diagnosis (10, 74). Multiple maneuvers described in the literature designed to provoke the sacroiliac joint and its dysfunction include Laguere test, Gillette test, Vorlauf test, Derbrolowsky test, inferolateral angle test, sitting flexion test, palpation over the iliac crests during sitting and standing or over the posterior superior iliac spine, anterior superior iliac spine or sacral sulcus, forward rotation test, backward rotation test, supine iliac gapping test, supine long sitting test, side-lying iliac compression test, prone knee flexion test, Patrick test, yeoman test, Gaenslen test, joint play, midline sacral thrust, and thigh thrust (10, 66-68, 71-83). Table 2, illustrates common tests performed at the bedside to evaluate the sacroiliac joint dysfunction.

Radiologic Evaluation

A multitude of investigators have reported on the effectiveness of radiological evaluations including plain films (84, 85), computed tomography (CT) (86-88), single photon emission computed tomography (SPECT) (89), bone scans (90, 91), nuclear imaging (92-94) and magnetic resonance imaging (95). While the radiologic studies can help in assessing the anatomic integrity of other possible nociceptive sources that may mimic sacroiliac joint pain, such as the lumbar intervertebral disc, they do not provide precise diagnostic information. They may also provide corroborative findings. Elgafy et al (87) in a retrospective evaluation showed that computed tomography scans were negative in 42.5% of symptomatic sacroiliac joints. Thus, the sensitivity of computed tomography was 57.5% and its specificity was 69%.

A caveat to add is the advantages of magnetic resonance imaging for early identification of the synovial changes, identifying inflammatory arthritides and when infectious is suspected.

Diagnostic Blocks

There are no definite historical, physical or radiologic features to provide a definite diagnosis of sacroiliac joint pain. Thus, diagnostic blocks of sacroiliac joint can be performed in order to test the hypothesis that the sacroiliac joint is the source of the patient's pain. The sacroiliac joint can be anesthetized with intraarticular injection of local anesthetic. If pain is not relieved, the joint cannot be

Table 2. Common tests utilized in evaluation of sacroiliac joint dysfunction

Laguere	Gillette	Patrick	Gaenslen
The patient lies supine and the examiner flexes, abducts and rotates the patient's affected joint. The examiner usually must stabilize the pelvis and pain signifies a positive test.	The patient is asked to stand on one leg with the opposite leg approximating toward the chest. If the joint side that is flexed moves up, this is considered a positive test.	The patient lies supine and places the foot of the symptomatic side on the opposite knee to achieve flexion, abduction, and external rotation of the hip. Pressing downward on the anterior superior iliac spine in question and on the flexed knee.	Also known as pelvic torsion test. Requires the patient to lie on their side with the upper leg hyperextended, and the lower leg flexed against the chest. An alternative test would be to lay the patient supine and the hip in question extends beyond the edge of the table. The patient then draws both legs up on the chest and then lowers the affected leg into full extension. Pain is indicative of a positive response.

considered the source of pain whereupon, a new hypothesis about the source of pain is required. Two positive responses are secured by performing controlled blocks, either in the form of placebo injections of normal saline or comparative local anesthetic blocks.

The sacroiliac joint can be anesthetized by injecting local anesthetic into the cavity of the joint, under fluoroscopic control (2, 7, 8, 96, 97). The face validity of sacroiliac joint blocks is established by injecting contrast medium into the joint in order to show that the needle has entered the joint cavity and that solutions that are injected do not escape from the cavity to reach other structures that might conceivably be an alternative source of pain (96). The construct validity of sacroiliac joint blocks is secured by performing comparative local anesthetic blocks, as for facet joint blocks to avoid false-positive results. Maigne et al (8) established that the false-positive rate of single, uncontrolled, sacroiliac joint injections was 20%. False-positive injections may occur with extravasation of anesthetic agent out of the joint secondary to defects in the joint capsule. False-negative results may occur from faulty needle placement, intravascular injection, or inability of the local anesthetic agent to reach the painful portion of the joint due to loculations. Prevalence of sacroiliac joint pain was demonstrated to be 10% to 30% by a single block (5, 7) and 10% to 19% by a double block paradigm (6, 8). Manchikanti et al (2) summarized the evidence of sacroiliac joint diagnostic blocks in an extensive evidence-based review. They included four studies: Pang et al (5), Schwarzer et al (7), Maigne et al (8), and Manchikanti et al (6). Even though sacroiliac joint block is considered as a gold standard, based on the short-term relief, there was no blinded comparison of the test and reference standard in evaluation of these investigations. Manchikanti et al (2) concluded that the evidence for specificity and validity of sacroiliac joint diagnostic injections was moderate. Slipman et al (10) believed that currently, there is consensus that a fluoroscopically guided diagnostic SI joint intraarticular injection represents the gold standard test to confirm the diagnosis of sacroiliac joint syndrome. This opinion was based on review of various studies (7, 8). Slipman et al (10) interpreted this test as positive if there is at least 80% reduction of the pre-block visual analog scale rating.

