

SPINE SECTION

Original Research Article

The Ability of Multi-Site, Multi-Depth Sacral Lateral Branch Blocks to Anesthetize the Sacroiliac Joint Complex

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ABSTRACT

Objective. To determine the physiologic effectiveness of multi-site, multi-depth sacral lateral branch injections.

Design. Double-blind, randomized, placebo-controlled study.

Setting. Outpatient pain management center.

Patients. Twenty asymptomatic volunteers.

Background. The dorsal innervation to the sacroiliac joint (SIJ) is from the L5 dorsal ramus and the S1-3 lateral branches. Multi-site, multi-depth lateral branch blocks were developed to compensate for the complex regional anatomy that limited the effectiveness of single-site, single-depth lateral branch injections.

Interventions. Bilateral multi-site, multi-depth lateral branch green dye injections and subsequent dissection on two cadavers revealed a 91% accuracy with this technique. Session 1: 20 asymptomatic subjects had a 25-g spinal needle probe their interosseous (IO) and dorsal sacroiliac (DSI) ligaments. The inferior dorsal SIJ was entered and capsular distension with contrast medium was performed. Discomfort had to occur with each provocation maneuver and a contained arthrogram was necessary to continue in the study. Session 2: 1 week later; computer randomized, double-blind multi-site, multi-depth lateral branch blocks injections were performed. Ten subjects received active (bupivacaine 0.75%) and 10 subjects received sham (normal saline) multi-site, multi-depth lateral branch injections. Thirty minutes later, provocation testing was repeated with identical methodology used in session 1.

Outcome measures. Presence or absence of pain for ligamentous probing and SIJ capsular distension.

Results. Seventy percent of the active group had an insensate IO and DSI ligaments, and inferior dorsal SIJ vs 0–10% of the sham group. Twenty percent of the active vs 10% of the sham group did not feel repeat capsular distension. Six of seven subjects (86%) retained the ability to feel repeat capsular distension despite an insensate dorsal SIJ complex.

Conclusion. Multi-site, multi-depth lateral branch blocks are physiologically effective at a rate of 70%. Multi-site, multi-depth lateral branch blocks do not effectively block the intra-articular portion of the SIJ. There is physiological evidence that the intra-articular portion of the SIJ is

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innervated from both ventral and dorsal sources. Comparative multi-site, multi-depth lateral branch blocks should be considered a potentially valuable tool to diagnose extra-articular SIJ pain and determine if lateral branch radiofrequency neurotomy may assist one with SIJ pain.

Key Words. Sacroiliac Joint; Injections; Anesthetic; Sacral Lateral Branch Nerve

Background

The sacroiliac joint is a possible source of back pain. It is innervated, and therefore, is endowed with the necessary anatomical substrate to become painful [1–8]. In normal volunteers, experimental noxious stimulation of the joint evokes pain low in the back, which can radiate into the gluteal region and upper posterior thigh [9]. In some patients, such patterns of pain can be relieved by anesthetizing the sacroiliac joint [10–13].

Intra-articular injections of local anesthetic agents have been the most commonly practiced diagnostic block for sacroiliac joint pain. When used in patients with persistent pain after lumbosacral arthrodesis, single (uncontrolled) intra-articular blocks suggest a prevalence of sacroiliac joint pain of 32% [14,15]. In patients with chronic low back pain, intra-articular blocks, using either anatomical or physiological controls, demonstrate a prevalence of 10–15% [16,17].

The specificity of intra-articular blocks, however, is capricious. Local anesthetics injected into the joint can escape, through defects in the ventral or dorsal capsule, and could anesthetize nearby structures [16,18]. Furthermore, although intra-articular blocks might successfully anesthetize the synovial portion of the joint, they do not necessarily anesthetize the interosseous or dorsal sacroiliac ligaments, which could be an additional or alternative source of pain in patients with sacroiliac disorders [5–7].

An alternative to intra-articular injections are nerve blocks, in which the nerves that supply the joint are anesthetized. However, the innervation of the sacroiliac joint is contentious, and has not been properly resolved. Some investigators maintain that the joint is innervated both posteriorly and anteriorly [3,4]. Others maintain that the innervation is exclusively posterior, and stems from the lateral branches of the sacral dorsal rami [1,2].

