Three Pathways between the Sacroiliac Joint and Neural Structures

Joseph D. Fortin, William J. Washington and Frank J. E. Falco

AJNR Am J Neuroradiol 1999, 20 (8) 1429-1434
http://www.ajnr.org/content/20/8/1429

Three Pathways between the Sacroiliac Joint and Neural Structures

Joseph D. Fortin, William J. Washington, and Frank J. E. Falco

BACKGROUND AND PURPOSE: **Despite ongoing clinical suspicion regarding the relationship between sacroiliac joint (SIJ) dysfunction and lower extremity symptoms, there is a paucity of scientific literature addressing this topic. The purpose of this study was to describe patterns of contrast extravasation during SIJ arthrography and postarthrography CT in patients with lower back pain and to determine whether there are pathways of communication between the SIJ and nearby neural structures.**

METHODS: **Fluoroscopically guided SIJ arthrography was performed on 76 SIJs. After the injection of contrast medium, anteroposterior, lateral, and oblique radiographs as well as 5-mm contiguous axial and direct coronal CT images were obtained. Contrast extravasation patterns were recorded for each joint. These observations included a search for contrast extravasation from the SIJ that contacted nearby lumbosacral nerve roots or structures of the plexus.**

RESULTS: **Sixty-one percent of all joints studied revealed one of five contrast extravasation patterns. Three of these observed patterns show a pathway of communication between the SIJ and nearby neural structures. These included posterior extravasation into the dorsal sacral foramina, superior recess extravasation at the sacral alar level to the fifth lumbar epiradicular sheath, and ventral extravasation to the lumbosacral plexus.**

CONCLUSION: **Three pathways between the SIJ and neural structures exist.**

At the turn of the century, strain of the sacroiliac joint (SIJ) was regarded as the primary etiologic factor leading to symptoms of sciatica (1). Later, in 1936, Pitkin and Pheasant (2) described lower extremity pain as originating in the sacroiliac and lumbosacral joints and their accessory ligaments and coined the term *sacroarthrogenic telalgia.* For decades, SIJ fusion was a common surgical procedure used to alleviate symptoms of sciatica (3). After Mixter and Barr's (4) initial description of the herniated nucleus pulposus, focus on the SIJ as a mediator of lower extremity symptoms fell from favor.

Since that time, however, there has been a growing understanding that morphologic changes are not necessarily predictive of the symptom complex of any individual with lower back pain (5−7). For instance, structural changes of the intervertebral disk, including some disk herniations causing neural compression, are seen in asymptomatic individuals (5, 7). Despite ongoing clinical suspicion regarding the relationship of the SIJ to lower extremity symptoms, there is a paucity of scientific literature addressing this topic.

Recently, Fortin et al (8, 9) documented that provocation (direct capsular stimulation at the time of injection) of the SIJ produces a referred pain pattern over the medial gluteal region in asymptomatic volunteers. There are also numerous reports of patients presumed to have idiopathic SIJ pain who also have an array of lower extremity symptoms, including radicular pain (1, 10, 11). Capsular irritation of the SIJ is thought to be the underlying mechanism leading to lower extremity symptoms, yet there are main nerve trunks adjacent to the SIJ, the role of which in the mediation of lower extremity symptoms remains unexplored. Moreover, recent studies identifying nociceptive and neuropathic inflammatory activation within spinal structures, including facet joints and intervertebral disks (12−14), emphasize the need to investigate pathways of communication between spinal structures and nearby neural elements. The purpose of this study was to report patterns of SIJ contrast extravasation during SIJ arthrography and observe the re-

Received, June 13, 1997; accepted after revision, March 9, 1999.

From Spine Technology and Rehabilitation, Indiana University School of Medicine (J.D.F.), Fort Wayne, IN, the Neuro Care Center (W.J.W.), Canton, OH, and Comprehensive Spine & Sports Medicine (F.J.E.F.), Wilmington, DE.

Address reprint requests to Joseph D. Fortin, DO, Division of Spine Technology and Rehabilitation, 7230 Engle Road, Suite 210 Fort Wayne, IN 46804.