Some authors have attempted to determine the role of L5 dorsal ramus block, along with S1 to S4 lateral branch blocks to protect the SI joint from an experimental stimulus (98). However, they showed that 6 out of 10 subjects retained the ability to perceive ligamentous probing. Specificity of lateral branch blocks was also evaluated by Dreyfuss et al (99). They showed that injections were found to be significantly non-specific in a study of S1 to S3 lateral branch blocks. In another pilot study, which was retrospective, authors based radiofrequency thermoneurolysis on the results of lateral branch blocks as a treatment for sacroiliac joint pain and concluded that in patients with sacroiliac joint pain who respond to L4, 5 dorsal rami and S1 to S3 lateral branch blocks, radiofrequency denervation of these nerves appears to an effective treatment (100). Thus, based on the available literature, it appears that blockade of the potential nerve supply to the sacroiliac joint is at best controversial.

Differential Diagnosis

The differential diagnosis of sacroiliac joint pain is extensive. The sacroiliac joint is interconnected with multiple spinal components, lacks reliable bedside tests and is even questioned as a pain generator. This coupled with the lack of specific laboratory diagnostic criteria and the presentation is dimmed by a large differential diagnosis. To better understand the spinal presentation of sacroiliac joint pain, the sacroiliac joint may be broken into four components: 1) musculoskeletal, 2) malignancy, 3) medical and surgical illness, and 4) inflammatory (Table 3).

The differential diagnosis of sacroiliac joint pain also includes myofascial pain syndrome and fibromyalgic presentation. The vague and difficult diagnostic dilemma of fibromyalgic presentation manifests as paralumbar discomfort with infragluteal pain and pain consistent with leg and groin pain. This would seem to mimic sacroiliac joint pain. Fibromyalgic presentation is frequently co-mingled with spinal axial disease, as patients tend to be sedentary, sometimes obese, and predominantly female (accelerated osteoporosis). Joint laxity might be suspected in some, especially those associated with traumatic induction of fibromyalgic presentation.

Sacroiliitis and Spondylitis

Inflammation of the sacroiliac joints is a feature of spondyloarthropathy. Spondylitis, an inflammatory back disease, presents as pain in the lower limbs back and groin (101). Spondyloarthropathies are characterized as back pain at night and at rest that improves with exercise, and may be migratory to the right and left infragluteal region. Frequently

Table 3. Potential causes of sacroiliac joint dysfunction

Musculoskeletal	Inflammatory	Malignancy	Medical
1. Ankylosing spondylitis	1. Inflammatory bowel disease	1. Lymphoma	1. Pituitary disease
2. Herniated nucleus pulposus	2. Pyogenic sacroiliitis	2. Ovarian Cancer	2. Fibromyalgia
3. Muscle strain	3. Sickle cell anemia	3. Intraspinal neoplasms	3. Osteoporosis
	4. Genetic disorders	4. Metastases	4. Abdominal aneurysm
	5. Reiter's syndrome	5. Carcinoma of colon	
	6. Eosinophilic granuloma	6. Carcinoma of prostate	
	7. Osteochondroma	7. Polymyalgia rheumatica	
	8. Psoriatic spondylitis	8. Multiple myeloma	
	9. Diffuse idiopathic skeletal hyperostosis		
	10. Retroperitoneal fibrosis		

asymptomatic in early stages, pain can escalate quickly and be severe. The differential diagnosis can be extensive, and should include urogenital infection, psoriatic presentation, Crohn's disease, inflammatory bowel disease, uveitis, family history, positive HLA-B27, and ankylosing spondylitis (101).

The spondyloarthropathies are a cluster of overlapping chronic inflammatory rheumatic diseases such as, reactive arthritis, ankylosing spondylitis, psoriasis, inflammatory bowel disease, and can be accompanied with rapid decline in function and pain. Primary pathology is at the sites of bony insertion of ligamentous tendons and the axial skeleton, including the sacroiliac joint. The spondyloarthropathies rarely divulge a cause, and may be triggered by environmental factors, genetic predisposition, chlamydial infection, and enterobacterial infections to name a few (102). Infectious septic sacroiliitis, although not specific of spondolyarthropathies, can be seen with other rheumatic diseases, and occasionally malignancy (103).

