Prospective Study

Value of Examination Under Fluoroscopy for the Assessment of Sacroiliac Joint Dysfunction

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Background: Pain emanating from the sacroiliac (SI) joint can have variable radiation patterns. Single physical examination tests for SI joint pain are inconsistent with multiple tests increasing both sensitivity and specificity.

Objective: To evaluate the use of fluoroscopy in the diagnosis of SI joint pain.

Study Design: Prospective double blind comparison study

Setting: Pain clinic and radiology setting in urban Veterans Administration (VA) in New Orleans, Louisiana.

Methods: Twenty-two adult men, patients at a southeastern United States VA interventional pain clinic, presented with unilateral low back pain of more than 2 months' duration. Patients with previous back surgery were excluded from the study. Each patient was given a Gapping test, Patrick (FABERE) test, and Gaenslen test. A second blinded physician placed each patient prone under fluoroscopic guidance, asking each patient to point to the most painful area. Pain was provoked by applying pressure with the heel of the palm in that area to determine the point of maximum tenderness. The area was marked with a radio-opaque object and was placed on the mark with a fluoroscopic imgage. A site within 1 cm of the SI joint was considered as a positive test. This was followed by a diagnostic injection under fluoroscopy with 1 mL 2% lidocaine. A positive result was considered as more than 2 hours of greater than 75% reduction in pain. Then, in 2-3 days this was followed by a therapeutic injection under fluoroscopy with 1 mL 0.5% bupivacaine and 40 mg methylprednisolone.

Results: Each patient was reassessed after 6 weeks. The sensitivity and specificity in addition to the positive and negative predictive values were determined for both the conventional examinations, as well as the examination under fluoroscopy. Finally, a receiver operating characteristic (ROC) curve was constructed to evaluate test performance. The sensitivity and specificity of the fluoroscopic examination were 0.82 and 0.80 respectively; Positive predictive value and negative predictive value were 0.93 and 0.57 respectively. The area under ROC curve was 0.812 which is considered a "good" test; however the area under ROC for the conventional examination were between 0.52 -0.58 which is considered "poor to fail".

Limitations: Variation in anatomy of the SI joint, small sample size.

Conclusions: Multiple structures of the SI joint complex can result in clinical symptoms of pain. These include intra-articular structures (degenerative arthritis, and inflammatory conditions) as well as extra-articular structures (ligaments, muscles, etc.).

Key words: Sacroilliac joint disease, radicular pain, thigh thrust test, compression test, distraction test, Gaenslen test, Patrick test (FABER test)

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Low back pain with or without lower extremity compromise is the most common type of pain experienced by adults and constitutes an important source of increased disability-adjusted life years in the US population, costing approximately $50 billion per year (1-3). Possible generators of low back pain include both spinal and nonspinal sources. Spinal

pain may be associated with muscles, nerves, facet joints, tumors, infection or instability. Nonspinal causes include the sacroiliac (SI) joint and hip joints (4).

It is well-known that the 3 most common causes of low back pain are intervertebral disc-related pain, facet joint pain, and SI joint dysfunction. SI joint pain accounts for approximately 15-30% of patients who present with axial low back pain (5). In this regard, the differential diagnosis of SI-mediated or modulated pain states includes discogenic pain, lumbosacral radiculitis, myofascial pain and/or trigger points of the gluteal musculature, piriformis syndrome, and lumbar facet arthropathy.

SI joint pathogenesis is typically associated with either an isolated traumatic event (44%), repetitive injury (21%), or is idiopathic (35%) (6). Among traumatic events, motor vehicle accidents and falls are typically the source, whereas a history of repeated physical events, such as lifting, running, or altered gait secondary to disorders of the lower extremities are the causes of repetitive injury-related SI-mediated pain pathogenesis. Inflammatory seronegative spondyloarthropathies are also associated with an increased risk of SI joint pain. These disorders are typically divided into psoriatic arthritis, ankylosing spondylitis, reactive arthritis, enteropathic arthritis (e.g., arthritis associated with inflammatory bowel disease), and idiopathic/undifferentiated spondyloarthropathy. A history of prior lumbar or lumbosacral fusion is also linked to SI joint pain.