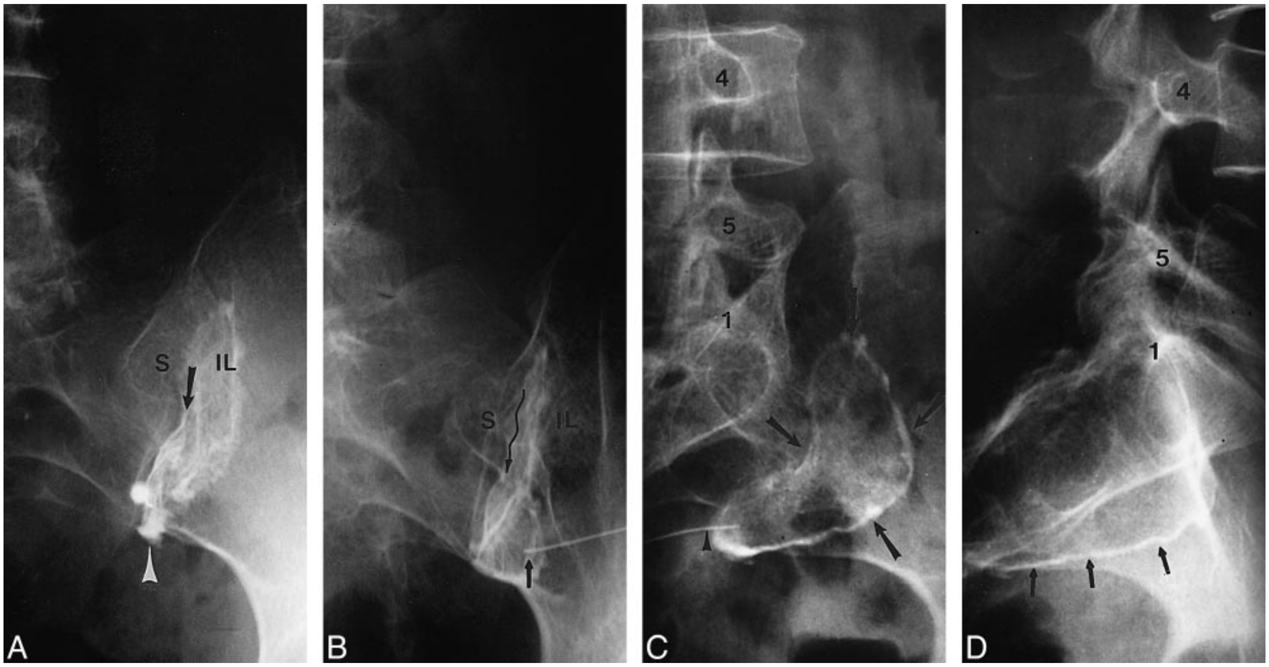

FIG 1. ''Normal'' right SIJ arthrograms of a 32-year-old woman with right-sided lower back and hip pain after a motor vehicle accident.

A, Anteroposterior view. Note the characteristic coin-shaped inferior recess (*arrowhead*) and the bead of contrast within the joint margin (*closed arrow*). Symbols: *S,* sacrum; *IL,* ilium; *3,* S3 dorsal sacral foramina.

B, Right anterior oblique projection delineates the full extent of the contrast medium within the joint space (*wavy arrow*). The closed arrow is directed to the needle tip.

C, Left anterior oblique view. This ''en face'' projection reveals the auricular configuration of the SIJ surface (*dark arrows*). Symbols: 4, pedicle of L4; 5, pedicle of L5; 1, pedicle of S1.

D, The ventral capsule of the joint is well demarcated (*arrows*) in this lateral, plain-film arthrogram.

lationship between the SIJ and nearby neural structures.

Methods

Forty-three consecutive patients with lower back pain (mean age, 33 years; age range, 24−48 years), were enrolled in the study after receiving Internal Review Board approval. The participants met the following criteria: back pain present for longer than 2 months; lower back pain:lower extremity pain ratio of greater than or equal to 75%:25%; no evidence of motor or sensory changes revealed by examination to suggest radiculopathy; no allergy to contrast media or iodine; Beta human chorionic gonadotropin-negative; and willingness to participate in the study. Investigators chose to study the SIJs on the symptomatic sides of the participants. Thirty-one of the 43 participants had bilateral complaints, which allowed for examination of 76 SIJs.