If the latter is correct, diagnostic blocks of the sacral lateral branches become a putative diagnostic test of sacroiliac joint pain, including pain stemming from the posterior ligaments of the

joint. These blocks involve placing needles, at a single depth, on the posterior surface of the sacrum, at one or more sites around the perimeter of the S1–3 posterior sacral foramina. Some investigators have performed such blocks in the pursuit of sacroiliac joint pain [19]. Others have sought to coagulate the lateral branches in the treatment of sacroiliac pain. [19–21]. In the latter context, lateral branch blocks (LBBs) provide a prognostic test to determine which patients might be offered lateral branch radiofrequency neurotomy. Pivotal to these practices, however, is the validity of LBBs.

One method of testing the validity of diagnostic blocks is to perform the blocks on normal volunteers to see if they are protected from experimentally-induced pain from the target structure [22]. When this was done for conventional sacral LBBs, they were found to be consistently ineffective in protecting volunteers from pain evoked from either the sacroiliac joint or its posterior ligaments [23]. A companion cadaver study mimicked these blocks with injections of dye. It revealed that only 36% of lateral branches were stained when the single-depth, single-site technique for blocks was used [23]. These deficiencies arose because sacral lateral branches vary in depth. Whereas some run across the surface of the sacrum, others run more superficially, between layers of the dorsal sacroiliac ligament. Therefore, agents injected at one depth may fail to reach nerves that run at another depth.

In order to accommodate these variations, a multi-site, multi-depth technique was developed. The principle was that small aliquots of local anesthetic should be injected both deep to and within the dorsal sacroiliac ligaments in order to better encompass the possible locations of the sacral lateral branches.

The primary objective of the present study was to test the validity of multi-depth blocks before applying them presumptively in patients with pain. The study also provided the opportunity to test two conjectures. If sacral lateral branches innervate the dorsal sacroiliac ligaments, then LBBs should protect volunteers from experimental pain evoked from these ligaments. Also, if lateral

branches exclusively innervate the sacroiliac joint, then LBBs should protect volunteers from experimental pain from this joint.

Methods

The study was approved by the Western Institutional Review Board for Human Subject Research Center in Olympia, Washington. The study was performed between January and May 2008.

A preliminary anatomic study was undertaken on two, fresh-frozen, cadaveric torsos that were brought to 37°Celsius. Bilateral S1-3 multi-site, multi-depth, sacral lateral branch injections with green dye were performed by the principal investigator using the technique described below. Dissection was undertaken by three co-investigators (TH, NM, BG) to quantify the degree of staining of these target lateral branch nerves.

An initial pool of 31 healthy, asymptomatic volunteers were screened to find 20 who were recruited: 10 for the active arm and 10 for the placebo arm of the study. All volunteers provided informed consent and were screened with an interview, questionnaire, and physical examination. In order to be eligible, volunteers had to have no neurological or musculoskeletal abnormalities; have normal skin sensitivity from the iliac crest to the greater trochanter and inferior gluteal folds; have no history of spine surgery or prior sacroiliac injections; and have no history of back pain lasting longer than 2 days during the previous 12 months. Subjects were compensated \$100 if they completed only the first injection session of the study, and \$400 if they completed the entire study.

Procedures were performed in a fluoroscopy suite without intravenous or oral sedation. All procedures were performed by the principal investigator in consistent fashion (P.D.).

The image-intensifier was rotated to a contralateral oblique orientation to view the medial aspect of the posterior superior iliac spine tangentially, and an insertion point was selected, over the sacroiliac joint, opposite the caudal end of the posterior superior iliac spine. The overlying skin was anesthetized with an intradermal injection of 1.0% lidocaine. A 25-gauge 3.5-inch Quincke spinal needle was advanced just medial to the convexity of the posterior superior iliac spine, parallel to the X-ray beam, deep into the interosseous ligament (Figures 1 and 2). Care was taken to avoid direct contact with osseous structures. Subjects were asked if they felt discomfort upon probing this ligament.

