

## Chapter 26

# Regenerative Medicine for Sacroiliac Joint Dysfunction

*Joseph A. Cabaret, MD, Laxmaiah Manchikanti, MD,  
and Aaron Calodney, MD*

### 1.0 INTRODUCTION

Regenerative medicine has been successfully used to treat painful joint arthropathies at various sites around the body. The sacroiliac joint is a common source of low back pain and disability that can be difficult to treat and that might also be effectively managed with regenerative medicine techniques (1-3). The evidence continues to evolve to support its use in sacroiliac joint related disorders (4,5).

Application of the principles of regenerative medicine are crucial due to the increasing socioeconomic burden imposed by chronic spinal pain, the resources utilized in managing chronic spinal pain with the growing number of modalities applied together with their alleged low quality and the high cost of interventions with multiple negative health policy implications (6-8). In fact, Dieleman et al (7,8), in an assessment of US spending on personal health care and public health from 1996 to 2013, showed that the conditions with the highest spending levels from 1996 to 2013 included low back and neck pain at the top, accounting for the third highest amount, with estimated care spending of \$87.6 billion. Further, expenditures of overall musculoskeletal disorders exceeded \$183 billion. The intervertebral discs, the zygapophysial (facet) joints, and sacroiliac joints have all been demonstrated, with controlled diagnostic techniques, to be common causes of chronic spinal pain (1-3,9-12).

### 2.0 PATHOPHYSIOLOGY

Sacroiliac joint dysfunction generally refers to pain in the sacroiliac joint region that is caused

by either hypermobility or hypomobility because of weakened, injured, or sprained ligaments (1-3). While the joint itself may initially appear structurally normal and healthy, abnormal motion can eventually result in sacroiliac joint arthritis (sacroiliitis), often not until after many years. The joint can be slightly subluxed and even locked positions can occur. The muscles can be involved or spasm with a painful and dysfunctional sacroiliac joint. Patients can develop tightness and dysfunction in the hamstring, quadriceps, iliotibial tract, and hip flexors.

Sacroiliac joint pain diagnosed by intra-articular blocks accounts for about 10-27% of chronic non-radicular low back pain (3). Symptoms are non-specific and can easily be confused with other sources of low back pain so the diagnosis is frequently overlooked. Additionally, pathology often does not show up on x-ray or MRI, making detection difficult (13). Sacroiliac joint pain can be disabling. It is more common in females and pain referral patterns are highly variable (1-3).

Trauma may cause sacroiliac joint pain, usually due to a lifting and twisting injury or fall onto the buttocks. With an injury to the sacroiliac joint, pain tends to be unilateral and can refer to the posterior thigh, iliac fossa, and buttocks. Sprains of the iliolumbar ligaments can also result in referred pain into the groin and genitalia. Stress across the sacroiliac joint following lumbar fusion, especially at the L5-S1 level, appears to be a common cause of sacroiliac joint pain, and may be considered a form of adjacent segment disorder. It has been reported that the sacroiliac joint is a common source of post-fusion low back pain (3,14,15). Other causes and predisposing factors

of sacroiliac joint pain include joint hypermobility syndromes (e.g., Ehlers-Danlos syndrome and pregnancy), hypomobility syndromes (advanced age and inflammatory arthritis, such as ankylosing spondylitis, Reiter's syndrome, RA, and psoriatic arthritis), leg or muscle length discrepancy, altered gait patterns, repetitive stress (marathoners), scoliosis, lumbosacral transitional vertebrae, and hip arthropathy (1-3,14,15). Hormone imbalances, particularly those associated with pregnancy and the hormone relaxin, can also cause a ligamentous laxity resulting in the weakening of the sacroiliac structure.

### 3.0 REGENERATIVE MEDICINE

Most sacroiliac joint patients stabilize with conservative care of 6-8 weeks. This consists of ice, anti-inflammatory medicines, physiotherapy (stabilization and/or manual manipulation), self-mobilization techniques, sacroiliac joint belt or tape (external fixation), psychological counseling, steroid injections, and radiofrequency denervation. Surgical fusion is an option with some favorable 2-year outcomes data for patients who have failed conservative care. The anti-inflammatory effect of injection therapy is often not permanent, and many patients wish to avoid surgical solutions. In these cases, prolotherapy, platelet rich plasma, and stem cell therapies are an option.

Sacroiliac joint pain can be disabling and there are few good solutions if simple therapies don't work. Many patients with confirmed sacroiliac joint pain fail to obtain adequate sustained relief with conservative care or steroid injection therapy and wish to avoid invasive sacroiliac joint fusion surgery due to its less than perfect risk to benefit ratio. Prolotherapy and/or intraarticular injections with PRP and or stem cells is a relatively new and increasingly popular option. Effective application in patients with sacroiliac joint pain has been documented with benefits lasting for many years. Instead of merely masking symptoms, regenerative medicine treatments aim at healing the underlying pathology that is causing pain and disability. There have been published reports of dramatic results but not all studies support the use of regenerative medicine for musculoskeletal indications. How-

ever, the existing body of literature is largely encouraging and merits further investigation (16-18).

The decision whether to use PRP, bone marrow aspirate stem cell concentrate (BMAC), stromal vascular fraction (SVF) or some combination thereof is still open for debate (19-23). There is little evidence that one is superior to the others or for combining various substrates. Experienced regenerative medicine clinicians often recommend stem cell concentrates when injecting into joints. At this point, this is largely conjectural and related to the belief that stem cell concentrates are better able to regenerate cartilage than platelet concentrates alone. Further high-quality laboratory and clinical studies are required to provide evidence-based answers to these questions. For now, regenerative medicine for sacroiliac joint pain remains a promising option.

The versatility of biologic therapy allows its use in spinal disc degeneration, as well as disc protrusion. The two biologics most commonly utilized and well studied are PRP and mesenchymal stem cells (MSCs) (19). In the United States, PRP is approved by the Food and Drug Administration (FDA) for use with ligament grafting and bony matrices during reconstructive procedures. This benefit occurs by increased concentration of growth factors that are secreted by a platelet in an inflammatory environment.

PRP is a concentrate of whole blood that is centrifuged to obtain a concentrate of plasma rich in platelets and hence growth factors. PRP provides multiple benefits with disc repair by the increased concentration of growth factors that are secreted by a platelet in an inflammatory environment, i.e., platelet-derived growth factors (PDGF) (19,21).

These growth factors are essential to the healing process, as they increase fibroblast or osteoblast metabolic activity while reducing cell apoptosis; promote angiogenesis, thereby increasing blood flow and circulation to the new-forming tissues; and increase the expression of the pro-collagen gene and collagen-derived growth factor, which increases the tensile strength of the new tissue (19,21,24-31). Even though components of PRP include platelets, leukocytes, and red blood cells, platelets are central to mediating the anabolic effects of PRP by virtue of releasing growth fac-

tors stored in their alpha granules (19,21). Notable growth factors released from platelets that are involved in the healing process include PDGF, transforming growth factor- $\beta$  (TGF- $\beta$ ), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), basic fibroblast growth factor (bFGF), insulin-like growth factor (IGF-1).

Multiple research activities have intensified in tissue engineering and regenerative medicine (19,20-23), with multiple preclinical studies demonstrating encouraging results in multiple spinal conditions (19,20,32-34).

There have not been many studies assessing the role of PRP or MSCs with sacroiliac joint injections. However, Sanapati et al (35) performed systematic assessment of the evidence, with identification of one RCT (5) and 2 observational stud-

ies (4,36). The results of these studies are shown in Table 1. Sanapati et al (35), based on one high quality RCT (5), one moderate quality observational study (36) and one low quality case report (4), presented the qualitative evidence as Level IV on scale of Level I to V using a qualitative modified approach to grading of evidence based on best evidence synthesis.

## 4.0 CLINICAL PRESENTATION

### 4.1 Symptoms and Signs

The pain diagram usually centers around the Venus Dimple or posterior superior iliac spine (PSIS) region below the L5 level (pelvis, buttock, hip, and groin) with radiation down the leg (Fig. 1) sometimes with transient numbness, tingling,

**Table 1.** Summary of sacroiliac joint injection PRP studies published to date.

Study Details	Methods	Results	Conclusion
<p>Singla et al, 2017 (5)</p> <p>Sample size=40</p> <p>Follow-up=3 months</p> <p>Prospective, randomized open blinded endpoint study</p> <p>Chronic low back pain with sacroiliac joint pathology</p>	<p>Patients were randomized into 2 groups with one group receiving 1.5 mL of methylprednisolone 40 mg/mL and 1.5 mL of 2% lidocaine with 0.5 mL of saline, whereas, PRP group receiving 3 mL of leukocyte free PRP with 0.5 mL of calcium chloride with ultrasound guided sacroiliac joint injection</p> <p>Outcomes were assessed with Visual Analog Scale (VAS) scores, Oswestry Disability Index (ODI), Short Form-12</p>	<ul style="list-style-type: none"> <li>At 3-month follow-up, 90% of the patients reported satisfactory relief with PRP; whereas, satisfactory relief was observed in 25% of the patients receiving steroids.</li> <li>A strong association was observed in patients receiving PRP and showing a reduction of VAS of greater than 50% from baseline</li> </ul>	<ul style="list-style-type: none"> <li>Positive first prospective, randomized study</li> <li>Small number of patients</li> </ul>
<p>Navani &amp; Gupta, 2015 (36)</p> <p>Sample size=10 (4 males, 6 females) with sacroiliac joint pain of greater than 6 months duration</p> <p>Age Distribution=5 patients below 40 and 5 patients over 40</p> <p>Sacroiliac joint pain</p>	<p>Sacroiliac joint injection under fluoroscopic guidance with PRP</p>	<ul style="list-style-type: none"> <li>All patients improved 3 months post injection and maintained low pain levels not requiring any additional treatment up to 6 months post injection</li> <li>SF-36 demonstrated improvement in both physical component summary scores and mental component summary scores in all patients</li> <li>No adverse events</li> </ul>	<p>A positive case series of 10 patients</p>
<p>Ko et al, 2017 (4)</p> <p>Sample size=4</p> <p>Follow-up=2 yrs.</p> <p>Case series</p>	<p>Sacroiliac joint injection with PRP under ultrasound</p> <p>Outcomes were assessed with Short form, McGill Pain Questionnaire, Numeric Rating Scale (NRS), Oswestry Disability Index (ODI)</p>	<ul style="list-style-type: none"> <li>At 12-month follow-up there was marked improvement in joint stability, a statistically significant reduction in pain, and improvement in quality of life</li> <li>The clinical benefits of PRP were still significant at 4 years post treatment</li> </ul>	<p>PRP showed long lasting positive results in this short case series of 4</p>

*Adapted from Sanapati J, Manchikanti L, Atluri S, et al. Do regenerative medicine therapies provide long-term relief in chronic low back pain: A systematic review and metaanalysis. Pain Physician 2018; 21:541-550 (35).*

weakness, instability (leg giving way), and even urinary frequency (1-3,37,38). For this reason, it can be mistaken for sciatica, but it rarely extends below the knee. Sacroiliac joint pain is usually a dull ache or stiffness but can be sharp and stabbing and is often aggravated with prolonged immobility (e.g., prolonged standing, sitting, or

lying down). Pain is usually unilateral and worse with turning in bed, getting out of bed, standing up from a seated position, or stepping up with the affected leg (stair and hill climbing), and often results in disturbed sitting patterns. It can be exacerbated by sexual intercourse but this is not specific to the sacroiliac joint. Pain is reported to increase during menstruation in women. Patients with severe and disabling sacroiliac joint dysfunction can suffer from insomnia and depression.