SIJ arthrography was performed as described in a previous study by Fortin and Tolchin (16). Complete arthrograms were obtained in all cases, and no complications resulting from the procedure were observed. No complications were anticipated because previous studies suggested that arthrography is a safe procedure in carefully selected participants (8, 9, 16). Nonetheless, patients were monitored for allergy to contrast medium, postprocedural infection, and bleeding. These problems were minimized by excluding those with histories of allergy to iodinated materials or contrast medium, using a sterile technique and 25-gauge spinal needles. Moreover, there are no major vessels along the needle pathway when using the technique previously described by Fortin et al (8, 9). After the injection of contrast medium, anteroposterior, lateral, and oblique radiographs were obtained for each SIJ. Postarthrography CT was performed on the same joints. Five-millimeter contiguous transaxial and direct coronal images were acquired. A −20° gantry tilt was used for the transaxial scans, and a +20° gantry angle was used for the coronal scans. Window-level settings as well as bone-detail algorithms were adjusted for optimal visualization of soft tissue and osseous structures. Two observers (J.F., F.F.), both of whom are experienced interpreters of SIJ arthrograms, graded the arthrograms and postarthrography CT findings. The joints were divided into anterior, posterior, superior, and inferior components for regional recording of contrast patterns from both techniques. Choices of contrast patterns included anterior, posterior, superior, and inferior extravasation. Other findings, such as capsular attenuation (ie, capsular bulge without associated extravasation) or diverticula, were noted by the observers but were not the focus of this study. In addition to recording the region of contrast extravasation from the joints, the observers were asked to search for extravasation of contrast medium from the SIJ that contacted nearby lumbosacral nerve roots or structures of the sacral plexus.

There was complete agreement between both reviewers regarding all but one case in which extension of contrast medium from the superior aspect of the joint had occurred. Both reviewers observed the leakage of contrast medium, yet one failed to document the extension of contrast medium into the adjacent L5 root canal, which was undoubtedly present on postarthrography CT scans (Fig 5). Complete concordance of findings between plain films and postarthrography CT was achieved in terms of the region of extravasation. CT was necessary to visualize the neural elements and to determine whether contrast medium contacted them.

Results

Thirty-nine percent of all SIJs studied showed no contrast medium extravasation. A normal SIJ arthrogram is shown in Figure 1. Sixty-one percent

TABLE 1: Observed contrast extravasation patterns from 76 sacroiliac joints

Pattern of extravasation	No. observed	Percentage
Ventral	12	16%
Dorsal to first sacral foramina	6	8%
Dorsal subligamentous	18	24%
Superior to sacral ala	2	3%
Inferior	9	12%
None	29	38%

of all SIJs studied revealed extravasation of contrast medium. Observed contrast medium extravasation patterns from the ventral, dorsal, superior, and inferior aspects of the 76 SIJ capsules are displayed in Table 1.

Ventral extravasation near the lumbosacral plexus was observed in 12 (16%) of the SIJs studied (Fig 2). Other ventral capsular findings, not included as frank contrast medium extravasation, deserve special mention. Six arthrograms revealed ventral capsular attenuation without extravasation, whereas nine others exhibited a wispy pattern of extravasation through a small ventral schism (Fig 3).

Dorsal leakage of contrast medium was seen in 24 (32%) of all SIJs. In six of these, contrast medium was observed to enter the first dorsal sacral foramen, which overlies the first sacral nerve root (Fig 4). In the others, contrast medium layered between the dorsal sacroiliac ligament and the sacrum.

