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Review Article

Sacroiliac Joint Syndrome

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The sacroiliac joint has long been considered to be a potential source of low back and/or buttock pain with or without lower extremity symptoms. Until recently, supportive evidence for this disorder has been empirical as it was solely derived from information garnered from patients who obtained successful treatment for a constellation of signs, symptoms and examination findings believed to be indicative of sacroiliac joint syndrome. Due to this fallacious reasoning, successful treatment denotes a correct diagnosis; many of the concepts espoused during the past few decades have been predicated upon spurious data. With the advent of and systematic utilization of fluoroscopically guided diagnostic sacroiliac joint blockade specific epidemiologic, symptomatic, examination, diagnostic, and outcome data have been derived. This review describes current concepts and provides information that expounds and, in some instances, supplants prior held notions about this disorder.

Keywords: sacroiliac joint syndrome, sacroiliac joint dysfunction, sacroiliac joint pain, low back pain, buttock pain

Sacroiliac strain was first mentioned in 1905 by Goldthwaite and Osgood as a source of low back pain (1). During the ensuing three decades, sacroiliac joint dysfunction was considered the primary cause of low back pain. In 1934, Mixter and Barr publicized the discovery of lumbar disc prolapse, thus providing a mechanical construct for lumbar pain (2). Since then, there has been substantial controversy over the existence and clinical relevance of sacroiliac joint syndrome (SIJS). To date, the evidence is only empirical and is derived from successful treatment of patients believed to possess a constellation of clinical symptoms and physical findings (3). Based upon history and physical examination findings, the epidemiology of sacroiliac joint (SIJ) pain has been reported to present with right-sided symptoms in 45% of cases, left in 35%, and bilaterally in 20%, with a prevalence of 22.5% to 62.8% (3-6). More recent investigations have attempted to establish the prevalence of SIJS utilizing diagnostic fluoroscopically guided intraarticular injections, reporting the prevalence in chronic low back pain population at 13-30% (7, 8). The objective of this article is to review the literature pertinent to sacroiliac joint syndrome with respect to anatomy, biomechanics, diagnosis, and treatment.

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ANATOMIC CONSIDERATIONS

The sacroiliac joint is a diarthrodial joint with a joint capsule and synovial fluid. The sacroiliac joint appears around the 10th week of gestation and becomes established by the 16th week (9-11). 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 (2) at birth, 7 cm (2) at puberty, and 17.5 cm (2) in the adult (12). The cartilage is 2 to 3 times thicker on the sacral side (13-15). The auricular-shaped joint has a long and short arm. The long arm is oriented posterolaterally and caudally, whereas the short arm is positioned posteriorly and cephalic (16). The morphology of the sacroiliac joint varies widely between individuals with respect to size, shape, and contour (3). The supporting structures of the SIJ include ligaments, and the muscles helping to support these ligaments, in a continuous effort to help maintain the biomechanical integrity of the SIJ during various activities (4). The fibers of the SIJ capsule blend anteriorly and posteriorly with numerous ligaments. The anterior capsule of the SIJ is well formed, but the posterior capsule frequently possesses multiple rents and tears (3). The ligaments which act in concert with the SIJ capsule are the anterior and posterior

sacroiliac ligament, interosseus ligament, sacrotuberous ligament, sacrospinous ligament and iliolumbar ligament (17-19). The interosseous ligament is the strongest ligament supporting the SIJ and is believed to be the strongest ligament in the body (3, 20, 21). The iliolumbar, sacrotuberous, and sacrospinous ligaments have been depicted as accessory ligaments (3). Structures that have connections or an intimate relationship with the aforementioned ligaments are the piriformis, biceps femoris, gluteus maximus and minimus, quadratus lumborum, erector spinae, iliacus, latissimus dorsi, and thoracodorsal fascia (20, 22, 23).