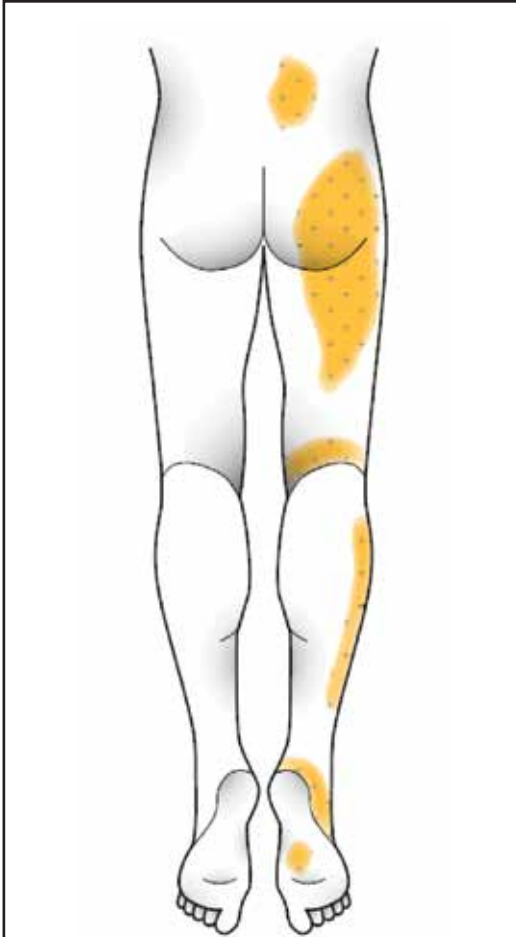
#### 4.2 Diagnosis

Diagnosis is established through patient history, physical examination, and other diagnostic tests (1-3,14,15,37-44).

History of prior trauma, prior lumbar fusion, prior pregnancy, or inflammatory arthritis is often reported. Differential diagnosis includes hip and lumbar spine (low back pain should be attributed to the lumbar spine until proven otherwise).

Physical exam is non-specific and no single test is considered diagnostic (1,3,41-44). The Fortin Test and provocative tests (Iliac Compression Test, Iliac Distraction Test, Thigh Thrust, Patrick's FABER Test, Gaenslen's Test) are 85% sensitive and 76% specific. For diagnostic purposes, positive results from 3 of 5 tests including Patrick's FABER Test, Gaenslen's Test, Distraction Test, Thigh Thrust, and Compression Test should be positive with inclusion of Iliac Compression Test or Thigh Thrust as shown in Fig. 2. In all the tests, pain along the typical area raises suspicion for sacroiliac joint dysfunction. Neurogenic weakness, numbness, or loss of reflex should alert clinicians to consider nerve root pathology. A new scale to diagnose sacroiliac joint instability that responds to prolotherapy has been recently co-developed and is undergoing validity and reliability testing (Whitmore-Gordons Sacroiliac Instability Tool) as shown in Table 2.

The current standard for diagnosis is sacroiliac joint injection confirmed under fluoroscopy or CT-guidance using controlled comparative local anesthetic or placebo-controlled blocks, with greater than 75% VAS reduction confirming the diagnosis (3).



**Fig. 1.** Illustration of pain referral patterns of the sacroiliac joint.

*Adapted and modified from: Fortin JD, et al. Sacroiliac joint: Pain referral maps upon applying a new injection/arthrography technique. Part I: Asymptomatic volunteers. Spine (Phila Pa 1976) 1994; 19:1475-1482 (35) and Fortin JD, et al. Sacroiliac joints: Pain referral maps upon applying a new injection/arthrography technique. Part II: Clinical evaluation. Spine (Phila Pa 1976) 1994; 19:1483-1489 (36).*

**Patrick's FABER Test**

*(flexion, abduction, external rotation test) The patient is in the supine position, and the examiner has the leg of the affected side bent at the hip and knee so that the foot is positioned just under the opposite knee. The examiner applies downward force on the knee to provoke the pain.*

**Gaenslen Test**

*(pelvic torsion test) The patient's affected side is placed at the edge of the exam table. The patient holds the unaffected limb pulling the flexed hip to the abdomen. The contralateral leg is allowed to hyperextend as it is permitted to move off the exam table towards the floor. Pain may then be expected to escalate on the affected side.*

**Distraction Test**

*(gapping test) The patient is placed in the supine position as the examiner moves to the affected side. The examiner applies pressure in a dorsolateral direction with both hands on the ipsilateral anterior superior iliac spine.*

**Thigh Thrust**

*(posterior shear test) The supine position is assumed by the patient and the examiner stands on the affected side. The patient places the hip in a 90 degree flexed position with slight adduction. A downward pressure is applied to the flexed knee to provoke the sacroiliac joint.*

**Compression/Approximation Test**

*The patient is placed in the lateral decubitus position with the painful side up and the hips and knees flexed at 45 and 90 degrees respectively. The examiner stands behind the patient and exerts a downward and medial force after placing both hands on the front side of the iliac crest so as to replicate/provoke pain.*



**Fig. 2.** Sacroiliac joint stress tests.

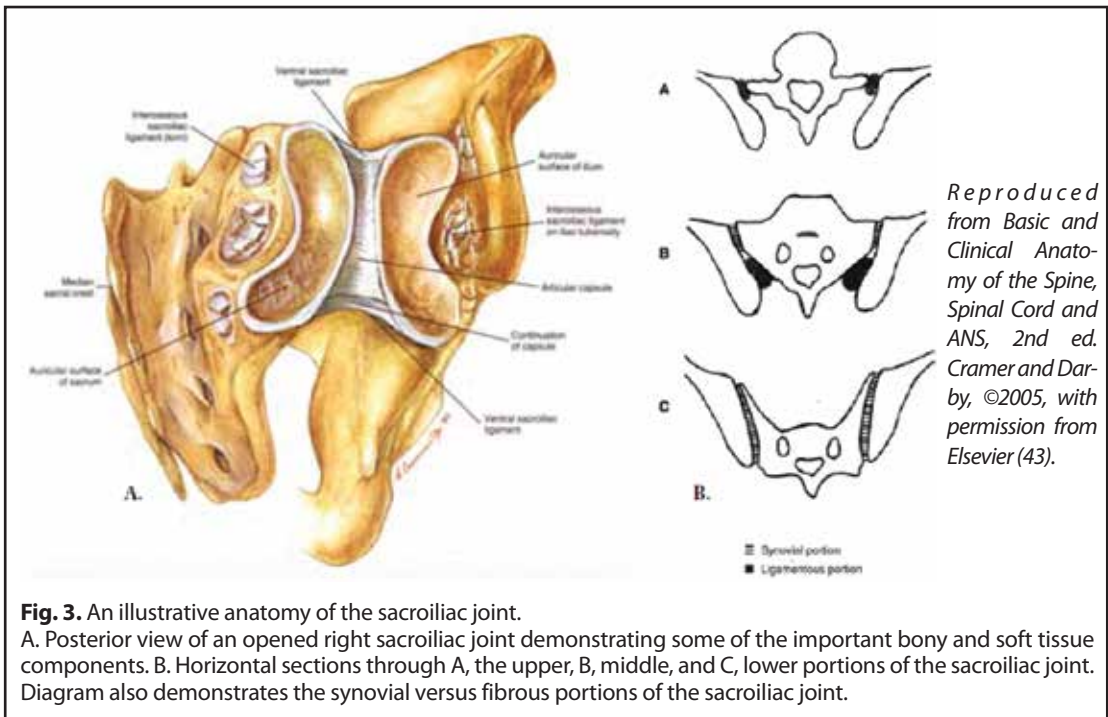
**Table 2.** Whitmore-Gordons Sacroiliac Instability Tool.

Please circle ONE number corresponding to the statement in EACH question that BEST describes your low back pain.						
Never	Rarely	Sometimes	Occasional	Often	Always	
0	1	2	3	4	5	1. I have pain in my buttock.
0	1	2	3	4	5	2. My back feels unstable.
0	1	2	3	4	5	3. I get pain (in the low back-buttock area) when I turn in bed.
0	1	2	3	4	5	4. I get pain (same area) when I get out of a low chair.
0	1	2	3	4	5	5. I get pains (same area) when I bend the leg up (such as to put on my sock).
0	1	2	3	4	5	6. I get pain (same area) when going up or down stairs.
0	1	2	3	4	5	7. I feel clicking/ clunking/ popping (same area) when I move.
8. I have had the following injuries to my low back:						
___ a) motor vehicle accident with foot on brake at time of impact (score as 5)						
___ b) fall on the same buttock or hip (score as 5)						
___ c) women: pregnancy-related pelvic pain (score as 5)						
___ c) men: unexplained pain (normal urology studies) referred into the testicle (score as 5)						
___ d) temporary relief with spinal manipulation or sacroiliac belt (score as 5)						
___ e) sports or work-related twisting-lifting injury—e.g., bowling, figure skating, etc. (score as 3)						
___ f) history of hypermobile “loose” joints (score as 2)						
Total Score						/60

**5.0 ANATOMY**

The sacroiliac joints are paired C-shaped or L-shaped diarthrodial synovial joints formed between the articular surfaces of the sacrum and the ilium bones, one on the left and one on the right (1,2,14,45). The joints are covered by two different kinds of cartilage; the sacral surface has hyaline cartilage and the ilial surface has fibrocartilage (Fig. 3). The sacroiliac joint is like a keystone designed to take compressive loads and transfer loads from the upper body to the lower body, acting as a shock

*Scoring: Preliminary data on consecutive patients suggests a score over 30 has a sensitivity of 85% and specificity close to 100% (with exclusion of fibromyalgia patients) in correlating with an unstable sacroiliac joint that would respond to the PRP prolotherapy treatment. (This is to be further studied with multivariate logistic stepwise regression analysis on a larger number of patients.)*



*Reproduced from Basic and Clinical Anatomy of the Spine, Spinal Cord and ANS, 2nd ed. Cramer and Darby, ©2005, with permission from Elsevier (43).*

**Fig. 3.** An illustrative anatomy of the sacroiliac joint. A. Posterior view of an opened right sacroiliac joint demonstrating some of the important bony and soft tissue components. B. Horizontal sections through A, the upper, B, middle, and C, lower portions of the sacroiliac joint. Diagram also demonstrates the synovial versus fibrous portions of the sacroiliac joint.