Ankylosing Spondylitis

Ankylosing spondylitis affects cartilage, joints and tendons, and is frequently migratory to the lumbosacral spine. Ankylosing spondylitis progresses unpredictably, and may stop at any point, although the sacroiliitis is common in most cases. Common radiographic findings include subchondral mineralization, cystic, and bony changes joined with osteophyte formation. These changes are graded 0-5 with the grade 5 being most pronounced.

Ankylosing spondylitis is usually revealed the second or third decade of life with , stiffness of the spine and proximal joints associated with high serum ESR, serum CRP, mild anemia, and HLA-B27 positive. Ankylosing spondylitis is a systemic inflammatory rheumatic disease involving spinal sacroiliac joints responsible for back pain, stiffness, varied pain patterns and progressive disability.

Pyogenic Sacroiliitis

The frequency of the sacroiliac joint pain and pyogenic infection is an alarmingly common. The joint space is usually invaded by bacteria by either direct penetration, hematogenous, or by nearby structures such as the gut. Location of the sacroiliac joint to the bowel would suggest bacteria may access the joint. The sacroiliac joint is the most commonly affected joint of the axial skeleton, a presentation age range 20-66, the average age is 22. Rapid deterioration of the joint occurs once the infection and inflammatory response is mounted. Common causes include drug abuse, urinary tract infection, bone infection, endocarditis, pregnancy, bowel disease, skin infections, bloodborne, and a curious association between buttock and hip injuries and pyogenic sacroiliitis. Pain is usually severe, and radiates to the low back, hip, thigh, abdomen, and calf. Abdominal pain and nausea are also frequently present. Pyogenic sacroiliitis is usually unilateral.

Prevalence of sacroiliitis in the primary care setting approaches 15%, 3-5% of those presenting to primary care with back pain (101). Sacroiliac joint inflammation accompanies psoriatic skin disease at a prevalence of approximately 1-3% (104). Inflammatory bowel disease, such as Crohn's disease, ulcerative colitis and irritable bowel, are also associated with sacroiliitis (105). Sacroiliitis occurs in 15% of patients with irritable bowel disease. A well-established relationship exists between inflammation of the joints, inflammation of the gut, and the spondolyarthropathies exists (106). Spondyloarthropathies is most common in patients between age 20 and 40, but can be seen in younger children and the elderly (107).

Reiter's Syndrome

Reiter's syndrome is a disease associated with the well-described triad of urethritis, arthritis, and conjunctivitis. Commonly found in younger men, an infectious etiology with environmental and genetic predisposition leads to febrile illness and dysentery. HLA-B27 antigens are found in laboratory analysis.

Arthritis may occur approximately three weeks after initial infection, and weightbearing joints are most affected. Back pain is a frequent symptom, and usually revealed by routine bone scan.

Maigne's syndrome

Maigne's syndrome is a lesion of T12-L1 posterior joints. This is a relevant disease process secondary to the sacroiliac joint as Maigne's syndrome is associated with pain and instability of the sacroiliac joint. Pain is typically referred to the iliac crest.

Management

Evaluation

Appropriate history, physical examination, and medical decision making from the initial evaluation of patient's presenting symptoms are essential (2). There are numerous acceptable medical methods to evaluate a chronic low back pain patient. These methods vary from physician to physician and textbook and textbook. Multiple components of evaluation include history taking with chief complaint, history of present illness, review of systems, and past, family, and/or social history; physical examination; and medical decision making. A suggested algorithm for comprehensive evaluation and management of chronic pain is illustrated in Fig. 2.

Treatment

Multiple treatments of sacroiliac joint dysfunction have been adapted by various disciplines that treat low back pain. These treatments have been highly variable from medical, osteopathic, physical therapy, chiropractic and interventional pain management. These modalities consist of physical therapy, orthotics, mobilization, therapeutic sacroiliac joint blocks, radiofrequency thermoneurolysis, cryoneurolysis, neuroaugmentation and surgery.