In addition, two (3%) arthrograms exhibited direct flow of contrast medium from the superior cap-

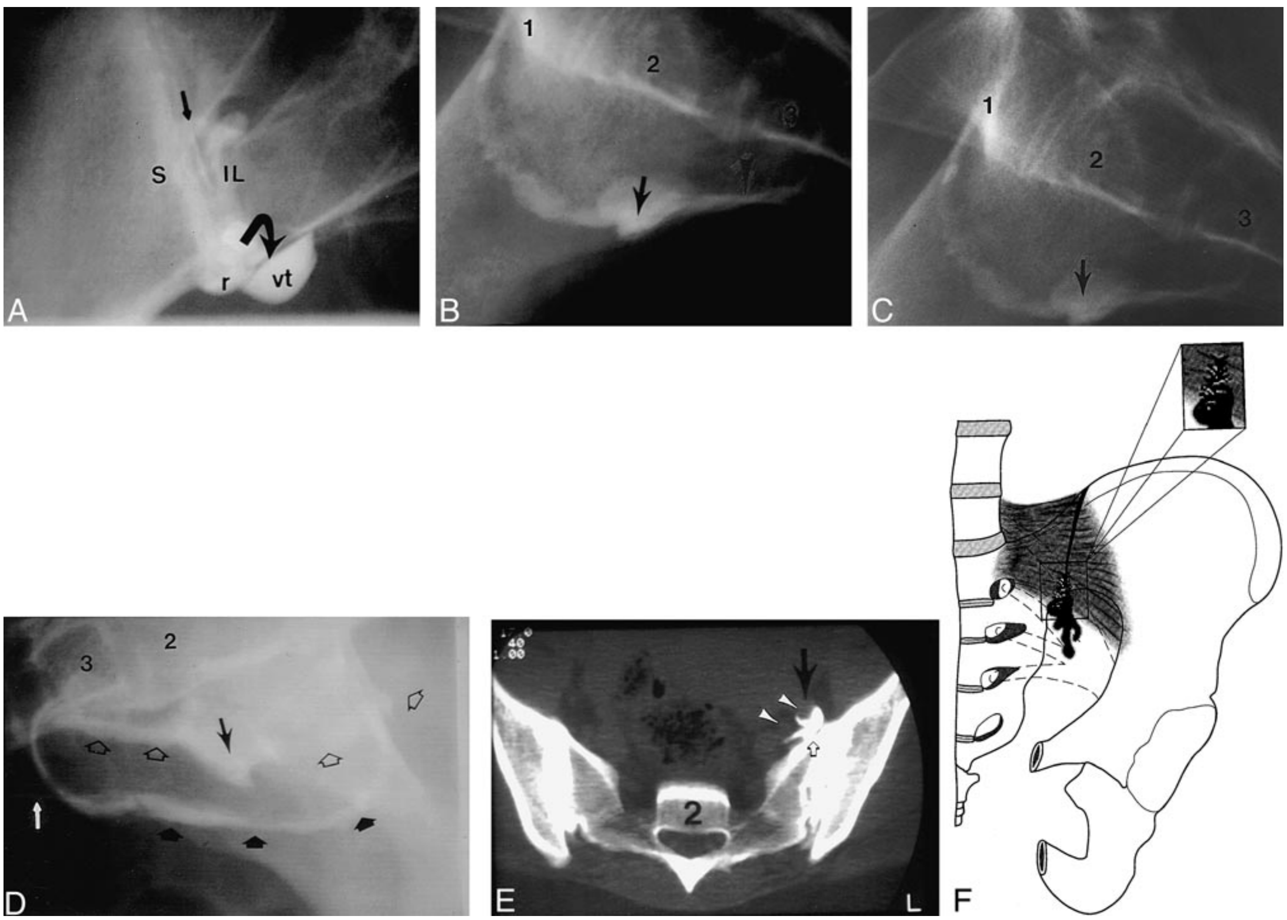

Fig 2. Images of a 36-year-old man with left-sided lower back, posterior hip, and thigh pain, who sustained an offshore work-related lifting injury.

A, Anteroposterior arthrogram of the inferior aspect of the left SIJ shows a normal inferior recess (*r*), bead of contrast within the joints margins (*arrow*), and collection of contrast medium escaping through a ventral tear (*VT*).