It remains unclear precisely how the anterior and posterior aspects of the SIJ are innervated. The anterior portion of the SIJ likely receives innervation from the posterior rami of the L1-S2 roots (22). The contribution from these root levels is unpredictable and dependent upon individual variation (3, 24). Additional innervation to the anterior joint may arise directly from the obturator nerve, superior gluteal nerve, and/or lumbosacral trunk (25, 26). The posterior portion of the joint is innervated by the posterior rami of L4-S3 (25) with a particular contribution from S1 and S2 (8, 26, 27). The S1 level may provide the greatest contribution to the SIJ (27). Murata et al (28) recently demonstrated, in rats, that sensory fibers from the L1 and L2 dorsal root ganglions passed through the paravertebral sympathetic trunk. The aforementioned nerves contain unmyelinated, encapsulated, and complex unencapsulated nerve endings that provide pain, thermal sensation, pressure, and position sense (22, 29, 30). An autonomic contribution to this joints' innervation further increases the complexity and variability of its neural supply (26, 31, 32).

BIOMECHANICAL CONSIDERATIONS

Forces of the lower extremities are transmitted to the trunk through the sacrum. The SIJ is capable of withstanding six times as much medial directed force and seven times as much lateral bending force than a lumbar motion segment (3). Upon weight bearing, the upper sacrum is forced downward and anteriorly, wedging into the ilia (33). The SIJ acts as a triplanar shock absorber (34) possessing motion that likely does not occur around a single fixed axis (3, 10, 34-37, 51). The SIJ is surrounded by some of the largest and most powerful muscles of the body, but none of these muscles have direct influence on joint motion (3). Several kinematic studies have demonstrated various types of motion in the SIJ, such as gliding, rotation, tilting, nodding, and translation (38-41, 59). Although the precise model of SIJ motion remains unclear, the predominant motion appears to be x-axis rotation with some z-axis translation (1) (3). The supporting ligaments surrounding the SIJ influence movement. The interosseous ligament resists the anterior and lateral displacement of the ilia. The sacrotuberous ligament functions to decrease the anterior rotation of the sacrum relative to the ilia (nutation) (65). Conversely, the sacroiliac ligament has been found to decrease posterior rotation of the sacrum relative to the ilia (counternutation) (65). Motion of the SIJ is usually limited to one to three degrees of rotation and 1.6 mm of translation, with 90 percent of rotation occurring along the x-axis (42, 43). Sturesson et al utilized radiostereometric analysis in patients with presumed SIJS to determine the degree of motion that occurred about the SIJ during the standing hip flexion test (Gillet test) (44). The greatest degree of movement detected was one degree. The use of roentgen stereophotogrammetric analysis has demonstrated that manipulation does not alter the position of the SIJ (45).

ETIOLOGICAL CONSIDERATIONS

Sacroiliac joint syndrome may occur acutely from trauma via transmission through the hamstring (46). It may also occur with sudden heavy lifting (47-49), prolonged lifting and bending (41), torsional strain (41), arising from a stooped position (41), fall onto a buttock (50), or rear-end motor vehicle accident with the ipsilateral foot on the brake (71). SIJS may occur from repetitive shear or torsional forces to the SIJ, as occurs in sports such as figure skating, golf, and bowling (71). Pain in SIJS may be aggravated by sitting (3, 46), or lying on the affected side (41, 46). Pain worsens with riding in a car, weight bearing on the affected side with standing or walking (46), valsalva (46), and forward flexion in the standing position with knee's fully extended (51). Pain is mitigated with weight bearing on the opposite leg while the ipsilateral leg concurrently flexed (46). One cannot rely on symptom description to make a diagnosis of SIJS because the clinical manifestation of this syndrome is too diverse (14, 18, 19, 24-26, 34, 36, 38, 39-42, 52), and overlaps with other musculoskeletal conditions (53). Using diagnostic sacroiliac joint block as the gold standard it has been demonstrated that history correlates poorly with the diagnosis of SIJS (7, 49) therefore, symptom location can merely suggest the presence of SIJS, and is not sufficient to enter it into the differential diagnosis (3, 33, 49).