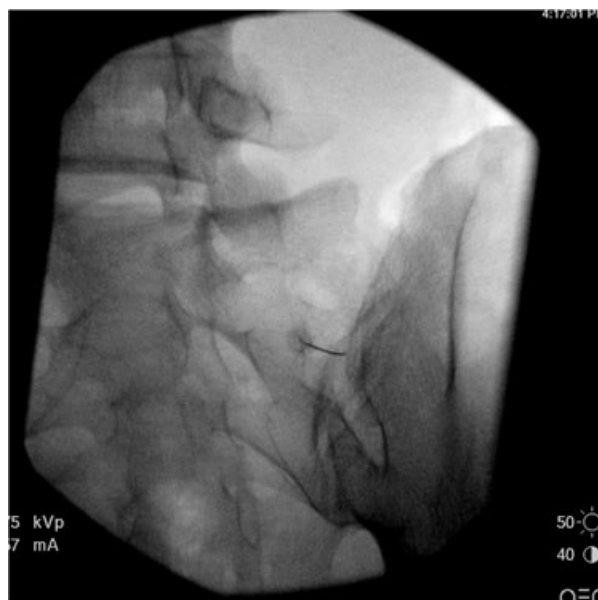


Figure 1 A contralateral oblique fluoroscopy view of a needle probing the interosseous sacroiliac ligament.

Next, an insertion point over the inferior portion of the sacroiliac joint was selected. The overlying skin was anesthetized with an intradermal injection of approximately 0.2 cc of 1.0% lidocaine. A 25-gauge 3.5-inch Quincke point spinal needle was passed through the insertion point under postero-anterior imaging just inferior

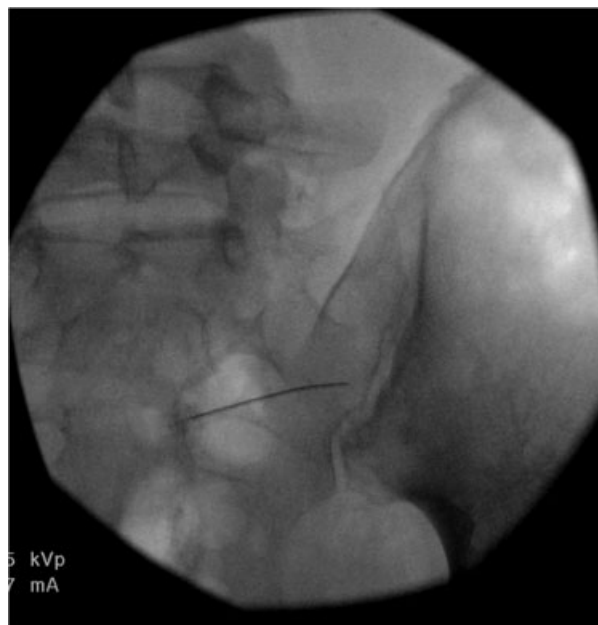


Figure 2 A postero-anterior fluoroscopy view of a needle probing the interosseous sacroiliac ligament.



Figure 3 A postero-anterior fluoroscopy view of a needle probing the dorsal sacroiliac ligament.

to the posterior superior iliac spine, along the plane of the sacroiliac joint, into the dorsal sacroiliac ligament (Figure 3). Care was taken to avoid direct contact with osseous structures. Subjects were asked if they felt discomfort upon probing this ligament.

Films were saved for each needle position during ligamentous probing. If each probed ligament caused discomfort the subject continued in the study.

Subsequently, an intra-articular injection of the sacroiliac joint was performed, according to the guidelines prescribed by the International Spine Intervention Society [24]. A 22-gauge 3.5-nch Quinke point needle was inserted in the inferior pole of the joint. Subjects were asked if they felt discomfort upon entering the joint. A minimal amount (0.2–0.3 cc) of contrast medium (Isovue M-300) was injected to confirm intra-articular injection. If venous uptake or dorsal ligamentous flow was noted, the needle was redirected, usually in an anterior direction and contrast medium was once again injected. If contrast remained within the joint a further aliquot was injected until either the subject reported discomfort upon capsular distension, or a firm end-point was reached without discomfort, or a maximum of 2.5 cc was injected. Subjects were asked if they felt discomfort upon