B, Lateral view confirms that the collection of contrast medium escaping through a ventral tear (*arrow*) is remote to the needle tip, which is in the inferior aspect of the capsule.Symbols: 1, body of S1; 2, body of S2; 3, body of S3.

C, Same projection as that shown in *B* except with a wider field of view. Arrow indicates ventral tear.

D, Offset opposite lateral arthrogram discloses an intact ventral capsule (*arrowheads*) on the contralateral side compared with a disrupted capsule with a ventral tear (*arrows*). White arrow points to the needle in inferior aspect of right SIJ.

E, Post-arthrography axial CT scan obtained at the S2 level (bone window/level settings), with contrast medium in both SIJs. Presacral collection of contrast medium is evidence of a left ventral capsular tear (*open arrow*). Contrast medium contracts the lumbosacral plexus elements (*arrowheads*).

F, Line drawing of the ventral hemipelvis, which allows contrast medium to escape and contact the neural elements of the sacral plexus (*interrupted lines*). The inset shows the torn fibers of the ventral capsule allowing contrast medium to leak slowly.

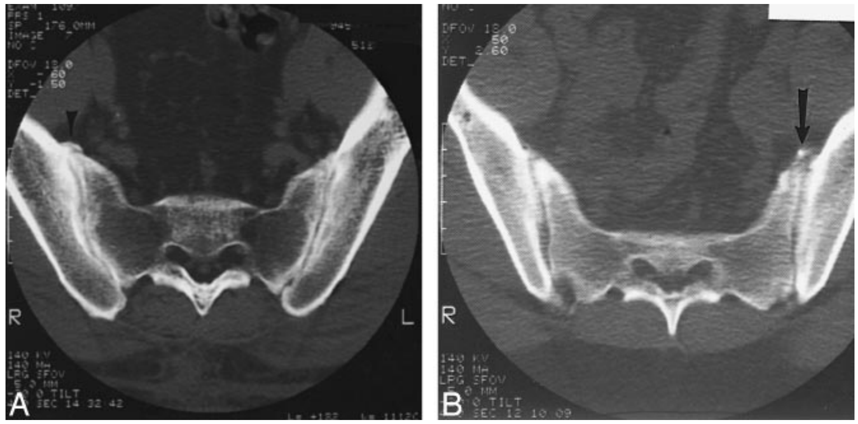

FIG 3. Capsular attention (ie, focal capsular bulge) and schism in a 28-year-old man with an insidious onset of lower back pain.

A, Concentric area of ventral capsular attenuation is displayed at soft-tissue settings (*arrowheads*) of this postarthrography axial CT scan obtained at the S2 level.

B, Markedly attenuated area of the ventral capsule and sacroiliac ligament allows seepage of contrast medium in a feathery, wispy dispersal pattern (ie, schism with indistinct margins) into the presacral region (*arrow*).