- ▷ Dorsal Posterior Sacroiliac Ligament
- ▷ Sacrotuberous Ligament
- ▷ Sacrospinous Ligament

The anterior ligament, in most cases, is just a slight thickening of the anterior joint capsule and not as well defined as the posterior sacroiliac ligaments. The dorsal interosseous ligaments are very short and strong ligaments that run perpendicular from the iliac surface to the sacrum, they keep the articular surfaces from abducting or opening/distracting. The long dorsal posterior sacroiliac ligaments run in an oblique vertical direction in a basket weave pattern. The sacrotuberous and sacrospinous ligaments (also known as the extrinsic sacroiliac joint ligaments) limit the amount the sacrum flexes.

### 5.2 Muscles

Many large and small muscles have relationships with the ligaments of the sacroiliac joint including the piriformis (piriformis syndrome is often related with sacroiliac joint dysfunction) rectus femoris, gluteus maximus and minimus, erector spinae, latissimus dorsi, thoracolumbar fascia, and iliacus.

### 5.3 Innervation

The sacroiliac joint is a pain-sensitive structure richly innervated by a combination of unmyelinated free nerve endings of the posterior primary rami of spinal segments L2-S3 (Fig. 5). The wide possibility of innervation may explain why pain originating from the joint can manifest in so many various ways, with different and unique referral patterns for individual patients (1,2,14,37,38,47-54). Cox and Fortin (47) described the anatomy of the lateral branches of the sacral dorsal rami and summarized the innervation as shown in Table 3 with the descriptions from various authors (48-54).

### 6.0 TECHNICAL CONSIDERATIONS

Appropriate preparation with monitoring, intravenous access, and sedation as required, are indicated. While physiological monitoring is required, intravenous access or sedation are optional and are based on medical necessity. Multiple techniques have been described (16-18,41-44,55-67).



**Fig. 5.** Neuroanatomical schematic in a previously instrumented spine at L5/S1, demonstrating the approximate locations of the L5 dorsal ramus and the sacral lateral branch which contribute to the majority of posterior sacroiliac joint innervation.

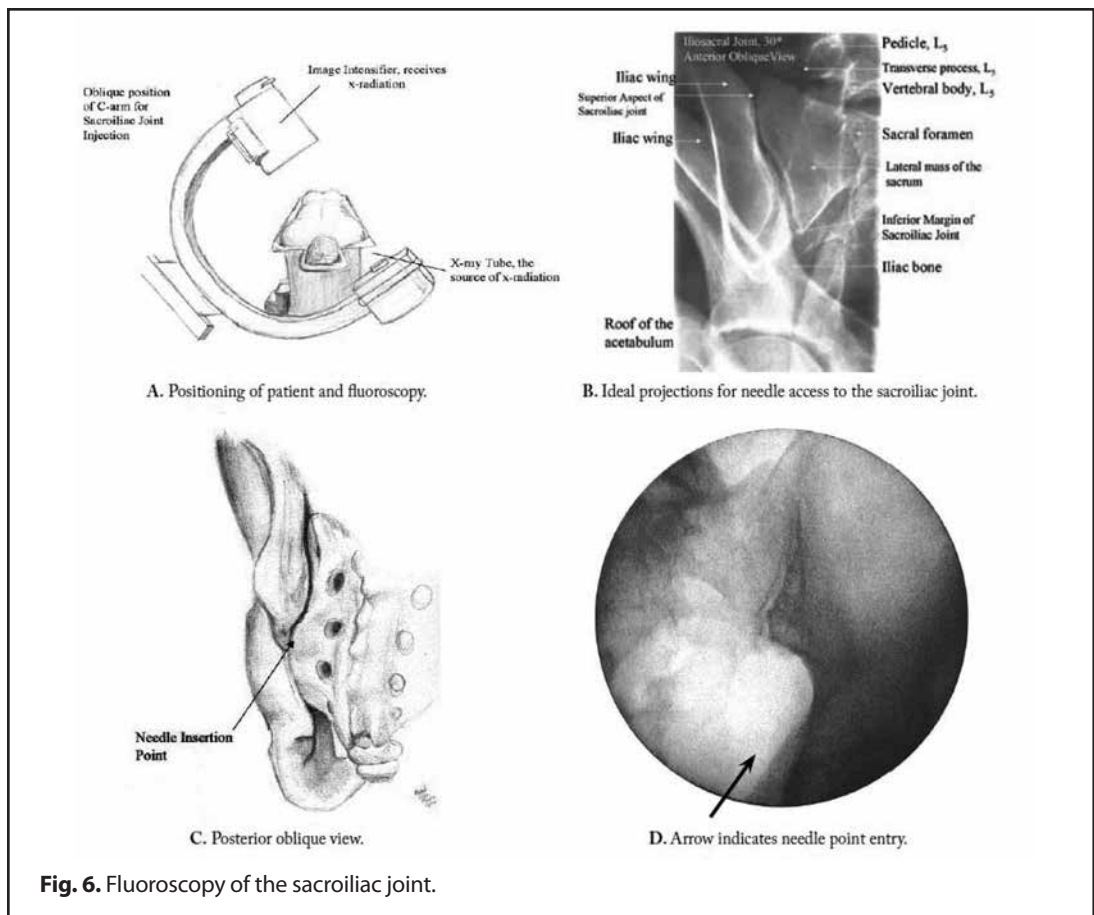


**Table 3.** Studies of sacroiliac joint innervation.

Author	Dorsal Rami Contribution	Ventral Rami Contribution	L5 Contribution
Solonen (46), 1957	S1 and S2	Yes (L4, L5 and S1)	Yes
Ikeda (47), 1991	L5, S1-S4	Yes (L5 and S2)	Yes
Grob et al (48), 1995	S1-S4	No	No
Yin et al (52), 2003	L5, S1-S3	Not studied	Yes
McGrath and Zhang (49), 2005*	S2-S4	Not studied	Not studied
Szadek et al (50), 2008†	Not studied	Yes(L4 and L5)	Yes
Willard et al (51), 2010	L5, S1-S4	Not studied	Yes

\*McGrath and Zhang (49) studied the innervation to the long posterior sacroiliac ligament only.

†Szadek et al (50) studied the innervation to the anterior sacroiliac ligaments.



### 6.1 Classic Technique

The patient is positioned prone. A lateral position with the affected joint superiorly may be used if the patient is unable to lie in prone position.

A sterile technique must be applied. Positioning and radiographic anatomy of the sacroiliac

joint are illustrated in Fig. 6. The sacroiliac joint is difficult to enter consistently. The difficulty arises because the joint does not present a single radiographic silhouette of its articular cavity (37). The joint is sinuous, both in caudocephalad direction and in a dorso-ventral direction (66).

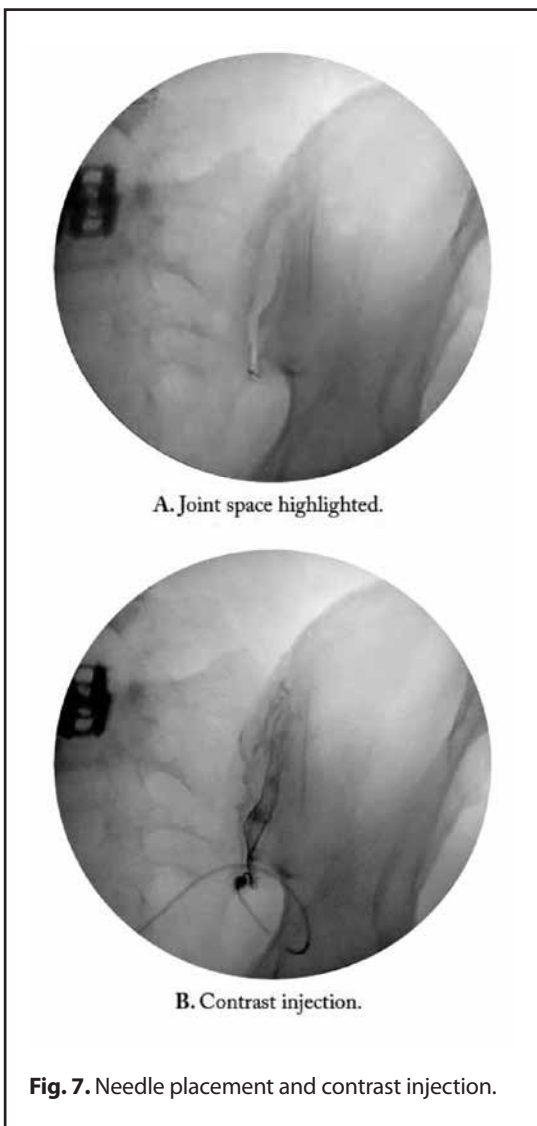
When viewed radiographically from behind, the joint presents multiple lines and shadows that represent its articular surfaces, but these lines are 2-dimensional projections of a sinuous 3-dimensional structure. Lines and spaces that may be evident may be located ventrally in the joint and overlaid by bone posteriorly, which prevents access to the apparent space (37). Thus, selecting a target point for entry into the joint involves an exercise, both in interpreting these multiple shadows correctly, and in obtaining a view of the joint in which the required target point is not overlaid by bone. When multiple

lines are seen, the medial lines indicate the posterior or dorsal joint margin, whereas lateral lines indicate ventral or anterior joint margins.