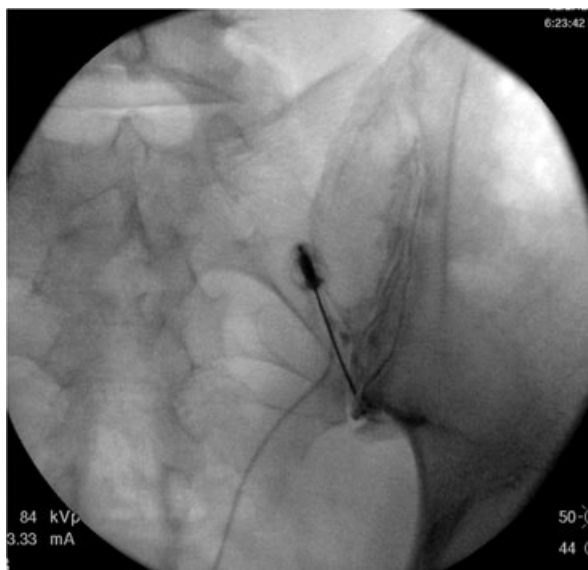


Figure 4 A postero-anterior fluoroscopy view of an arthrogram of the sacroiliac joint.

capsular distension. The volume of injectate that caused discomfort upon capsular distension was recorded. Postero-anterior lateral, ipsilateral and contralateral oblique digitally formatted images were saved (Figures 4 and 5).

If subjects had ventral capsular tears (as detected on lateral imaging) they were excluded from further participation in the study. Additionally, if there was unavoidable venous uptake, substantial dorsal extravasation, lack of pain upon capsular distension, extravasation to regional neural ele-



Figure 5 A lateral fluoroscopy view of an arthrogram of the sacroiliac joint.

ments, or the inability to inject contrast into the sacroiliac joint these subjects were excluded.

Of the 31 subjects initially screened for the study, 11 did not qualify, because of venous uptake, dorsal, inferior, or ventral capsular defects, inability to feel pain upon capsular distension or inability to obtain an adequate arthrogram despite intraarticular placement. Twenty subjects remained eligible, and proceeded to the second phase of the study. There were eight females and 12 males, with a median age of 39 (range: 23–56).

Between 5 and 7 days after the initial injections, these subjects returned to undergo L5 dorsal ramus and multi-site, multi-depth S1-3 lateral branch injections, on the side previously tested, using a 25-gauge Quinke point spinal needle.

Using computer randomization, 10 subjects were allocated to receive 0.75% bupivacaine (active) injections and 10 to receive saline (control) injections. The randomization schedule was available only to the assistant preparing the injection solutions. The operator (P.D.), the investigator obtaining data (T.H.), and the subjects were all blinded as to the agent injected. A stronger concentration of bupivacaine was used than may be conventional in an attempt to limit potential false negative blocks.

The L5 dorsal ramus injection was performed using a previously described and validated technique [22,25] (Figure 6). Prior to performing sacral lateral branch injections postero-anterior imaging through the L5-S1 disc space was obtained. For

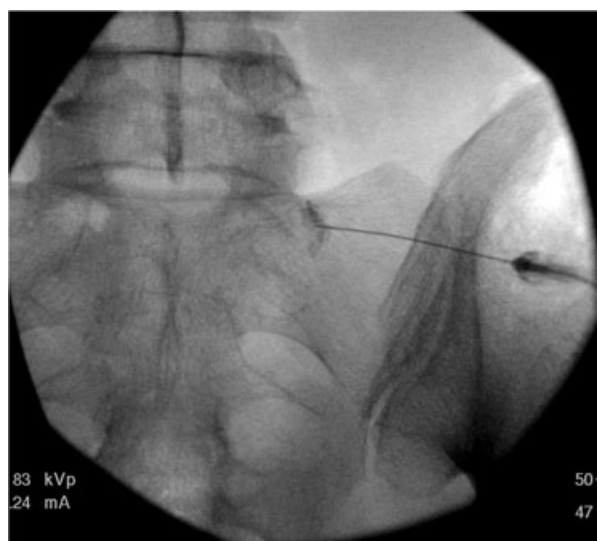


Figure 6 A postero-anterior fluoroscopy view of an injection of contrast medium prior to a L5 dorsal ramus block.