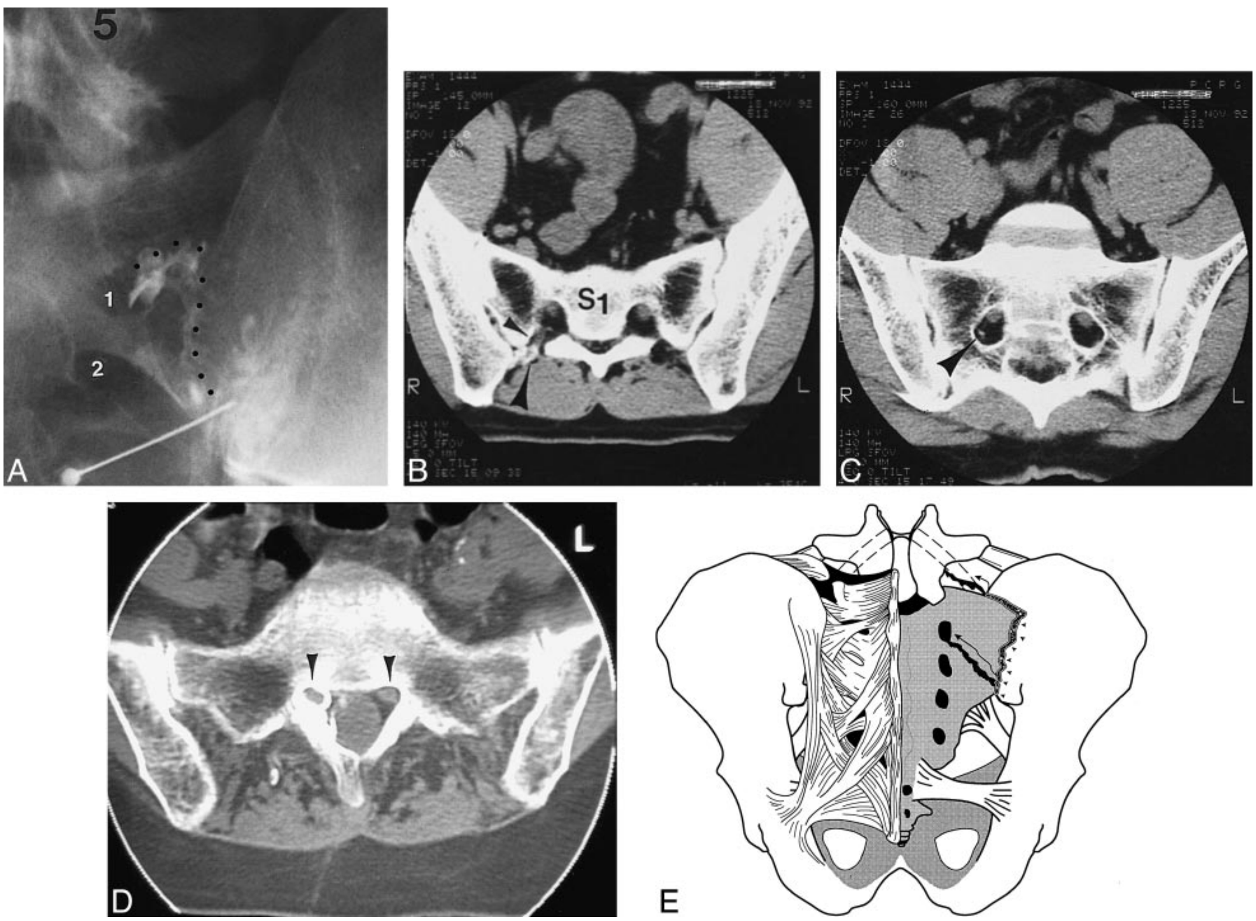

FIG 4. A 42-year-old laborer with back pain and occasional posterior right lower extremity pain to the calf. A potential pathway between the SIJ and anterior ramus of S1 is present.

A, Arthrogram of the anteroposterior view reveals contrast medium extending (*dotted line*) into the S1 dorsal foramina (*1*). Symbols: 2, S2 dorsal foramina; 5, pedicle of L5.

B and *C,* Axial and direct coronal postarthrography CT scan through the S1 foramina (soft-tissue window/level settings). Contrast is observed in the right S1 dorsal foramina on both scans (*arrowheads*).

D, Compare this axial CT scan at the S1 level in another patient after bilateral SIJ arthrography to the above case. The arrowheads point to the S1 anterior rami bilaterally. Notice on the right how contrast medium encircles the S1 segmental root.

E, Line drawing of the dorsal view of the pelvis and L5−S1 motion segment. Small arrowheads on the right indicate where the ilium has been ''resected'' to reveal the SIJ; the dorsal ligaments have been stripped away. The fine wavy arrow indicates contrast medium tracking subligamentously from the SIJ to the S1 dorsal-sacral foramina. The small curved arrow (at the top of the right SIJ) indicates contrast medium extravasating from the superior aspect of the right SIJ into the right L5 root canal. The discontinuous lines indicate the L5 segmental nerve roots.