Under image intensifier control, a 25- or 22-gauge, 3.5-inch spinal needle is directed into the inferior aspect of the sacroiliac joint using a posterior approach. The usual border of entry is the inferior one-third of the joint. There is often a lucency in the inferior aspect of the joint, which allows the least resistance upon needle passage. There may be 2 or more “limbs” of the joint, because the joint is laterally divergent from its posterior to anterior borders and has interdigitations. In this instance, the border has interdigitations, wherein the medial or posterior division is the most amenable to needle placement (55).

If the inferior aspect of the joint cannot be entered, the joint is accessed through the deeper, more rostral aspect of the joint. Rotating the C-arm side to side in an axial plane will permit a better 3-dimensional perspective of the joint and enable selection of the “window” for optimal needle trajectory. With few exceptions, a direct posterior approach is used (42). Once the dorsal sacroiliac and interosseus ligaments are engaged, the needle often takes a characteristic bend because it conforms with the interdigitating contours of the diarthrodial joint. This phenomenon is often preceded by a subtle tactile sensation of a ‘giving away’ or loss of resistance as the needle penetrates through the ligaments to enter the joint.

If bony resistance is met after the ligaments are engaged and the needle is not yet within the joint margin, the needle should be withdrawn slightly without becoming disengaged. Subsequent needle advancement, while simultaneously rotating it around its own longitudinal axis, will allow it to deflect and conform to the joint margins. Once the needle has entered the joint space, intraarticular placement is confirmed with an injection of contrast medium. If the needle has been correctly placed, injection of the contrast medium will outline the joint space. Only a minimum volume of contrast medium (0.3 mL to 0.5 mL) is required to establish intraarticular injection. As shown in Fig. 7, in posteroanterior view, the contrast medium should be seen to travel cephalad along the joint line. In lateral views, the contrast medium most densely outlines the parameter of the joint.



**6.2 Technique Without Oblique Angulation**

Sacroiliac joint injection may be performed without angulation with the C-arm positioned in straight anteroposterior (AP) view. Khuba et al (56) assessed fluoroscopic sacroiliac joint injection without oblique angulation and lack of necessity of oblique angulation. They successfully injected 60 sacroiliac joints of 58 patients under AP fluoroscopic view. Seventy percent of sacroiliac joints were seen as 2 separate medial and lateral joint spaces and were entered in distal 1 cm of the medial joint space. In 30%, the joints were seen as straight line rather than two separate spaces, so the image intensifier of the fluoroscopy was tilted cran-

nially to elongate the image of the lower part of the posterior sacroiliac joint and then the sacroiliac joint was entered in its distal 1 cm.

Technique was as follows: The patients were positioned prone on the operating table. First an AP image of the respective SI joints was taken. If the AP image showed the anterior and posterior joint spaces as separate lateral and medial joint lines, respectively (Fig. 8A), then the lower part of medial joint line was entered with a 22 G, 10 cm spinal needle under a gun barrel view with the fluoroscope (Fig. 8B). The distal end of the spinal needle was slightly bent so as to facilitate easy manipulation of the needle into the joint space. If the SI



A. AP view showing separate A) posterior joint and B) anterior joint.



B. Needle with contrast in SI joint.

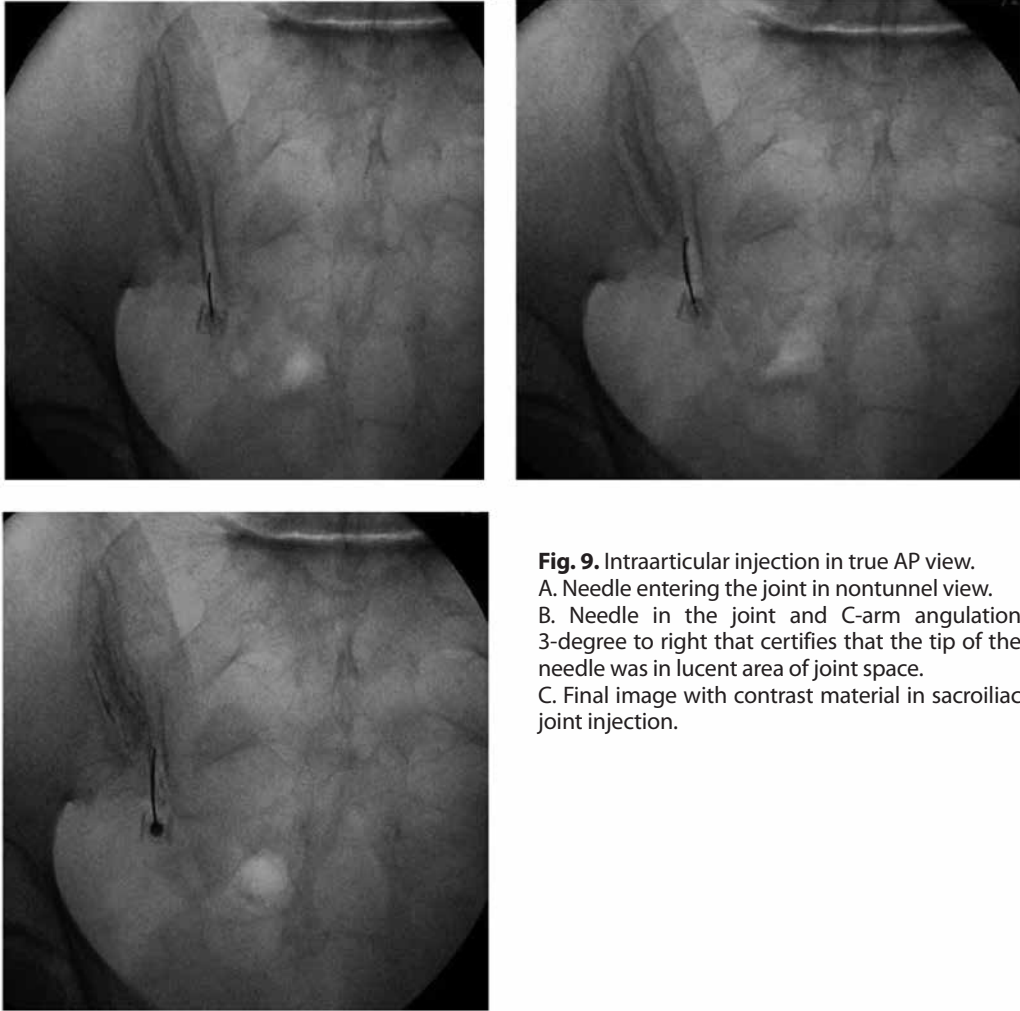


C. SI joint seen as single in AP view.



D. Needle with contrast in AP view.

**Fig. 8.** Illustration of sacroiliac joint injection without oblique angulation.



**Fig. 9.** Intraarticular injection in true AP view.  
A. Needle entering the joint in nontunnel view.  
B. Needle in the joint and C-arm angulation 3-degree to right that certifies that the tip of the needle was in lucent area of joint space.  
C. Final image with contrast material in sacroiliac joint injection.

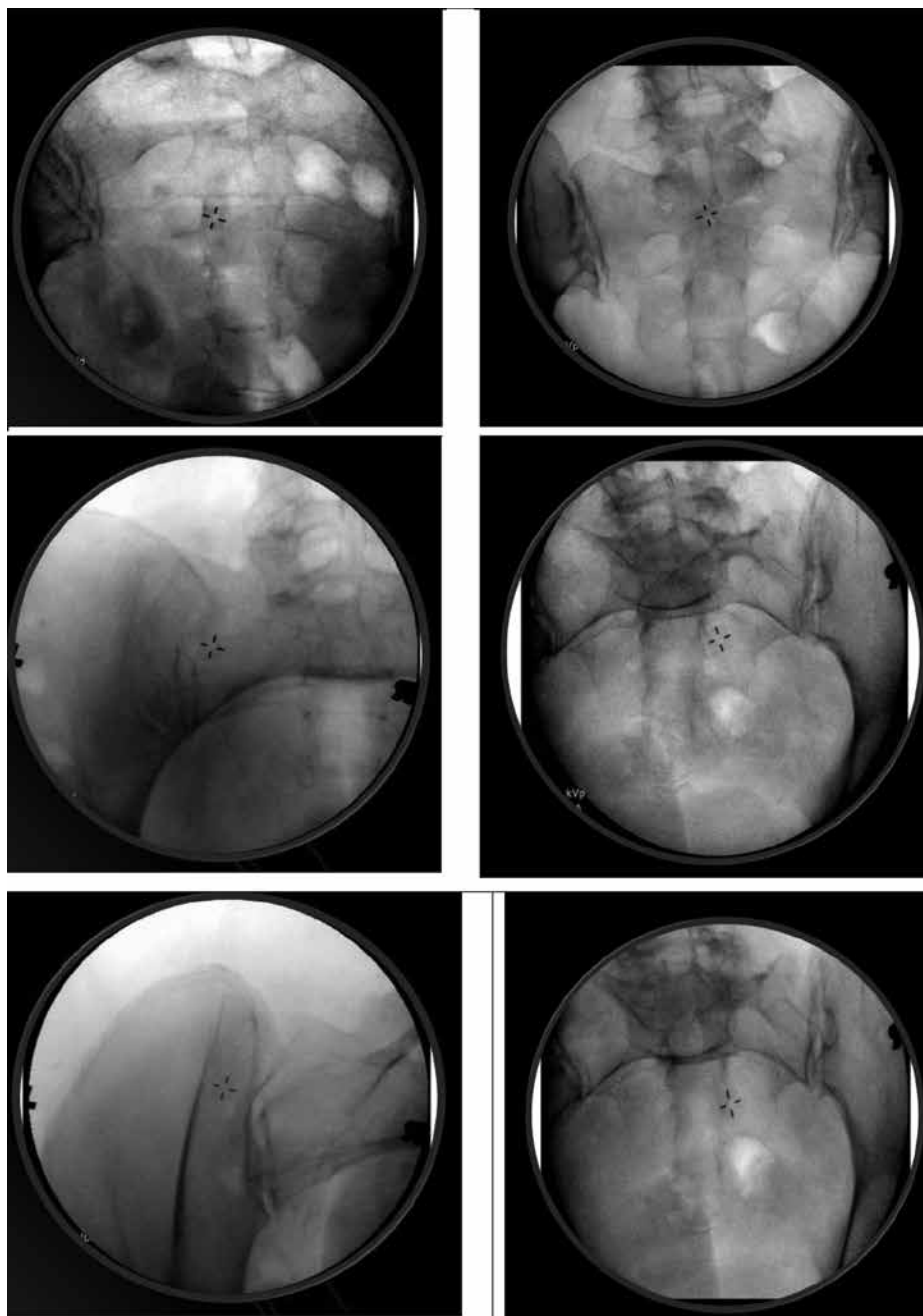
joint was seen as a straight line rather than 2 joint spaces in the AP view (Fig. 8C) then the image intensifier of the fluoroscope was tilted cranially to elongate the image of the lower part of the posterior sacroiliac joint thus facilitating entry into the posterior SI joint space. This was confirmed by administering 0.3 to 0.5 mL of radiopaque contrast medium (Omnipaque 240) and seeing contrast flow in the superior or anterior part of the joint (Fig. 8D). Following confirmation of the contrast in the sacroiliac joint, injection was administered into the joint.