sacral lateral branch injections, needles were placed 8–10 mm peripheral to the posterior sacral foramina, at various locations using clock-face coordinates. The center of the clock was registered at the lateral margin of the foramen. At the S1 and S2 levels, on the right, needles were placed at the 2:30, 4:00, and 5:30 positions, and on the left they were placed at the 9:30, 8:00, and 6:30 positions. At the S3 level, on the right needles were placed at the 2:30 and 4:00 positions, and on the left at the 9:30 and 8:00 positions.

A standardized skin ruler (Epsilon™, Baylis Medical, Montreal Canada) was used to assure that the target needles were placed 8–10 mm from the lateral margin of the posterior sacral foramen at each segmental level. The center of the Epsilon was positioned directly over the lateral margin of the foramen. If the Epsilon is appropriately rotated, the tips of its open end of the Epsilon correspond to the proximal (e.g., 2:30 right) and distal (e.g., 5:30 right) injection positions; and half way between these two points corresponds to the mid (e.g., 4:00 right) injection position. As the radius of the Epsilon is 10 mm, injection at or just inside the ring corresponds with approximately 8–10 mm lateral to the lateral margin of the foramen (Figures 7–9).

For these lateral branch injections, a minimal amount of contrast medium was initially injected under postero-anterior imaging (Figures 7–9). If epidural or venous flow was noted, the needle was redirected. If neither epidural nor venous flow was noted, then 0.2 cc of the allocated agent (saline or bupivacaine) was injected. The needle was then pulled back approximately one bevel length (approximately 3 mm) and another 0.2 cc of the allocated agent was injected. The same protocol was followed at each target segment. The subjects rested supine for 30 minutes following the injections.

After 30 minutes, subjects returned to the fluoroscopy suite and underwent repeat stimulation of their interosseous and dorsal sacroiliac ligaments, the entry point for their sacroiliac joint, and their sacroiliac joint. The films saved from the initial injection session were used to place needles at the same sites that previously had been found to be painful. The presence or absence of discomfort with each maneuver was again recorded. If discomfort was not appreciated upon ligament entry the needle was twice redirected at different depths to assure the ligament was insensate.

After completion of all injections, subjects were examined to determine if they developed any areas