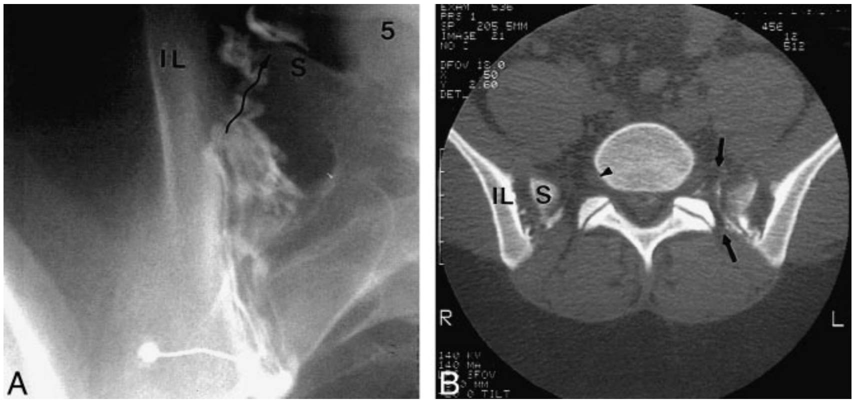

FIG 5. Another pathway between the SIJ and neural structures was found in this 33-year-old patient with lower back pain and left lower extremity paresthesias.

A, Arthrogram of the anteroposterior view allowed visualization of contrast medium extravasating from the superior recess (*wavy line*) of the SIJ toward the L5 root canal. Symbols: 5, L5 vertebral body; S, sacral ala; IL, ilium.

B, Postarthrography axial CT scan obtained at the L5−S1 level reveals contrast medium extending to the L5 epiradicular sheath (*arrows*). The arrowhead points to the contralateral L5 anterior ramus. Symbols: *S,* sacral ala; *IL,* ilium. Refer to Figure 4E for a comparative line drawing.

sular recess along the sacral ala to the fifth lumbar epiradicular sheath (Fig 5).

Discussion

During the past several decades, there have been numerous reports of patients suspected of having idiopathic SIJ pain who also have associated lower extremity symptoms, including radicular pain (2, 10, 11). The mechanism by which lower extremity pain occurs in patients with SIJ dysfunction remains unknown. Unfortunately, spinal morphologic studies often fail to be adequately predictive of the true pain generator in any given patient. Studies that seek to explain morphologic and physiologic changes and how they relate to the evolution of spinal pain syndromes are much needed.

In this study, five principal patterns of extracapsular contrast extravasation from the SIJ were observed using plain-film arthrography and postarthrography CT. Three of these patterns reveal a potential pathway of communication between the SIJ and nearby neural structures. These include posterior extension into the dorsal sacral foramina, superior recess extravasation at the sacral alar level to the fifth lumbar epiradicular sheath, and ventral leakage to the lumbosacral plexus.

Frank extravasation of contrast medium is easily visible on both plain-film arthrograms and postarthrography CT scans. The added value of postarthrography CT lies in its greater sensitivity for detection of subtle capsular changes and extravasation of small amounts of contrast medium. This is especially true for the ventral capsule in which changes of normal capsular structure are seen. The range of ventral capsular findings may represent points on a continuum of the same process. The patterns of ventral capsular attenuation and schism later might become frank ventral tears.

The large percentage of observed dorsal extravasation is not surprising considering that the dorsal capsule is discontinuous compared with the ventral capsule, which is a continuous sheet of connective tissue (10). The dorsal capsule allows contrast medium to track along the posterior aspect of the sacrum and enter the dorsal sacral foramen relatively unimpeded.

Our findings raised some intriguing questions that have provided the substrate for investigations that are currently underway. Is it plausible that in the setting of capsular disruption, intra-articular contents, including inflammatory chemical mediators in symptomatic patients, could leak from the SIJ in a manner similar to the extracapsular contrast extravasation patterns observed in this study? If so, irritation of adjacent neural structures could manifest as lower extremity symptoms.

The role of contrast-enhanced anatomic studies as progenitors in revealing spine pain mechanisms bears historical significance. For example, Lindblom (18) provided the foundation for the understanding of discogenic pain when he injected red dye into the nucleus pulposus of cadaveric disks and observed it leaking through annular rents. Similarly, we think that patterns of communication from the SIJ to nearby neural structures may have significance. There is evidence of a substantial role for biochemical or inflammatory mediators in discogenic and facet joint pain (12−15). Accordingly, the pathophysiologic mechanism by which SIJ dysfunction leads to lower extremity pain may include biochemical factors that affect regional nerves via direct communication from the SIJ.