With this technique, the procedure is performed in an AP view without C-arm angulation. The ac-

curacy of the intraarticular injection is confirmed by using intraarticular contrast material. The authors report a successful intraarticular contrast spread in all sacroiliac joint injections. Figure 9 shows intraarticular injection in true AP view.

### 6.3 Benjamin Technique

Benjamin (57) described an alternate technique to enter the sacroiliac joint under fluoroscopic guidance. However, the technique or results have not yet been published. The technique is as follows: the procedure is started with straight AP fluoro positioning as shown in Fig. 10 (A1 and A2) showing 2 different cases. Following this, the fluo-



**Fig. 10.** Benyamin’s technique: Positioning and exposure of joint.

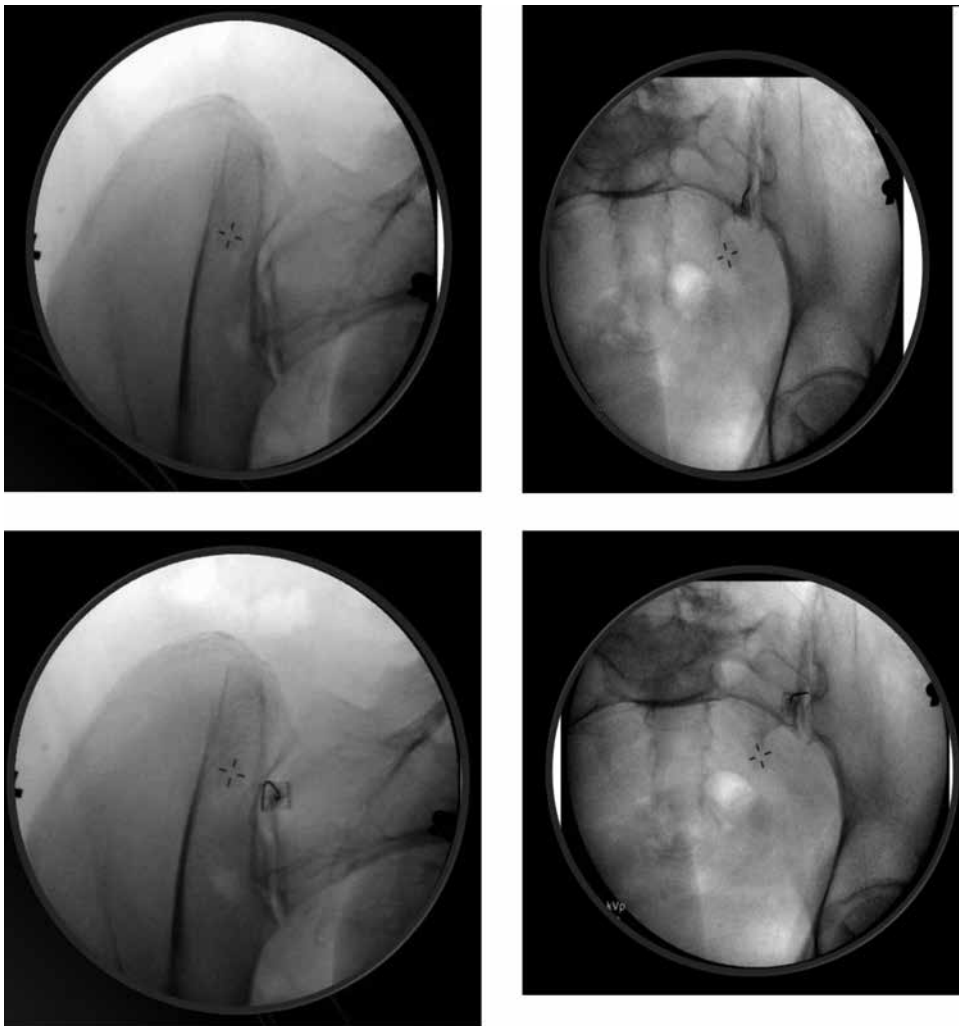
Top left: Straight AP fluoro position: 2 different cases. Top right: Straight AP fluoro position: 2 different cases. Middle left: Straight AP fluoro position: 2 different cases. Tilt fluoro caudally (instead of the traditional cephalad tilt) until the bony ridges of sacrum and iliac present as a contiguous line. Middle right: Straight AP fluoro position: 2 different cases. Tilt fluoro caudally (instead of the traditional cephalad tilt) until the bony ridges of sacrum and iliac present as a contiguous line Bottom left: Rotate the fluoro to contralateral oblique until a lucency appears at mid-point of the joint. Bottom right: Rotate the fluoro to contralateral oblique until a lucency appears at mid-point of the joint.

roscopy is tilted caudally instead of the traditional cephalad tilt until the bony ridges of the sacrum and ilium present as a contiguous line (Fig. 10 B1 and B2). Following this, fluoro is rotated to contralateral oblique until a lucency appears at midpoint of the joint (Fig. 10 C1 and C2).

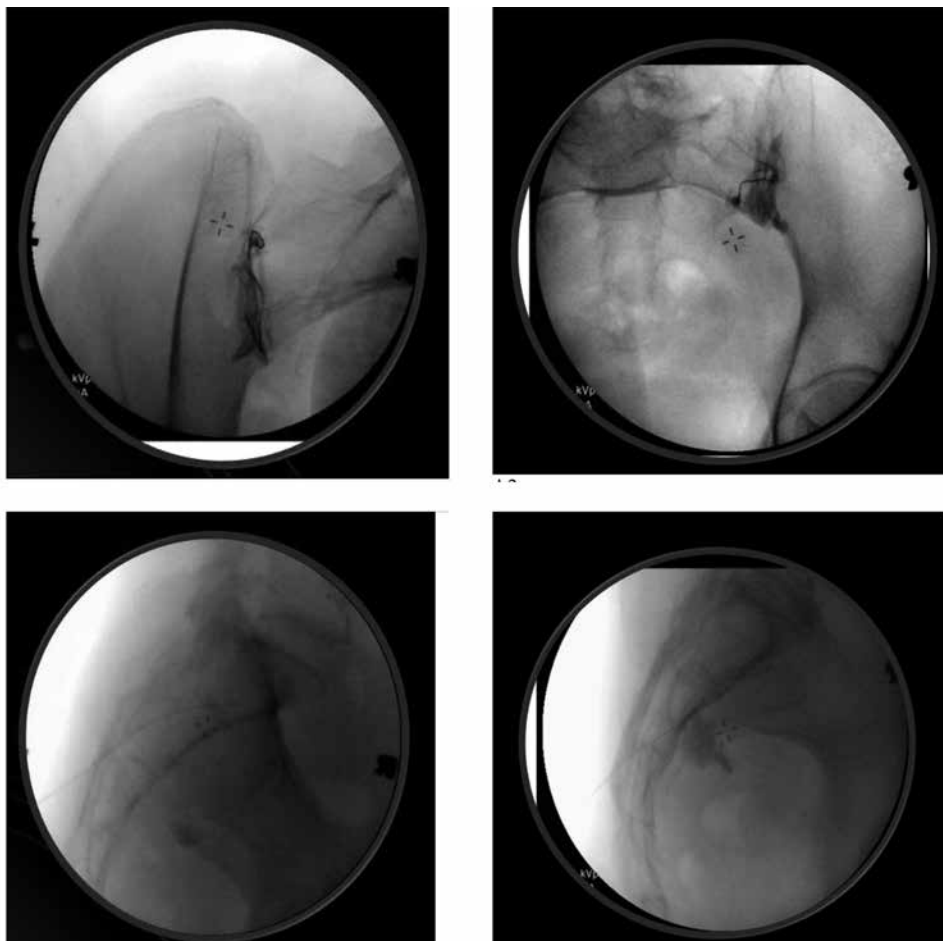
As shown in Fig. 11 A1 and A2, lucency is seen at the midpoint of the right sacroiliac joint. After confirmation of lucency at midpoint of the sacroiliac joint, the needle is placed into the lucent

spot using the tunnel vision and it is advanced deeply into the joint as shown in Fig. 11 B1 and B2 (57).

The next step is to inject contrast after confirming the needle position with its deep placement as shown in Fig. 12 A1 and A2. As shown in Fig. 12 B1 and B2, lateral fluoroscopic view further confirming correct needle placement and any leakages as seen with right sacroiliac joint injection in Fig. 12 B2 (57).



**Fig. 11.** Benjamin's technique: Final positioning with needle placement. Top. Lucency seen at mid-point of right SI joint Bottom: The needle is placed into the lucent spot using the tunnel vision and is advanced deeply into the joint.