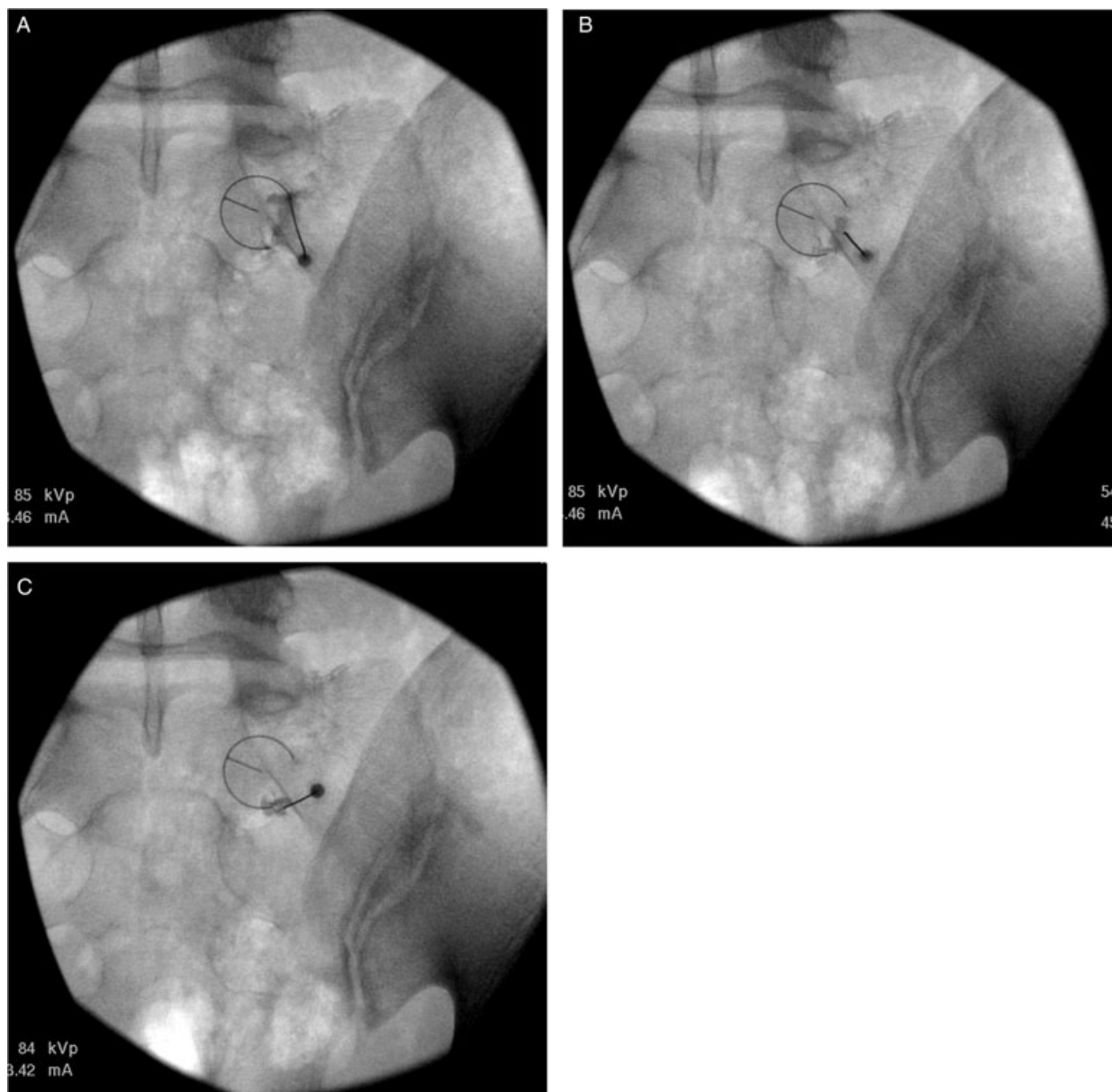


Figure 7 Postero-anterior fluoroscopy views of injections of contrast medium from needles placed at various positions for S1 lateral branch blocks. (A) 2:30 position. (B) 4:00 position. (C) 5:30 position.

of cutaneous numbness in the back, buttock, or upper thigh after the LBIs. If a subject had numbness, its distribution was noted.

The primary outcome measure used in this study was whether subjects were protected or not from repeat stimulation of structures shown previously to be painful upon probing or distension. The numbers of subjects who reported pain or no pain upon repeat stimulation were tallied, and proportions were calculated. Proportions observed in the active and placebo groups were compared using 95% confidence intervals of a proportion.

Results

In the preliminary anatomic study, staining of the target S1-S3 lateral branch nerves occurred in 31/34 sites targeted. This constitutes a success rate of 91% (95% confidence intervals: 82%–100%).

All 20-study subjects felt pain when the interosseous ligament and posterior sacroiliac ligament were probed. The average volume that produced capsular distention and associated discomfort was 1.26 cc (range: 0.6–2.5 cc). Similar