Conclusion

Contrast extravasation after SIJ arthrography can be visualized in patients with lower back pain. Five extravasation patterns were observed, including three pathways of communication between the SIJ and nearby neural structures.

References

1. Goldthwaite GE, Osgood RB. **Consideration of the pelvic articulations from an anatomical, pathological, andchemical standpoint.** *Boston Med Surg J* 1905;152:593–601
2. Pitkin HC, Pheasant HC. **Sacroarthrogenic telalgia.** *J Bone Joint Surg Am* 1936;18:111–133
3. Smith-Peterson MN, Rogers WA. **End-result study of arthrodesis of the sacroiliac joint for arthritis. Traumatic and nontraumatic.** *J Bone and Joint Surg Am* 1926;8:118–136

4. Mixter WJ, Barr JS. **Rupture of the intervertebral disc with involvement of the spinal canal.** *N Engl J Med* 1934;211:210–215
5. Bodin SD, David DO, Dina TS. **Abnormal magnetic resonance scans of the lumbar spine in asymptomatic subjects. A prospective investigation.** *J Bone Joint Surg Am* 1990;72:403–408
6. Hitselberger WE, Witten RM. **Abnormal myelograms in asymptomatic patients.** *J Neurosurg* 1968;28:204–206
7. Jensen MC, Brant-Zawadski MN, Obuchowski N, Modic MT, Malkasian D, Ross JS. **Magnetic resonance imaging of the lumbar spine in people without back pain.** *N Engl J Med* 1994;2:69–73
8. Fortin JD, Aprill CN, Ponthieux B, Pier J. **Sacroiliac joint. Pain referral maps upon applying a new injection/arthrography technique. Part II. Clinical evaluation.** *Spine* 1994;19:1483–1489
9. Fortin JD, Dwyer AP, West S, Pier J. **Sacroiliac joint. Pain referral maps upon applying a new injection/arthrography technique. Part I. Asymptomatic volunteers.** *Spine* 1994;19:1475–1482
10. Bernard TN Fr, Cassidy DJ. **SIJ syndrome.** In: Frymoyer J, ed. *The Adult Spine. Principles and Practice.* New York: Raven Press 1991;2107–2130
11. Bernard TN Jr, Kirkaldy-Willis WA. **Recognizing specific characteristics of nonspecific low back pain.** *Clin Orthop* 1987;217:266–280
12. Beaman DN, Graziano CP, Glover RA, Wojtys EM, Chang V. **Substance P innervation of lumbar spine facet joints.** *Spine* 1993;18:1044–1049
13. Saal JS, Franson RC, Dobrow R, Saal JA, White AH, Goldthwaite N. **High levels of inflammatory phospholipase A2 activity in lumbar disc herniations.** *Spine* 1990;15:674–678
14. Willburger RE, Wittenberg RH. **Prostaglandin release from lumbar disc and fat tissue.** *Spine* 1994;19:2068–2070
15. Wittenberg RH, Willburger RE, Kleemeyer KS, Peskar BA. **In vitro release of prostaglandins and leukotrienes from synovial tissue, cartilage, and bone in degenerative joint diseases.** *Arthritis Rheum* 1993;36:(10)1444–1450
16. Fortin JD, Tolchin R. **Sacroiliac arthrograms and post-arthrography CT.** *Arch Phys Med Rehabil* 1993;74:1259 [Abstract]
17. Willard FH. **The muscular, ligamentous and neural structure of the low back and its relation to back pain.** In: Vleeming A, Mooney V, Dorman T, Snijders C, Stoeckart R, eds. *Movement Stability and Low Back.* New York: Churchill Livingstone; 1997;14–17
18. Lindblom K. **Protrusions of the discs and nerve compression in the lumbar region.** *Acta Radiol Scand* 1944;25:195–212