In addition to history, there are several types of clinical examinations for diagnosing SI joint pain; however, the accuracy of clinical examination for SI joint dysfunction is quite limited. In fact, there is no precise historical or physical examination finding that is either unequivocally sufficiently sensitive or specific for SI joint pain. Therefore, multiple physical exam tests have been employed that collectively significantly increase diagnostic precision (7). Most of these physical examination tests are considered to be positive because they reproduce the pain state; they are described as provocation examinations. The 5 most commonly utilized include the distraction (gapping) test, thigh thrust test, the Gaenslen test, the compression test, and the Patrick or FABER test (8). Three or more positive tests, though not diagnostic, have been found to have better sensitivity and specificity (85% and 79%, respectively), as well as improved positive and negative predictive values (77% and 87%, respectively).

The present study evaluated the efficacy of examination under fluoroscopy for the assessment of SI dysfunction, as compared to conventional physical examinations. The results of the present investigation revealed that local anesthetic diagnostic blocks under fluoroscopic guidance remains the "gold standard" for the diagnosis of SI joint pain (1,2).

Methods

This prospective comparison study addressed the efficacy of examination under fluoroscopy for the assessment of SI dysfunction to the commonly practiced distraction (gapping) test, Patrick (FABER) test and Gaenslen test. A total of 22 patients, all men between the ages of 30 to 70 years, with unilateral low back pain of more than 2 months duration, with or without radiation to the lower extremity, were randomly chosen. Patients who had previous back surgery were excluded from the study.

This study was conducted at a southeastern US Department of Veterans Affairs interventional pain clinic. After obtaining institutional review board approval, all patients underwent the 3 conventionally practiced physical exam maneuvers. For the distraction (gapping) test, the patient was positioned supine with a pillow under his knees and one arm placed under his lumbar spine. The examiner stood at the patient's side and used a crossed-arm technique to apply dorsolateral pressure in a sustained manner to the bilateral anterosuperior iliac spines. For the Gaenslen test, the patient was positioned supine at the edge of the examination table in a position such that the lower extremity of the affected side was allowed to drop toward the floor in an extension motion past the horizontal plane of the examination table. The contralateral (unaffected) hip was flexed maximally with the patient actively pulling that knee toward the chest. The examiner exerted downward/dorsal pressure on the anterior aspects of both knees in an attempt to facilitate a rotation motion. Finally, for the Patrick test (FABER test), the patient was positioned supine. The femur on the affected side was flexed, abducted, and externally rotated (FABER) so as to place the lateral malleolus on the anterior aspect of the contralateral knee. The unaffected hemipelvis was stabilized at the anterior superior iliac spine and dorsal (downward) pressure was applied to the knee of the affected side (9). Since there is no one physical exam that has high sensitivity or specificity, at least 3 positive tests were considered positive in this study. Subsequently, in another patient room, a second investigator blinded to the physical exam positioned the patient prone under a

fluoroscope and asked the patient to point to the most painful area. Pain was provoked by applying pressure with the heel of the palm in that area to determine the point of maximum tenderness. The area was marked with a radiopaque object; in these cases we used a US one-cent coin, commonly called a penny. Then, the penny was placed on the mark and a fluoroscopic picture taken. A site within one cm (edge of the penny on or overlapping the joint) of the SI joint was taken as a positive test. This was followed by a diagnostic injection under fluoroscopy with one mL of 2% lidocaine. A positive result was considered as more than 2 hours of greater than 75% reduction in pain. Then, in 2-3 days this was followed by a therapeutic injection under fluoroscopy with one mL of 0.5% bupivacaine and 40 mg methylprednisolone. Patients where reassessed after 6 weeks. The sensitivity and specificity, in addition to the positive and negative predictive values, were determined for both the conventional examinations as well as the examination under fluoroscopy. Finally, a receiver operating characteristic (ROC) curve was constructed to evaluate test performance.