PAIN REFERRAL ZONES

The constellation of symptoms attributed to SIJS includes pain referral to various anatomic regions. A plethora of literature exists describing the numerous pain referral

Table 1. *Frequency of pain referral to the lumbar, buttock, groin, and abdominal regions*

Anatomic region	Percentage of patients with pain
Upper lumbar	6
Lower lumbar	72
Buttock	94
Groin	14
Abdomen	2

Adapted and modified from Slipman et al (50).

zones, attributed to SIJS, in which the diagnosis was predicated upon a patients' history and physical examination (4, 18, 19, 25, 35-40, 43, 46-49). Specific pain referral zones reported include the lower lumbar region (4, 18, 19, 25, 54-59), upper lumbar region (41), buttock (4, 18, 19, 25, 36, 39, 40, 60, 61), greater trochanteric (18, 39, 40, 62), groin and medial thigh (4, 37, 40, 43), anterior thigh (40, 44), posterior thigh (46, 63-66), lateral thigh (40), lower abdomen (36, 68), posterior calf (4, 35, 38, 39, 43), lateral calf (35, 38, 39, 40, 43). Only a scant amount of literature exists describing the pain referral zones of SIJS based on symptom relief following a diagnostic SIJ injection (7, 46, 68-70). Pain referral zones developed in patients who obtained symptom relief following a diagnostic intraarticular injection identified symptoms in the posterior superior iliac spine (46), lower lumbar region (7, 70), upper lumbar region (68), buttock (7, 68, 69), greater trochanter (70), groin and medial thigh (7, 70), anterior, posterior and lateral thigh (70), posterior, lateral and anterior calf (70), ankle (70), and lateral, plantar and dorsal foot (7, 70) (Tables 1 & 2). Slipman et al (70) identified a statistically significant relationship between patient age (less than age 40), and the presence of pain distal to the knee. The diffuseness of the sacroiliac joint pain referral zones may arise for several reasons: the joint's innervation is highly variable and complex (14, 71, 72), pain may be somatically referred from other primary osseous and ligamentous nociceptors, such as the zygapophyseal joint and disc (68, 72, 73) adjacent structures, such as the piriformis muscle (66), sciatic nerve (66), and L5 nerve root (74), may be affected by intrinsic joint pathology and become active nociceptors (39), and (4) pain referral patterns may be dependent on the distinct locations of injury within the sacroiliac joint (75).

ASSESSMENT

Physical Examination

The SIJ is mobile, albeit limited to only a few millimeters of glide and two to three degrees of rotation (43, 44, 60, 66, 75). An array of SIJ examination maneuvers have been described in the medical, osteopathic, physical therapy, and chiropractic literature designed to either provoke SIJ pain or detect aberrant motion (3, 20, 35, 36, 38, 76, 77). Examples of these maneuvers include: standing Gillet, Vorlauf test, Derbrolowsky test, inferior lateral 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's test, Yeoman's test, Gaenslen's test, joint play, midline sacral thrust, and thigh thrust (3). However, the examination maneuvers for aberrant motion have demonstrated to have poor inter- and intratester reliability (38, 78-80). The multiple studies demonstrating miniscule motion of the SIJ, less than 2 degrees, and the studies affirming reliable assessment of SIJ

Table 2. *Frequency of pain referral to the lower extremity*

Anatomic region	Percentage of patients with pain
Thigh	48
Posterior	30
Lateral	20
Anterior	10
Medial	0
Lower leg	28
Posterior	18
Lateral	12
Anterior	10
Medial	0
Ankle	14
Foot	12
Lateral	8
Plantar	4
Dorsal	4
Medial	0

Adapted and modified from Slipman et al (70).

motion during physical examination does not occur underscores the importance of abandoning such maneuvers during a musculoskeletal examination (43, 44). As Sturesson eloquently stated "what is assumed to be detectable as dissimilar movement of the SIJ during the standing hip flexion test is probably an illusion", should also be applied to other exam maneuvers used to supposedly detect aberrant SIJ motion (44).