Physical therapy and Exercises

There are no prospective trials that have evaluated the effect of physical therapy, aerobic exercise, stabilization exercises or restoration of range of motion in sacroiliac joint syndrome. However, exercises have been an important aspect in the treatment of sacroiliac joint syndrome, along with stabilization rather empirically. Physical therapy strategies have emphasized on pelvic stabilization (108) and restoration of postural and dynamic muscle imbalances with correction of gait abnormalities (89). Multiple authors have described typical muscle imbalance patterns in patients with sacroiliac joint dysfunction (10, 109). These range from a scenario in which certain truncal and lower extremity muscles tighten and weaken the sacroiliac joint. This process essentially may involve a multitude of muscles, including iliopsoas, quadratus lumborum, piriformis, gluteus maximus, hamstrings and weakening of the

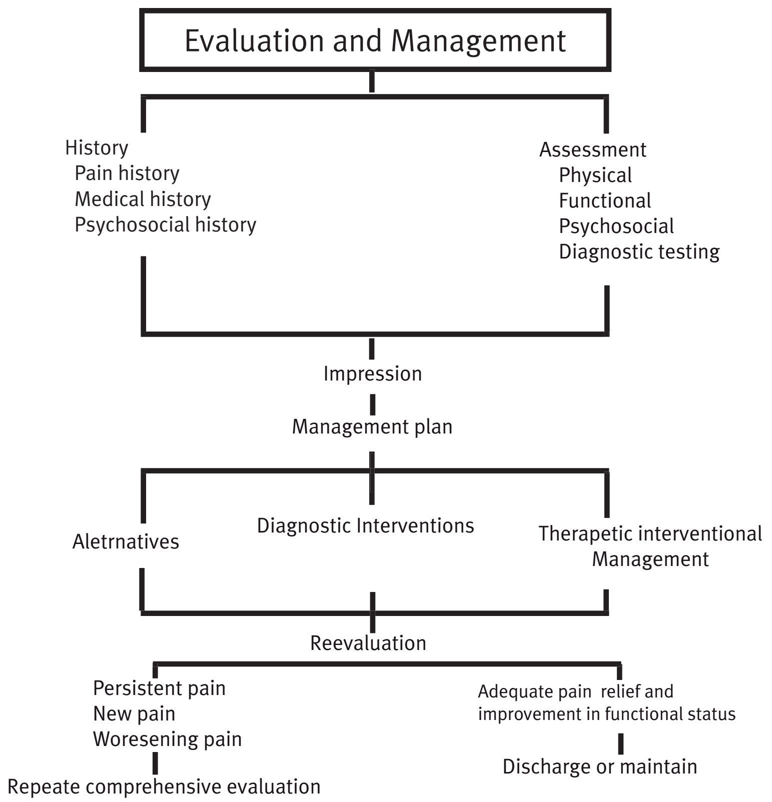

Fig. 2. Suggested algorithm for comprehensive evaluation and management of chronic pain

Adapted from Manchikanti et al (2) with permission from authors and publisher

dynamic muscles including gluteus maximus, oblique abdominals and multifidus (110). Thus, if these imbalances actually are detected, a physical therapy program concentrating on stretching and strengthening of the weak muscles is an important element in treatment of a sacroiliac joint dysfunction (10).

Orthotics

Numerous investigators have advocated the use of orthotics in the treatment of sacroiliac joint dysfunction (111-113). However, similar to various other modalities of treatments, there have been no prospective controlled trials evaluating the effectiveness of orthotics. Commonly, the use of sacroiliac joint and pelvic stabilization orthotics has been employed in an attempt to limit sacroiliac joint motion and improve proprioception (48, 114). The importance of placement of the belt also has been delineated that it should be above the greater trochanter (111). This was based on reports demonstrating that 7 of 12 sacroiliac joints in 6 cadavers have an average motion decrease of 29.3% with a 50 newton belt.

Manual Therapy

Manual therapy has been advocated commonly as a means of treatment of sacroiliac joint dysfunction and stabilization. However, Tullberg et al (114) showed that manipulation does not alter the position of the sacrum in relation to the ilium. The studies in support of manual therapy based on the diagnosis of sacroiliac joint dysfunction on history and physical examination suggested benefits of manipulation (113, 115).

Therapeutic Sacroiliac Joint Blocks

There are no controlled trials evaluating the effectiveness of intraarticular injections of sacroiliac joint.