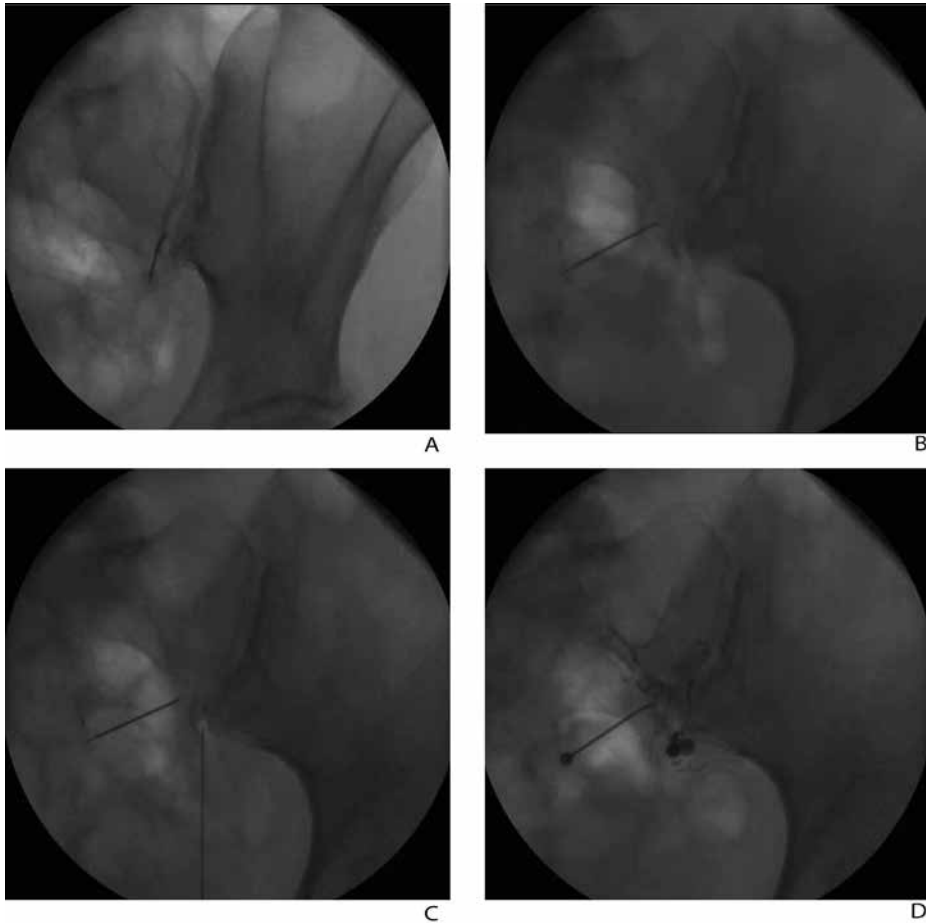


**Fig. 12.** Benyamin's technique: Final positioning and contrast injection. Top: Once the needle is embedded deep in the joint, a small volume of contrast is injected to confirm intra-articular needle placement. Bottom: Lateral fluoroscopic view further confirming correct needle placement (and in the case on right: small anterior leakage of contrast resulting from anterior SI ligament damage)

#### 6.4 Double Needle Technique

Gupta (58) described an alternate double needle technique. After obtaining appropriate fluoroscopic images, the tip of a 3.5-inch long, 22-gauge curved tip spinal needle is advanced into the SIJ (Fig. 13). Once the tip of the needle is correctly placed, its position is checked under continuous fluoroscopy while moving the C-arm in the right and left oblique directions (dynamic fluoroscopy). On dynamic fluoroscopy, the tip of the needle should remain within the joint line and not appear to be on the bone. If the tip of the needle appears to be on the bone (Fig. 13B), a new joint line will

need to be identified (the most translucent area through the joint) by dynamic fluoroscopy and another needle advanced into the newly identified joint line (Fig. 13C). Dynamic fluoroscopy is repeated again to confirm that the tip of the second needle remains in the joint line. Once both needles are in place, contrast is injected through the needle that is most likely to be in the joint (Fig. 13D). If the contrast dye spread is not satisfactory, then contrast is injected through the other needle. I (JAC) have found this technique very helpful in accurately performing an SIJ injection, which can at times be challenging.



**Fig. 13.** SI joint injection technique as described by Gupta (56). A. A curved tip needle is advanced into the right sacroiliac joint. B. On dynamic fluoroscopy the tip of the needle appears to be on bone rather than in the joint. C. On dynamic fluoroscopy another translucent joint is identified and a second needle is advanced into the joint. D. Contrast is injected through the first needle which shows contrast spreading medially – possibly a vascular spread.

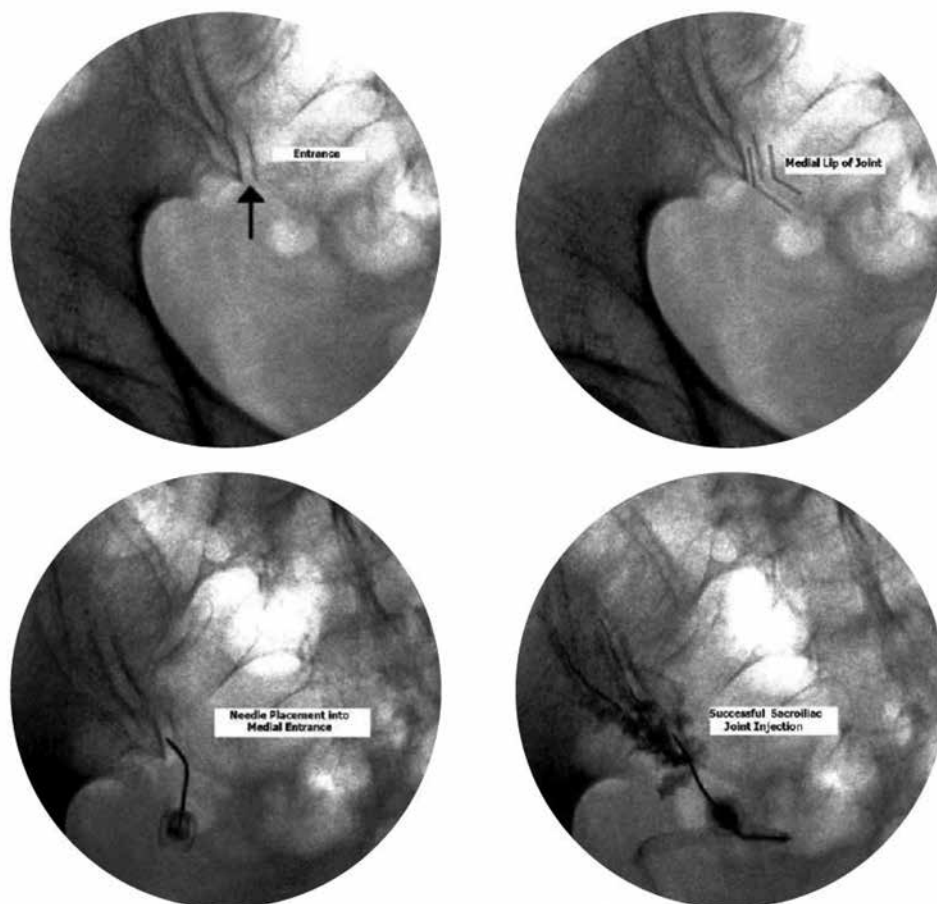
Source: Gupta S. Double needle technique: an alternative method for performing difficult sacroiliac joint injections. *Pain Physician* 2011; 14:281-284 (56).

### 6.5 Modified Technique by Daitch et al

Daitch et al (59) described a modified sacroiliac joint injection technique. To aide in penetrating the potentially thick capsule in the lowest portion of the joint, it is recommended to use a 22-gauge spinal needle with a slight bend at the tip. The curved tip enhances maneuverability during the entry phase while the 22-gauge size is more easily manipulated once the joint is penetrated. The C-arm is positioned in a PA projection with slight cephalocaudal tilt and an oblique view 5 degrees

ipsilaterally. The C-arm is then adjusted until the medial view of the sacroiliac joint line is clearly visible (Fig. 14A). Once the medial joint line is identified, the C-arm is maneuvered until the medial lip of the joint and the edge of the sacrum are clearly identified (Fig. 14B). Obtaining a clear view of this junction significantly improves success rate. The 22-gauge needle is guided into the most inferior and medial aspect of the sacroiliac joint (Fig. 14C). The joint is most easily accessed if the needle entry is slightly inferior to this aspect





**Fig. 14.** Modified sacroiliac joint injection techniques as described by Daitch et al (57). a. Medial view of the sacroiliac joint line. b. Medial tip of the joint and edge of the sacrum. c. A 22-gauge needle guided into the most inferior and medial aspect of the sacroiliac joint. d. Flow of contrast into medial and lateral sacroiliac joint lines.

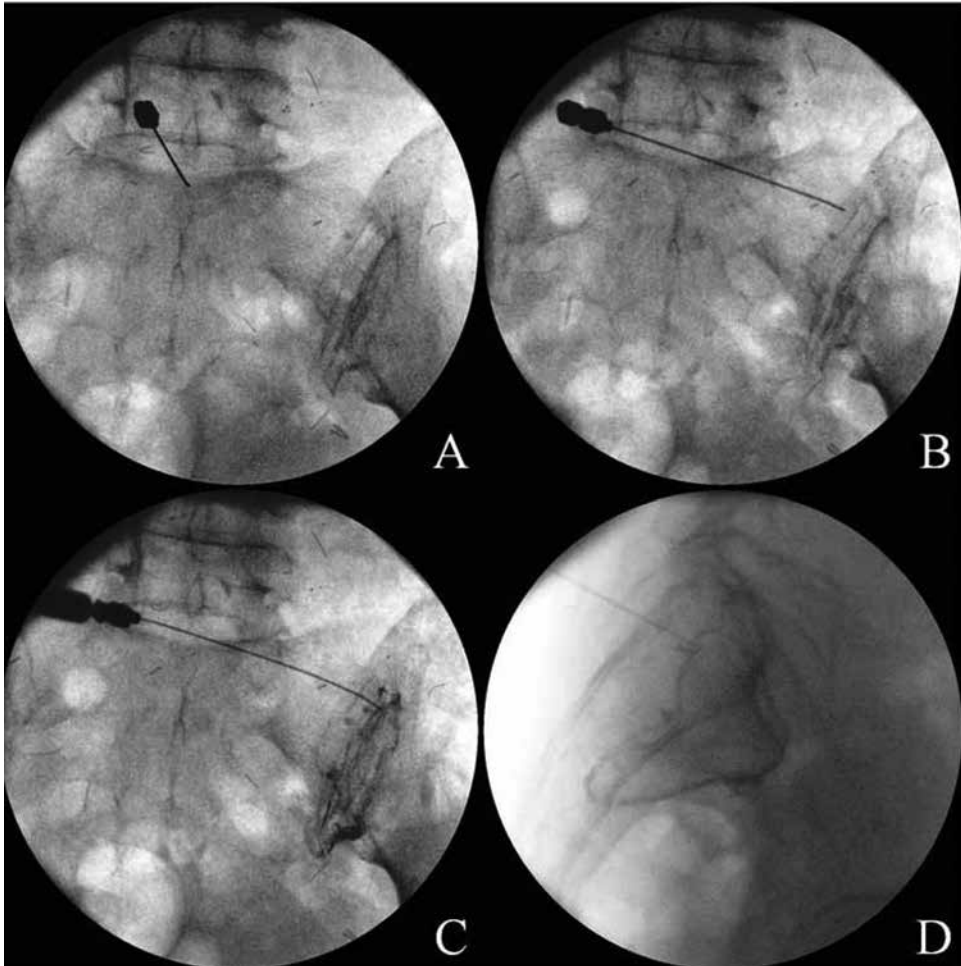
*Reproduced from Daitch et al (57) with permission from the authors and the American Society of Interventional Pain Physicians.*

and guided upward into the base of the joint. Figure 14D shows the flow of contrast into both medial and lateral sacroiliac joint lines. The authors claim that this technique usually allows entry of the sacroiliac joint in less than 30 seconds. The key elements of this approach are entering the medial aspect of the joint and obtaining a clear view of the edge of the sacrum.