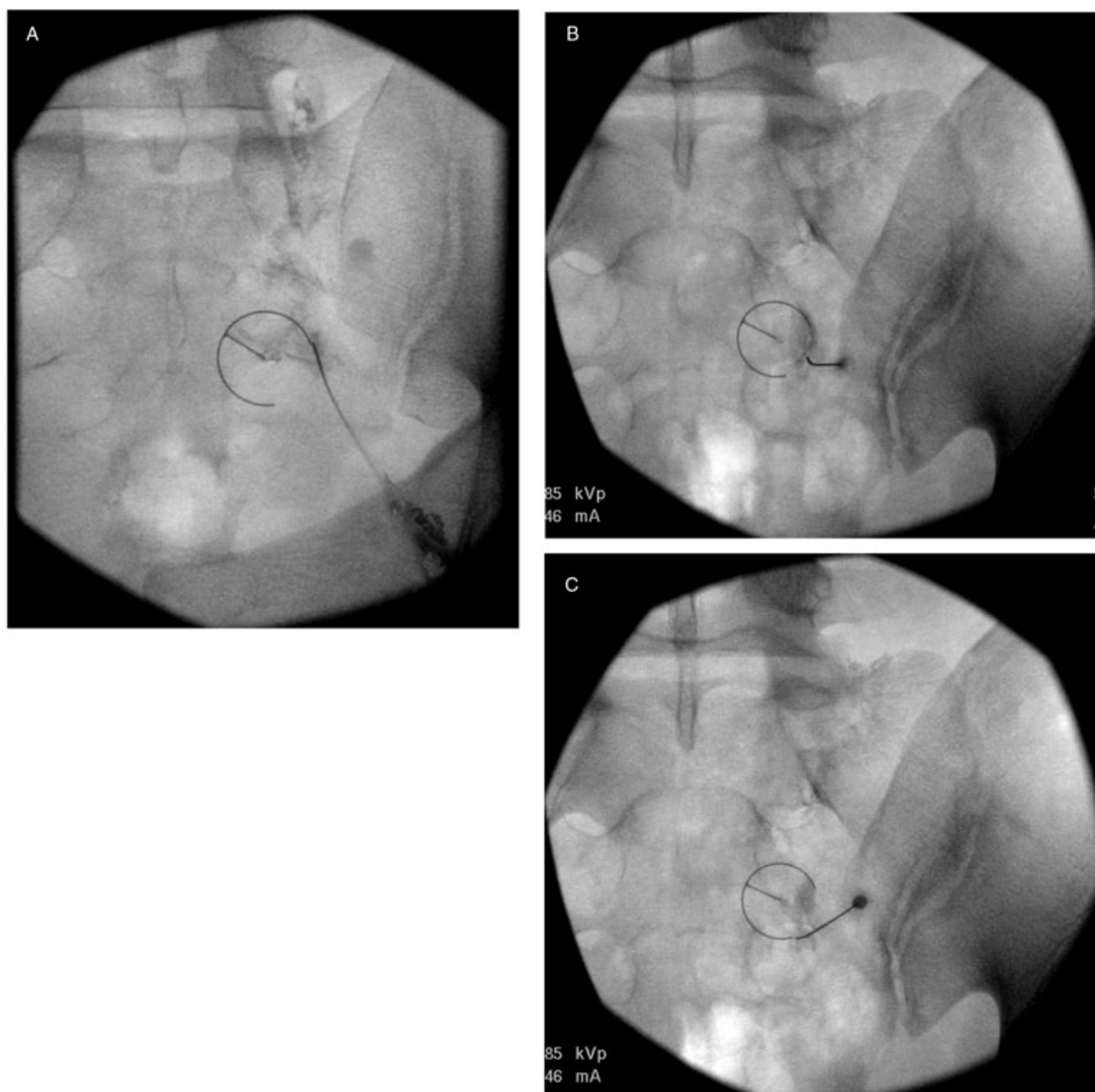


Figure 8 Postero-anterior fluoroscopy views of injections of contrast medium from needles placed at various positions for S2 lateral branch blocks. (A) 2:30 position. (B) 4:00 position. (C) 5:30 position.

volumes were observed in all subjects upon repeat intra-articular injections without evidence of new capsular defects.

In the active (0.75% bupivacaine) group, 7/10 felt no pain upon repeat probing of the interosseous ligament; 7/10 felt no pain upon repeat probing of the dorsal sacroiliac ligament; and 7/10 did not feel pain upon repeat dorsal joint entry. However, only 2/10 felt no pain when the joint was distended. The remaining eight subjects were not protected from pain upon distension of the joint (Table 1).

In the control (saline) group, only one of 10 subjects was protected from pain upon repeat probing of the interosseous ligament; none was protected from pain from the dorsal sacroiliac ligament; and all 10 felt pain upon repeat entry into the joint. Only one subject felt no pain upon distension of the joint. The remaining nine subjects reported pain or discomfort when the joint was distended (Table 1).