Results

The results of this investigation revealed that the sensitivity and specificity of fluoroscopic examination were 0.82 and 0.80 respectively (Table 1). The positive predictive value and negative predictive value were 0.93 and 0.57 respectively (Table 1). The area under the ROC curve was 0.812 which is considered a "good" test; however the areas under the ROC curve for the conventional examination were between 0.52 -0.58 which is considered "poor to fail" (Fig. 1, Table 1).

Discussion

SI joint pain has been considered the primary source of low back pain in 10% to 27% of patients with mechanical low back pain below L5 utilizing controlled comparative local anesthetic blocks (10-16). It is the result of either direct trauma, unidirectional pelvic shear, inflammation, torsional forces or idiopathic onset (17-19). The clinical finding that the SI joint is a source of pain in many patients is supported by histologic examination of joint structures and surrounding tissues. Positive immunohistochemical staining for calcitonin gene-related peptide and substance P has been identified in both iliac and sacral cartilage and adjacent ligamentous structures (9). Yet care providers remain reluctant because evidence supporting the SI joint as a pain generator is largely empirical, mostly derived from successful treatment of patients with suspected SI joint pain (20). Additionally, diagnostic approaches remain quite limited, thus adding to the controversy (21).

The SI joint is the articulating surface between

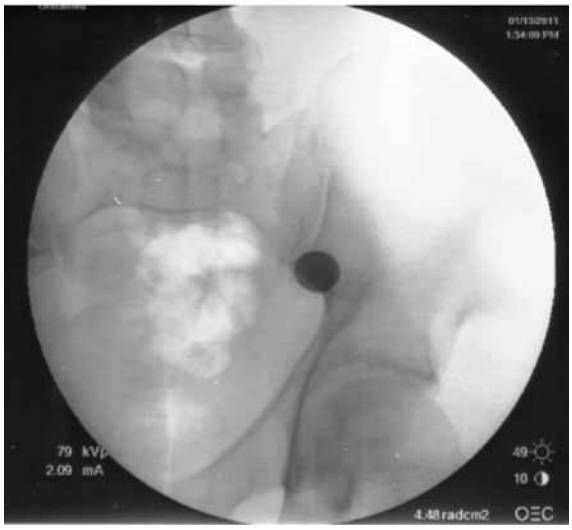

Fig. 1. *Fluoroscopic imaging of radio-opaque object overlying sacroiliac joint indicating a positive test result.*

Table 1. *Fluoroscopic Exam against all these test results.*

	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Receiver Operating Characteristic (ROC) Curve
Distraction Test	0.67	0.38	0.5	0.56	0.526
FABERE Test	0.64	-	1	0	-
Gaenslen's Test	0.67	0.5	0.88	0.22	0.583
Combined Physical Exams	0.67	0.5	0.88	0.22	0.583
Fluoroscopic Exam	0.82	0.80	0.93	0.57	0.812

Combined Physical Exams positive when at least two of the above three were positive.
Combined results and Gaenslen's Test have exactly the same diagnosis results.
All FABERE test were positive for the whole sample, so specificity and ROC were not available

the sacrum and the iliac bones, thus providing the functional unit connecting the spine to the lower extremities. The SI joint is classified as a true diarthrodial joint, with opposing articular surfaces separated by a synovial fluid-filled space and covered by a fibrous capsule (9). The anterior portion of the SI joint is described as a true synovial joint because it is mainly composed of hyaline cartilage. Nevertheless, the posterior portion is a syndesmosis composed of the musculus pyriformis, musculus gluteus medius and minimus, and ligament sacroiliaca (22), providing adequate stability to the articulation.