Maigne et al (8) and Dreyfuss et al (67) showed that sacroiliac pain provocation tests do not definitively demonstrate the presence of SIJ pain. Slipman et al (81) demonstrated a positive predictive value of 60% in diagnosing SIJS in patients with three positive provocative SIJ. More recently, Broadhurst and Bond reported a sensitivity range of 77 to 87% when three provocative SIJ maneuvers are positive (82). Multiple positive SIJ provocation tests, though not diagnostic for SIJS, do enter SIJS into the differential diagnosis. Thus, a corroborative history and physical examination can enter SIJS into the differential diagnosis, but cannot make a definitive diagnosis of SIJS (80).

Radiologic Evaluation

Many studies have been done reporting on the efficacy of plain films (83, 18) computed tomography (CT (85), single photon emission computed tomography (SPECT) (27), bone scans (86, 87), nuclear imaging (88-91), and magnetic resonance imaging (MRI) (92) to detect the SIJ as the pain generator , however, corroborative radiologic findings have not been identified in patients with SIJS. The aforementioned radiologic studies can help in assessing the anatomic integrity of other possible nociceptive sources that may mimic SIJ pain, such as the lumbar intervertebral disc.

Diagnostic Injections

A major advance in the refinement of the diagnostic approach to low back disorders sprung from the work of Steindler and Luck in 1938 (53). In 1979, the utilization of fluoroscopic guidance was introduced for aspiration of sacroiliac joints (93). Currently, there is consensus that a fluoroscopically guided diagnostic SIJ intraarticular injection represents the gold standard test to confirm the diagnosis of SIJS (7,8,27, 33, 41, 42, 50, 80, 94-96). We interpret this test as positive if there is at least 80% reduction of the pre-block VAS rating. A false positive rate of 29% has been reported with a single diagnostic sacroiliac joint block (55), leading to the recommendation by a few authors that a double-blind paradigm be employed (7, 67, 68).

MANAGEMENT

Multiple treatments of SIJS have been adopted by various disciplines that treat low back pain. These treatment modalities consist of physical therapy, orthotics, mobilization, therapeutic sacroiliac joint block, and surgery.

There are no prospective trials that have evaluated the effect of aerobic exercise, stabilization exercises, or restoration of range of motion in SJIS. Empirically, exercise has been an important aspect in the treatment of SIJS. Physical therapy strategies should emphasize pelvic stabilization (97), restoration of postural and dynamic muscle imbalances, and correction of gait abnormalities (27). Janda (98) has described the typical muscle imbalance patterns in patients with SIJS. He describes a scenario in which certain truncal and lower extremity muscles have a tendency to tighten and weaken as a result of SIJ pathology. This process involves tightening of the postural muscles including the iliopsoas, quadratus lumborum, piriformis, gluteus maximus, hamstring and tensor fascia lata, and weakening of the dynamic muscles including the gluteus maximus, oblique abdominals, multifidus, and vastus medialis obliques (99). Assuming muscle imbalances actually occur, a physical therapy program that concentrates on stretching the aforementioned tight musculature and strengthening the weak muscles becomes a key element in treatment of SIJS (100). As symptoms are controlled, therapy should be advanced to activity-specific stabilization exercises to incorporate return to the patients' occupational, sporting, and/or avocational activities.

Various investigators have advocated the use of orthotics in the treatment of SIJS (68, 71, 72, 101-103), but there have been no prospective studies performed to evaluate their effectiveness. Clinicians often correct leg length discrepancies of greater than one-half inch, as such inequalities have been described as altering normal SIJ function (104). The use of SIJ and pelvic stabilization orthotics has been employed in an attempt to limit SIJ motion and improve proprioception (45, 71). It has been suggested that placement of the belt should occur just above the greater trochanter (100). Vleeming et al (101) demonstrated that seven of 12 sacroiliac joints in six cadavers had an average motion decrease of 29.3% with a 50 Newton belt. Studies looking at the use of SIJ belts in live subjects are needed to assess whether Vleeming's aforementioned findings occur during various physiologic and vocational activities (101).