### 6.6 Upper One-Third Joint Injection

Multiple techniques have been described for entering the sacroiliac joint and placement of the

injectate. However, the majority of the techniques are limited to middle third and lower third, with lower one third joint technique being the most commonly used method. Consequently, it is also important to focus on multiple other techniques and also reach the upper third of the joint space. Park et al (60) described the following a technique: “The patients were prepared in a prone position with a pillow under the abdomen. The procedure area was prepared and draped in the usual sterile fashion. Before insertion of the needle, the subcutaneous tissue was infiltrated with 1% lidocaine in



**Fig. 15.** The upper one-third joint technique for fluoroscopically guided sacroiliac joint injection.

A. Note the placement of the needle in the midline of the L5-S1 interspinous space.

B. The needle directed toward the SIJ.

C. Injection of the contrast material spread throughout the SIJ in an superior to inferior fashion.

D. In lateral fluoroscopic view, the contrast material reached lower one-third joint.

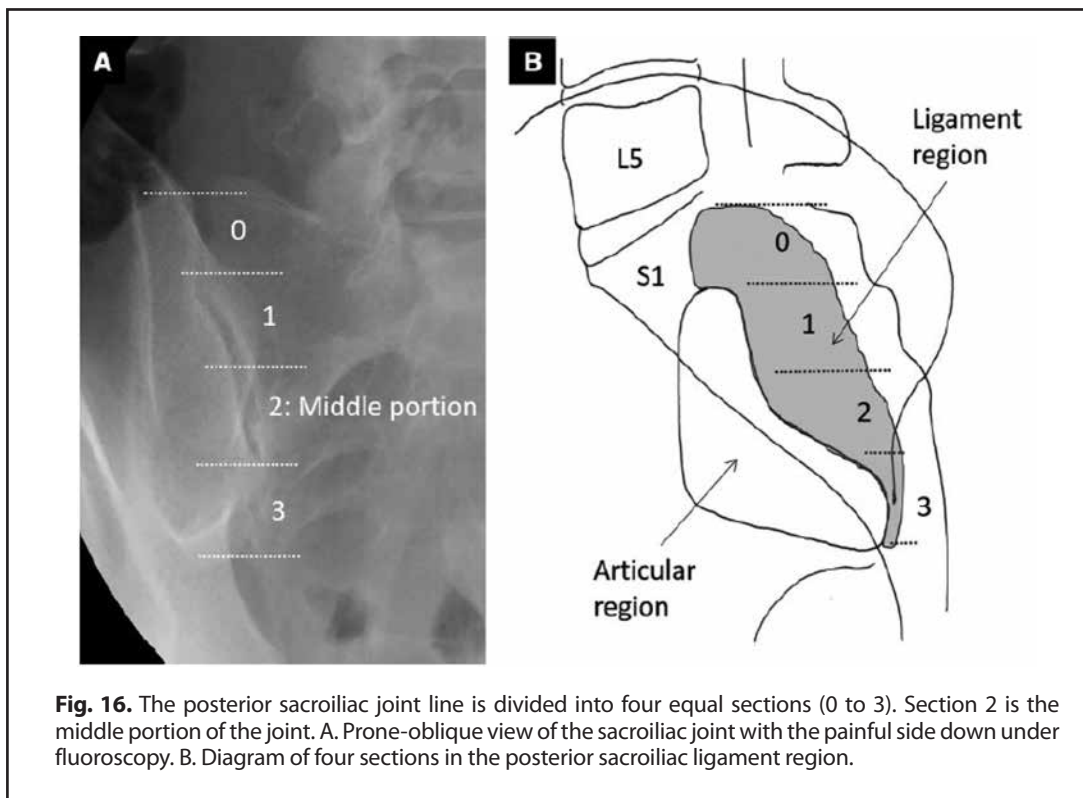
Source: Park J, Park HJ, Moon DE, et al. Radiologic analysis and clinical study of the upper one-third joint technique for fluoroscopically guided sacroiliac joint injection. *Pain Physician* 2015; 18:495-503 (58).

the midline of the L5-S1 interspinous space. A 10 cm long, 22-gauge curved-tip spinal needle was advanced into the skin and directed towards the upper one-third joint at about a 45° angle. As the needle hit a firm tissue on the silhouette of the iliac crest in the AP fluoroscopic view, we could distinguish between the sacrum and the iliac crest by rotating the curved needle. The curved-tip needle was advanced beyond the line of the iliac crest until the needle reached the joint with a pop sensa-

tion. The intraarticular position was confirmed by injecting 0.2 – 0.5 mL contrast material through the needle. The injected contrast material spread throughout the SIJ in a cephalocaudal fashion. After the contrast material outlined the SIJ without vascular runoff, a solution of choice may be injected (Fig. 15)."

### 6.7 Injection of the Middle Portion of the Joint

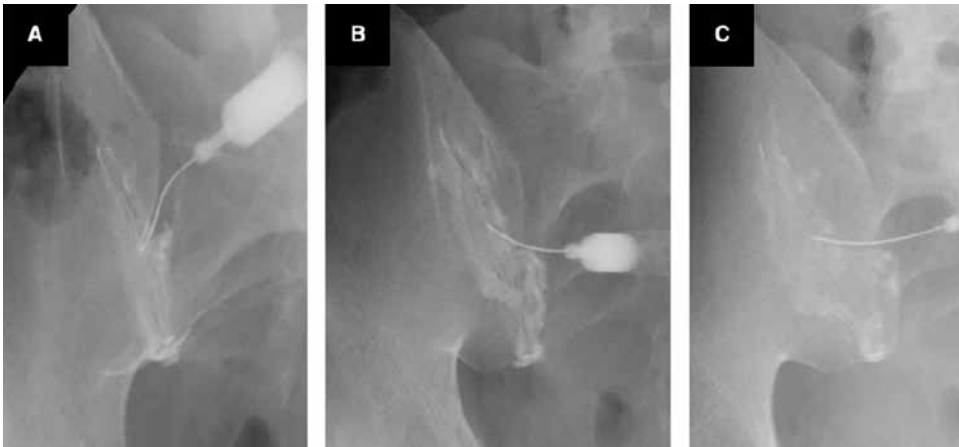
As described earlier, the majority of injections



are performed into the lower third of the sacroiliac joint. However, Kurosawa et al (61) have described fluoroscopy-guided sacroiliac intraarticular injections via the middle portion of the joint as well. Injection of the middle portion of the joint was also described by Benyamin (57) and Ikeda et al (62). Potentially injection of lower third may be difficult and also may not reach the entire joint space. Consequently, targeting the middle third of the joint may be advantageous. Kurosawa et al (61) described this technique in 69 consecutive patients showing an 80% success rate of entering the joint. Further, in 20 cases where this technique was unsuccessful, the conventional method was also unsuccessful in 17 of these cases. The described technique of Kurosawa et al (61) is as follows: “Patients are positioned prone on the fluoroscopy table. With the patient lying prone-oblique with the painful side down on a fluoroscopy table, the posterior sacroiliac joint line is divided into four sections (Fig. 16). After administering local anesthetics at the needle entry point, a 23-gauge or 22-gauge, 90-mm straight spinal needle is inserted

into the middle portion of the joint. The needle is advanced nearly perpendicular to the fluoroscopic beam angle. After the needle is inserted and advanced until the bone tissue, the fluoroscopy tube was angled at a caudal tilt of 25–30°. The image clearly showed the recess between the ilium and sacrum. The needle direction could be adjusted under fluoroscopic guidance to the obviously detected posterior margin of the joint. When the needle is advanced until it reached the ilium bone wall in the middle portion, contrast medium was injected. However, because of the presence of ilium cartilage, the tip of the needle was occasionally blocked; the needle, then, had to be slightly retracted while simultaneously injecting the contrast medium. This slight retraction allowed the contrast medium to flow freely into the joint cavity. After the joint was outlined by contrast medium, injectate is placed (Fig. 17).

Depending on the needs of each case, the retro-oblique view was useful for confirming whether the needle tip had reached into the middle portion of the joint. When the needle tip did not insert into



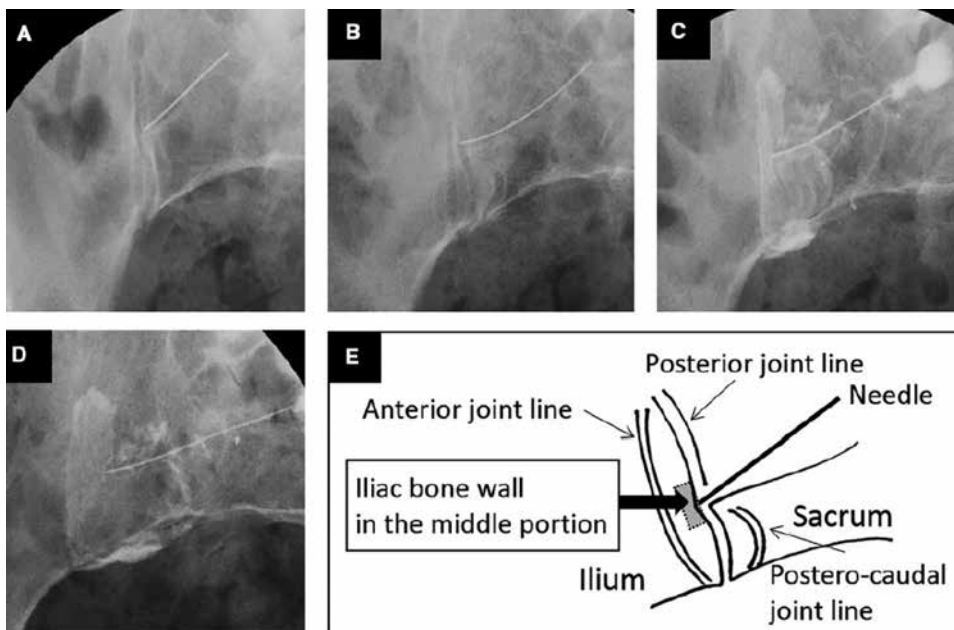
**Fig. 17.** Injection of contrast medium to outline the joint. A. Injection of contrast medium with the fluoroscopic tube angled caudally at 25–30°. The contrast medium outlines the joint. B. Posteroanterior view after contrast medium injection. C. Contra-oblique view. The needle is inserted into the joint via the middle portion.

the posterior margin of the joint with the posterior and anterior joint lines superimposed, we rotated the patient's body in the retro-oblique direction, such that the anterior and posterior joint lines were separated, to confirm that the needle tip had reached the ilium bone line in the middle portion of the joint (Fig. 18).