Norman and May (13) reported their experience with 300 patients using intraarticular hydrocortisone. However, while they have claimed successful treatment, they have not reported their actual results. Maugers et al (116) in a retrospective study reported their experience of sacroiliac joint block for patients with sero-negative spondyloarthropathy with greater than 70% relief of symptoms in 79% of patients for an average of 8.4 months. Slipman et al (117) in a retrospective study reported the experience of intraarticular sacroiliac joint injection of steroid in conjunction with physical therapy. They based the diagnosis on a minimum of an 80% decrease in pre and post sacroiliac joint block visual analog scale (VAS) scores. They reported, at a mean follow-up of 22.9 months, VAS scores were reduced by 50% with a statistically significant improvement in Oswestry Disability Scores. Pulisetti and Ebraheim (118) in a prospective evaluation of 58 patients with a total of 71 CT-guided sacroiliac joint injections reported more than 75% relief for 2 to 14 days with 64 injections. Further, they reported that 58 patients had relief immediately after the injection, whereas, 6 patients had relief after 6 to 12 hours. They also observed symptom provocation in 64 of the 71 joints. They concluded that long-lasting relief from injections of non-inflammatory sacroiliac joint syndromes is an exception rather than a rule and CT guided sacroiliac joint injection is one of the best methods currently available to confirm the source of low back symptoms. They also reported that patients with previous back surgery had definite but less than 50% relief. Drawbacks of this study include high volume injection of approximately 10 mL with 6 mg of betamethasone (1 mL) and 9 mL of 1% lidocaine typically into a joint lacking target specificity of delivery of steroids.

Braun et al (119) also evaluated computed tomographic guided corticosteroid injections of the sacroiliac joints in patients with spondyloarthropathy with sacroiliitis. They also assessed the degree of inflammation in the joints with dynamic magnetic resonance imaging. They treated 30 patients with ankylosing spondylitis with severe inflammatory back pain for more than 3 months. Their results demonstrated that there was significant improvement in inflammatory back pain and sacroiliitis at 5.2 $\pm$ 1.3 months after therapy in 25 (83%) of the patients.

Radiofrequency Neurotomy

Radiofrequency denervation or neurotomy has been used frequently for a long time as a treatment for facet joint pain. However, radiofrequency denervation of the sacroiliac joint is controversial. Descriptions include denervation of the joint itself or the denervation of medial branch, dorsal rami and lateral branch blocks. There are no controlled trials evaluating the effectiveness of radiofrequency neurotomy.

Ferrante et al (120) evaluated the role and effectiveness of radiofrequency denervation of the sacroiliac joints. They reported the results of a consecutive series of 50 sacroiliac joint radiofrequency denervations performed in 33 patients with sacroiliac joint dysfunction. All patients underwent diagnostic sacroiliac joint injections with local anesthetic prior to denervation. They established criteria for successful radiofrequency denervation as at least a 50% decrease in their pain levels for a period of at least 6 months. Twelve of 33 or 36.4% of the patients met this criteria. The average duration of pain relief was 12.0 $\pm$ 1.2 months in responders versus 0.9 $\pm$ 0.2 months in non-responders. Failure of denervation correlated with the presence of disability and pain on lateral flexion to the affected side. They reported that successful denervation was associated not only in the decrease of pain but also with a change in the pain diagram and a reduction in the pattern of referred pain, in normalization of the sacroiliac joint pain provocation test and reduction in the use of opioids. Ferrante et al (120) concluded that the results suggested that radiofrequency denervation of the sacroiliac joint can significantly reduce pain in selected patients with sacroiliac joint dysfunction for a protracted time.

Cohen and Abdi (100) studied the role of lateral branch blocks as a treatment for sacroiliac joint pain in a pilot study. They included 18 patients with sacroiliac joint pain confirmed by diagnosis of sacroiliac joint blocks. They all underwent lateral branch blocks and dorsal rami blocks. Ten of the 18 patients underwent previous blocks prior to their sacroiliac joint injections that were unsuccessful at alleviating their pain. Most were involved or had previously tried physical therapy. Three patients also had prior back surgery. However, all the patients were working and none were collecting disability. Only one patient was involved in legal proceedings. They reported that 13 of 18 patients or 72% obtained significant (greater than 50%) pain relief following lateral branch blocks. Of these 13 patients, 2 obtained prolonged relief lasting several months and did not undergo radiofrequency neurotomy. A total of 9 patients obtaining greater than 50% relief with lateral branch blocks proceeded to undergo radiofrequency denervation. In 5 of these 9 patients, a confirmatory block was performed with 2% lidocaine before the radiofrequency procedure. Eight of 9 patients reported significant pain relief following radiofrequency that persisted at their 9-month follow-up. Thus, they reported 89% success rate. Numerous criticisms forwarded against this study are it is a retrospective pilot as authors have admitted. It is not clear if they have performed L4 primary dorsal ramus block or medial branch block and only 9 of the 17 patients successfully obtaining pain relief following lateral branch blocks underwent radiofrequency neurotomy. If success rate of 8 patients out of 17 is considered a success, it will be less than 50%. This is also in contradiction to the reports of Dreyfuss et al (98, 99) with inability to be target specific with lateral branch blocks and also their inability to block nociception to ligamentous probing. The only difference these authors had compared to Dreyfuss et al (98, 99) were they included L4 medial branch or dorsal ramus.