Manual therapy has also been proposed as a means of treating patients with SIJS. Prospective studies performed by Osterbauer et al (103) and Kirkaldy-Willis and Cassidy (104) suggested benefit, however, the diagnosis of SIJS was based on history and physical examination. Tullberg et al (45) demonstrated by roentgen stereophotogrammetric analysis that manipulation does not alter the position of the sacrum in relation of the ilium. Further studies assessing the outcome of manual therapy on patients with SIJS diagnosed by fluoroscopically guided diagnostic intraarticular injection is required before definitive statements regarding the efficacy of manipulation can be made (105).

In the United States there has been a dramatic increase in visits to practitioners of alternative medicine, with expenditures in the range of $21.2 billion in 1997 (105). Although SIJS specifically has not been addressed in the literature in terms of alternative and complementary medicine, the problem of low back pain in general has been widely studied. Survey data suggest that back pain is one of the most common indications for referral to acupuncturists (106). A meta-analysis of randomized controlled trials of acupuncture for back pain found that acupuncture was shown to be superior to various control interventions, although there is insufficient evidence to state whether it is superior to placebo (107). Preliminary studies have found biofeedback (108), relaxation training (109), and self-hypnosis (110) to be of some benefit in chronic low back pain. Massage (111) and bipolar magnets (112) have not been shown to alleviate chronic low back pain. More investigations into the specific effectiveness of alternative and complementary therapies for the treatment of SIJS are needed.

Several authors have written about the efficacy of fluoroscopically guided intra-articular steroid sacroiliac joint block for patients with SIJS (50, 51, 115). Norman and May (113) claimed successful treatment of over 300 patients with SIJS using intra-articular hydrocortisone, but their actual results are not reported. Maugers et al (114) reported a retrospective study on the efficacy of therapeutic sacroiliac joint block for patients with seronegative spondyloarthropathy experiencing symptoms of sacroiliitis. They reported greater than 70% relief of symptoms in 79.2% of subjects for an average of 8.4 months. In a retrospective study, Slipman et al (115) used intra-articular sacroiliac joint injection of steroid and physical therapy to treat patients experiencing symptoms of SIJS diagnosed by a minimum of an 80% decrease in pre and post sacroiliac joint block 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.

Surgery is not indicated for patients with acute SIJS, but may be an option for those suffering with intractable pain. Gaenslen (116) reported results of SIJ fusion in nine patients, with very good or good results in eight, and seven returning to work. Miltney and Lowndorf (51) retrospectively reported good results of SIJ fusion in eight of nine patients with SIJ sprain of over one year's duration. Waisbrod and co-workers (117) retrospectively reported their results after 22 sacroiliac joint fusions in 21 patients diagnosed by physical examination, plain films, CT, bone scan and positive sacroiliac joint block. A 50% decrease in pain occurred in 11 patients, all of whom fused. Reassessment of the results after excluding patients with abnormal psychological testing resulted in an improvement in outcomes with 73% reporting good/excellent results. These authors believe a success rate of approximately 70% can be achieved with SIJ fusion for intractable SIJS provided strict preoperative selection criteria are used. In 1998, Moore (118) presented results on 110 patients followed for 2 to 8 years following SIJ fusion. He reported that in appropriately selected patients, diagnosed by a positive double-blind sacroiliac joint block and negative low lumbar discography, 90% good or excellent results were achieved.

Diagnostic and Therapeutic Algorithm

An evidence based diagnostic and therapeutic algorithm for the treatment of SIJS can be formulated. Such an algorithm is predicated upon recent information concerning the epidemiology, anatomy, biomechanics, history and physical examination, radiologic studies, diagnostic intra-articular sacroiliac injections, treatment options for SIJS.

All patients presenting with low lumbar and/or buttock pain with or without lower extremity pain, triggered by a traumatic event, should be evaluated with provocative, rather than aberrant motion detection, maneuvers for SIJS. Those with three or more positive maneuvers have SIJS entered into the differential diagnosis as a possible etiology of their pain. An outpatient physical therapy program specifically aimed at re-establishing the delicate interplay between the various muscles and ligaments that maintains the integrity of the sacroiliac joint, as previously described, is prescribed. In addition, a long acting oral non-steroidal anti-inflammatory drug is initiated. The patient is re-evaluated in three to four weeks. If the patient continues to report