The SI joint's innervation pattern is variable and a subject of controversy, making the understanding, diagnosis and treatment of SI joint pain difficult (11,9). Initial studies considered the lumbosacral plexus, dorsal rami of S1 and S2, superior gluteal nerve and the obturator nerve as being the main sources of innervation (23). It has been proposed that the sacral plexus and spinal nerves may innervate the anterior and posterior portion of the SI joints respectively. Bernard (24) considered that the anterior innervation arises from the L2 to S2 nerve roots whereas the posterior innervation stems exclusively from the lateral branches of the posterior rami of L4 to S3. Several authors still consider that even though there may be input from the ventral rami, the innervation to the SI joint is provided mainly by the dorsal rami of nerve endings previously mentioned (25,26). Murata et al (27) reported that the dorsal root ganglia from L1 to S2 ipsilateral to the joint provided the sensory innervation of the SI joint in a murine model. Similarly, fetal pelves dissections revealed neural filaments solely in the dorsal mesenchyme, providing conclusive evidence that innervation of the SI joint arises in the dorsal rami (26,28). Despite multiple studies, the exact innervation pattern of the SI joint still remains unclear (25,27-33).

The SI joint receives proprioceptive and nociceptive afferents units as demonstrated by multiple neurophysiologic studies revealing the complexity of the articulation (29,32-37). The average mechanical threshold of an SI joint nociceptive unit was higher (70 grams) when compared with the mechanical threshold for lumbar facet joint nociceptive units (6 grams), but lower than the threshold for units located in the anterior lumbar disc (241 grams). This result suggests that pain sensitivity of the SI joint is higher than the anterior portions of the lumbar disc but lower than the lumbar facet joints (35,37,38).

Multiple studies have been conducted to analyze the referral patterns based on joint provocation and analgesia. Slipman et al (39) demonstrated SI joint pain referral zones based on an analgesic response to low-volume local anesthetic injection. Fortin et al (40) contributed to the development of a pain referral map in the SI joint using contrast medium injection provocation followed by local anesthetic injection in asymptomatic volunteer donors and evaluated the applicability of the pain referral map as a screening tool for patients with SI joint pain (41). Schwarzer et al (42) demonstrated that groin pain was the only pain referral pattern found to be associated with response to an SI joint block .

The highly complex joint innervation and pain referral pattern make the SI joint a challenging articulation in terms of diagnosis and treatment. A plethora of physical examination tests have been developed as diagnostic aids in supposed patients with SI joint pain, the most common being distraction (gapping) test, Patrick test, and Gaenslen test (10). According to the existing literature, 2 distraction tests have a sensitivity of 11% - 21% and specificity of 90% - 100%; FABERE test has a sensitivity of 57%-77% and specificity of 100%; and Gaenslen test has a sensitivity of 68% and specificity of 35%. Medical history and physical examination correlation can provide a differential diagnosis, but an ultimate decision cannot be established only based on these characteristics (43). Likewise, in spite of the reported efficacy of imaging studies such as plain films (44), bone scans (45,46), magnetic resonance imaging (47), single photon emission computed tomography (48), computed tomography (49,50) and nuclear imaging (51-55), the evidence is limited to provide a definitive diagnosis based on radiologic evaluation (11). As a result, there are no conclusive features supported by historical, physical or radiological findings to provide a definitive diagnosis of SI joint pain (56,57).

SI diagnostic joint injections have been commonly performed by many means, including without image guidance, based on clinical examination and tenderness (58). However, a local anesthetic diagnostic block under fluoroscope guidance still remain the "gold standard" for SI joint pain (21).

Conclusion

In conclusion, the fluoroscopic penny test is a valuable addition to an interventional pain physician's armamentarium for diagnosing SI joint pain. Most commonly, SI joint pain may be misinterpreted as facetogenic pain and vice versa. The fluoroscopic penny test, combined with physical exam maneuvers, may help the diagnostician obtain an accurate diagnosis by helping to rule out

alternative diagnoses such as facetogenic pain, iliolumbar syndrome and superior cluneal nerve entrapment. A drawback of this technique includes increased, albeit, minimal exposure to ionizing radiation for both the patient and fluoroscope operator. Based on our studies, however, the penny test is the most sensitive and specific maneuver for SI joint dysfunction. Additional data may be gathered in future studies in order to add power by way of more patients to our statistical analysis.

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