Complications of sacroiliac joint injection include infection, trauma to the sciatic nerve and other complications related to drug administration. Without fluoroscopy, successful joint injection as documented with CT is successful in only 22% (121). Notable in the study was epidural spread in 24% or foraminal filling in 44%. Hansen (122) showed that of the 60 patients that were chosen for sacroiliac joint blind injections, five patients were felt to have received needle placement approximating therapeutic sacral joint injection. Hansen (122) injected 15 patients by the description of most intense pain, predominantly identified as the posterior superior iliac spine. None of these injections provided proper arthrogram. The remainder of the patients had varied complaints of point of maximum discomfort. None of the 60 injections provided sacroiliac joint arthrography.

Surgery

Surgical fixation of the sacroiliac joint is performed by a surgeon, and presumes that the joint is unstable. The premise that stabilization of the joint will decrease pain and subsequent disability remains un-proven. Traumatic, or other etiologies associated with joint laxity might find this procedure to be of benefit, but not routinely performed for sacroiliac joint pain.

Gaenslen (123) reported results of sacroiliac joint fusion in 9 patients with very good or good results in 8 and 7 returning to work. Miltney and Lowndorf (49) reported good results of sacroiliac joint fusion in 8 of 9 patients with sacroiliac joint sprain of over 1 year's duration. Waisbrod et al (124) also reported results of their fusion in 21 patients, with a 50% decrease in pain occurring in 11 patients. Moore (125) reported their results on 110 patients whom they followed for approximately 2 to 8 years. However, in contrast to others, he selected their patients on a positive double-blind sacroiliac joint block and negative low lumbar discography. He reported 90% (good or excellent) results.

Neuroaugmentation

Neuroaugmentation has been reported, however, it is not common. Calvillo (126) reported 2 cases of severe sacroiliac joint pain that were resistant to conventional management techniques. Both of these patients had undergone lumbar fusion which was considered as a predisposing factor. Both the patients were treated by implanting a neural prosthesis at the third sacral nerve roots. Stimulation was tried for one week with bilateral, percutaneously implanted, cardiac pacing wires at the third sacral nerves. Both of the patients experienced relief of approximately 60% of their pain during the trial. Permanent implantation was reported with improvement in their pain status and improvement in activities of daily living. The authors suggested that neuroaugmentation can be a reasonable option in patients with refractory sacroiliac joint pain.

Summary

The sacroiliac joint is a complex joint, and an integral component of the spinal axial support system. The interrelationships of the sacroiliac joint to the lumbar spine and lower extremities place this joint as a pivotal and key interface that requires stability for optimal ambulatory and functional capacity. Furthermore, it appears that the sacroiliac joint is a pain generator, and should remain an important consideration with infragluteal and lower extremity pain, and is easily accessed for diagnostic and therapeutic purposes. The joint is a point of risk for inflammation and infection, and aggressive treatment should be implemented when suspected. Significant morbidity results from a joint that has experienced an infection, with acceleration of arthritic progression. Spondyloarthropathies remain a fairly common cause of sacroiliac joint pain, and injection of the joint is a useful treatment, enhancing quality of life indices and decreasing progression of narcotic based pain medication. Neurotomy, and other sensory destructive procedures should be considered when treating a joint that demonstrates temporary relief from injection, and is a useful next step after injection of local anesthetic or corticosteroid when prolonged relief cycling is sought. Finally, the sacroiliac joint is an under-appreciated, often ignored component of spinal axial pain. The utility of treatment when sacroiliac joint pathology is suspected can not be over stressed. An important caveat to injection therapy of the sacroiliac joint is that fluoroscopic guidance is necessary for accurate placement of drug, and should be considered necessary for determination of therapeutic or diagnostic effectiveness.

The sacroiliac joint will not divulge its significance to pain with routine bedside tests, and a considerable interspecialty and practitioner variation exists when assessing this joint. When the sacroiliac joint is a suspected pain generator, this leaves the interventionalist an ideal position to demonstrate joint contribution pain and dysfunction by injection therapy.

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