significant pain, a diagnostic fluoroscopic guided intra-articular sacroiliac joint injection is offered. If a positive response is obtained, then two therapeutic fluoroscopically guided intra-articular sacroiliac joint injections, as previously described, performed two weeks apart, are offered. Simultaneously, the patient continues in outpatient physical therapy. If the patient has greater than 90% relief after the initial therapeutic injection, subsequent injections are cancelled. After another three to four weeks, the patient is re-evaluated. If the patient reports some benefit, but continued pain, a third therapeutic injection is offered. The patient is re-evaluated again two weeks following the aforementioned injection. In rare instances, if the patient continues to describe pain, a fourth and final therapeutic injection may be offered. If the patient fails this therapeutic regime a critical decision has to be made; is the patient a non-responder to conservative care or was the diagnostic block a false positive response? In such cases a double-blind double-block paradigm is performed followed by lumbar discography. If the patient has a positive response to the former and a normal discogram, then SIJ fusion surgery is warranted. If lumbar discography demonstrates internal disc disruption syndrome at one or more levels, then this entity must be addressed as it represents the likely diagnosis. If at any time during the therapeutic algorithm, the patient reports greater than 90% relief of pain, subsequent injection are cancelled, the patient is instructed to complete the outpatient physical therapy program, continue the home exercise program, and is re-evaluated on an as needed basis.

SUMMARY

In summary, the SIJ is generally accepted as a potential source of low back and/or buttock pain with or without lower extremity pain. Sacroiliac joint satisfies all the criteria to be considered a pain generator, including: (1) it should have a nerve supply; (2) it should be susceptible to disease or injuries known to be painful; (3) it should be capable of causing pain similar to that seen clinically (72). Painful conditions of the SIJ are known to result from spondyloarthropathies (119), infection (120), malignancy (121), and trauma (3, 72). Using intra-articular injections both provocatively in normal subjects (33), and diagnostically is chronic pain populations (7, 8), the sacroiliac joint has been demonstrated to be a source of pain. Specific pain referral zones reported include the lower lumbar region (4, 18, 19, 25, 54-59), upper lumbar region (41), buttock (4, 18, 19, 25, 36, 39, 40, 60, 61), greater trochanteric (18, 39, 40, 62), groin and medial thigh (4, 37, 40, 43), anterior thigh (40, 44), posterior thigh (4, 40, 46, 63-66), lateral thigh (40), lower abdomen (36, 67), posterior calf (4, 35, 38, 39, 43), lateral calf (35, 38, 39, 40, 43). Only a scant amount of literature exists describing the pain referral zones of SIJS in patients who have undergone diagnostic injection procedures (7, 68-70). Pain referral zones developed in patients who obtained symptom relief following a diagnostic intraarticular injection identified symptoms in the posterior superior iliac spine (46), lower lumbar region (7, 70), upper lumbar region (68), buttock (7, 68, 70), greater trochanter (70), groin and medial thigh (7, 70), anterior, posterior and lateral thigh (70), posterior, lateral and anterior calf (70), ankle (70), and lateral, plantar and dorsal foot (7, 70). Anatomically and biomechanically, the SIJ shares all its muscles with the hip joint, thus it is unable to function in isolation; its' movements must be synchronized with the hip and the L5/S1 junction (122). Subsequently, the SIJ is subject to unidirectional pelvic shear, repetitive and torsional forces which can contribute to SIJ pain.

CONCLUSION

History and physical examination can enter Sacroiliac Joint Syndrome into the differential diagnosis, but cannot make a definitive diagnosis of Sacroiliac Joint Syndrome. Plain films, bone scan, SPECT, CT and MRI are not helpful in making the diagnosis of Sacroiliac Joint Syndrome. Fluoroscopically guided intra-articular SIJB with local anesthetic is the gold standard test for making the diagnosis of Sacroiliac Joint Syndrome (7, 8, 27, 33, 41, 42, 50, 75, 98, 99). Treatment options for Sacroiliac Joint Syndrome includes physical therapy, orthotics, manipulation, therapeutic SIJB, and, for intractable cases, surgical fusion.

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