### 6.8 Modified Technique with Lateral Projection

Multiple techniques have been described utilizing AP view and oblique views. The lateral view is underutilized. Kasliwal and Kasliwal (63) described a modified technique that uses the lateral view to create a 3-dimensional view of the sacroiliac joint to aid in gauging the accurateness of the contrast spread and to obtain a precise block. They also proposed that the contrast medium most densely outlines the parameter of the joint in the lateral view in contrast to AP view wherein the joint space is outlined with contrast traveling cephalad along with the joint line. They described that out of 30 cases, needle position and contrast spread was satisfactory in 28 cases. The described technique by Kasliwal and Kasliwal (63) is as follows: "The patients are positioned prone on the fluoroscopic table. The injection site is prepared and draped using sterile technique. The fluoroscopy tube is started in the PA view, angled cephalad to focus the beam downward on the lower

part of the sacroiliac joint, and rotated toward the contralateral oblique view (0 – 30°) until a clear view of the sacroiliac joint is obtained, such as to visualize the widest space at the most inferior aspect of the sacroiliac joint. The C-arm is angled in such a way that the silhouettes of the posterior and the anterior aspects of the sacroiliac joint are seen to overlap and the hyper lucent area noted between the joint lines (Fig. 19B). The target area for the SIJ is the inferior third lucent area. If the anterior (lateral silhouette) and posterior (medial silhouette) lines of the joint appear divergent, the posterior border is selected for cannulation. After obtaining appropriate fluoroscopic images, the injection site was marked and anesthetized using local anaesthesia. A 23-gauge, 3.5-inch long, curved tip spinal needle was directed into the inferior aspect of the sacroiliac joint using a posterior approach. As the needle contacts firm tissues on the posterior aspect of the joint, it should be maneuvered through the ligaments and capsule into the joint which gives a subtle tactile sensation of a 'giving away' or loss of resistance. Then a needle is advanced by about 5 mm, usually by angling the needle tip slightly laterally and cephalad to follow the natural curve of the joint. After the tip of the needle has reached the target zone, the oblique views (ipsilateral and contra lateral) are used to ensure that the needle



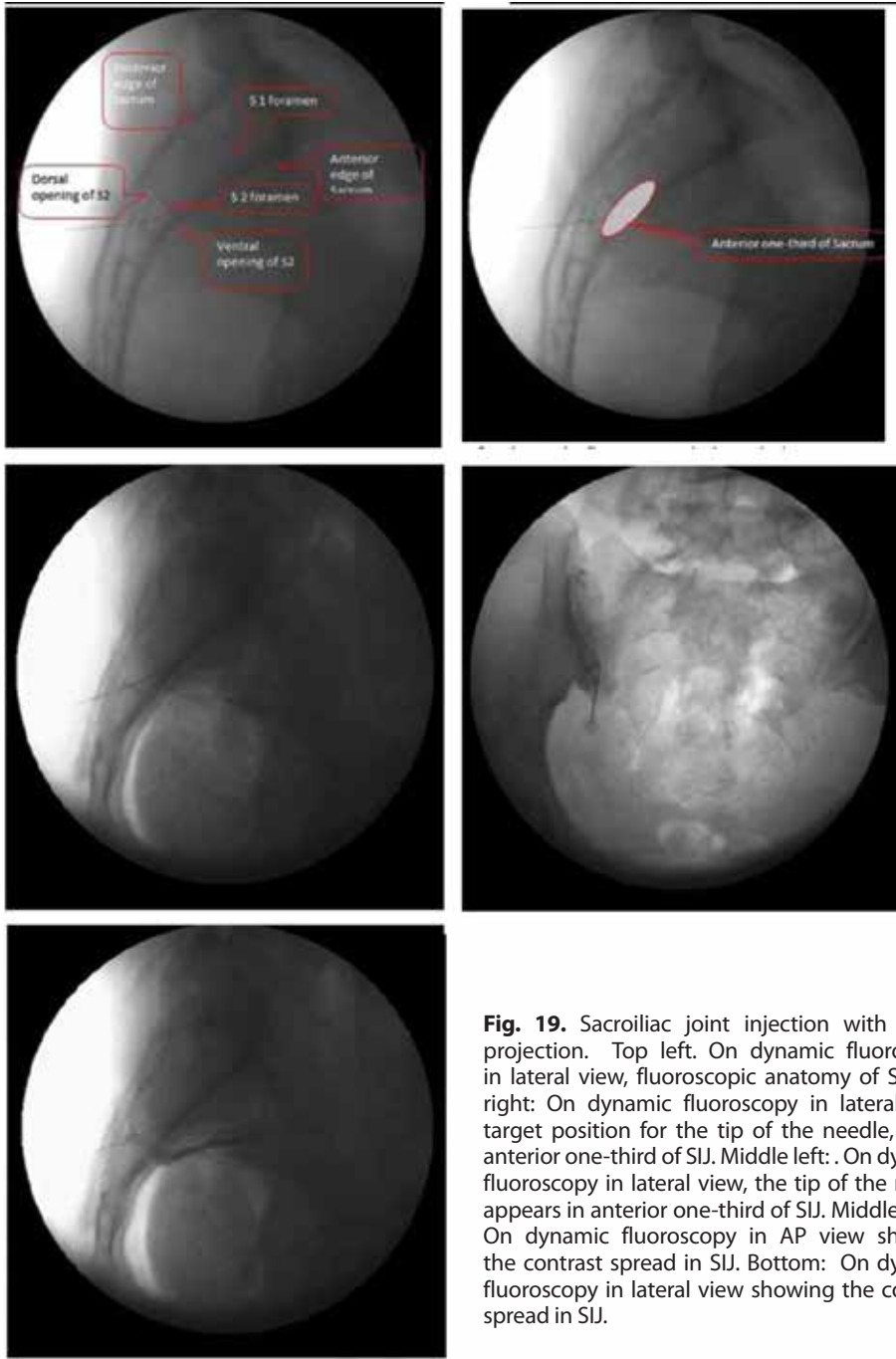
**Fig. 18.** Retro-oblique view technique. A. Image shows the patient lying prone-oblique with the painful side down and with the fluoroscopic tube angled caudally at 30°. The posterior and anterior joint line are superimposed. The needle seems to be blocked and cannot reach the posterior margin of the joint. B. Radiograph after rotating the patient’s body in a retro-oblique direction shows separation of the anterior and postero-caudal joint lines. Usually, the anterior joint line comes to be observed laterally and postero-caudal joint line moves medially. It can be confirmed that the needle tip has access to the ilium bone line beyond the sacrum boundary in the middle portion. C. Radiograph displays contrast medium outlining the joint. Initially, the needle is advanced until it reaches the ilium bone wall. Subsequently, the needle is slightly retracted while contrast medium is simultaneously injected. This slight retraction allows the contrast medium to flow freely into the joint cavity. D. Radiograph displays the contra-oblique view. The needle has been inserted into the joint via the middle portion. E. Diagram of the retro-oblique view technique.

is placed within the joint space and this is visible in different views. The tip of the needle should appear between the joint lines in the joint space and not seem to be on the bone. Then the position of the needle tip is checked using lateral fluoroscopy. In the lateral view, the needle tip position is checked and manipulated to keep it at or above the S2 foramen ventral opening and in the anterior one-third of the sacroiliac joint. If the needle tip is below the S2 level, the needle is withdrawn 5 – 10 mm, angled cephalad, and advanced again to reach the S2 level or above. Once the needle is in place, contrast is injected through the needle (Fig. 19C). In a PA view, the

contrast travels cephalad along the joint line and spreads throughout the sacroiliac joint in an inferior to superior fashion (Fig. 19D). In the lateral view, the contrast spread will be flask shaped as shown in Fig. 19E and densely outlines the sacroiliac joint’s anterior, posterior, inferior, and sometimes superior border.”

### 6.9 True Anteroposterior View

Taheri et al (67) described a technique without posterior angulation similar to the technique in true AP view similar to the technique described by Khuba et al (56) without oblique angulation.



**Fig. 19.** Sacroiliac joint injection with lateral projection. Top left. On dynamic fluoroscopy in lateral view, fluoroscopic anatomy of SIJ. Top right: On dynamic fluoroscopy in lateral view, target position for the needle, i.e., in anterior one-third of SIJ. Middle left: . On dynamic fluoroscopy in lateral view, the tip of the needle appears in anterior one-third of SIJ. Middle right: On dynamic fluoroscopy in AP view showing the contrast spread in SIJ. Bottom: On dynamic fluoroscopy in lateral view showing the contrast spread in SIJ.

## 7.0 CONCLUSION

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PRP and stem cell injections can potentially represent a viable treatment option for sacroiliac joint pain. Double blind randomized controlled trials (RCTs) have shown both PRP and Prolotherapy to be effective in treating varying regions of the body. It is therefore reasonable to consider that PRP could be similarly effective in treating pain related to the sacroiliac joints. At the very least, PRP is autologous and has limit-

ed side effects other than a temporary increase in pain. Further investigation with RCTs, larger patient numbers, and longer follow up periods are needed.

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This chapter includes portions from a previous book chapter from the Hansen et al chapter from 2007 (1) with permission from ASIPP Publishing.

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