The proportions of subjects who were protected from pain by active LBBs were significantly greater than those who were protected by placebo

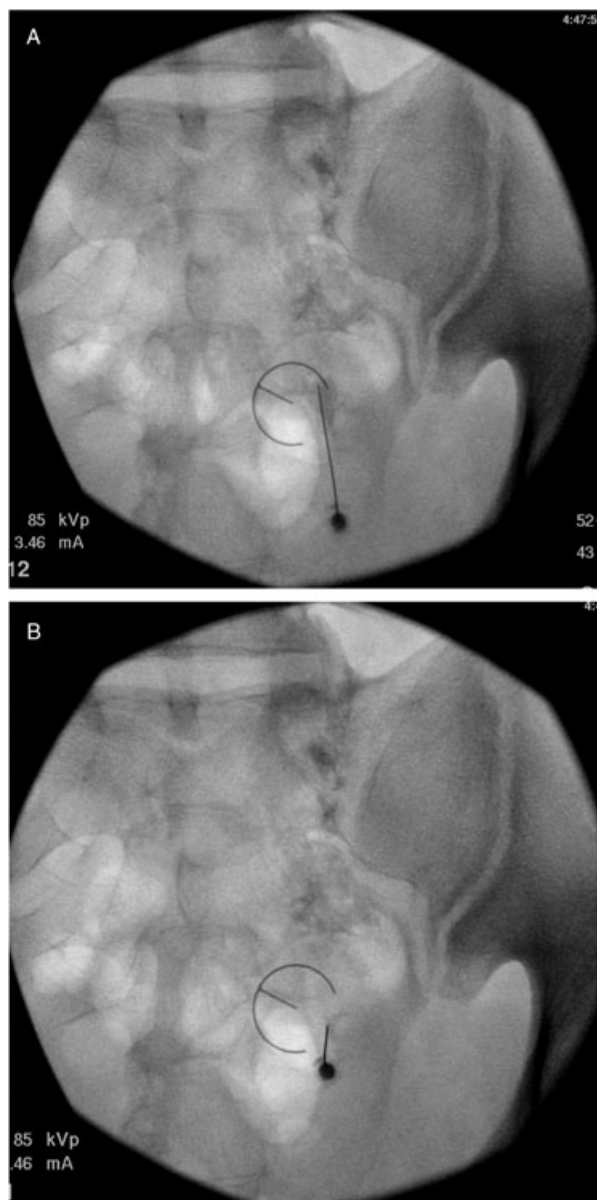


Figure 9 Postero-anterior fluoroscopy views of injections of contrast medium from needles placed at various positions for S3 lateral branch blocks. (A) 2:30 position. (B) 4:00 position.

blocks, for stimulation of the interosseous and dorsal sacroiliac ligament, and for entry into the sacroiliac joint. Only a minority of subjects in both groups were protected from joint distension, and the proportions were not significantly different (Table 1).

Six of seven subjects in whom the active LBBs were effective (insensate dorsal sacroiliac ligament and interosseous ligaments) retained the ability to feel repeat capsular distension. Four subjects in

Table 1 The proportions, and 95% confidence intervals, of patients who reported no pain in response to noxious stimuli around the sacroiliac joint, following either active or sham L5 dorsal ramus and multi-site, multi-depth sacral lateral branch injections

Stimulus	Proportion with Complete Anesthesia	
	Active N = 10	Sham N = 10
Probing interosseous ligament	0.70 0.42–0.98	0.10 0.00–0.29
Probing posterior SI ligament	0.70 0.42–0.98	0.00 0.00–0.28
Dorsal inferior joint entry	0.70 0.42–0.98	0.00 0.00–0.28
Capsular distension	0.20 0.00–0.45	0.10 0.00–0.29

Proportions are significantly different statistically if their 95% confidence intervals do not overlap.

the active group developed an area of numbness, approximately 5 cm by 5 cm in size, over the mid-lateral ipsilateral buttock. Only one of these subjects had complete anesthesia of the interosseous ligament, dorsal sacroiliac ligament and dorsal inferior portion of the SIJ. No lower extremity, groin or saddle anesthesia occurred in the active LBI group.

Discussion

The multi-site, multi-depth technique tested in the present study for sacral LBBs was developed for several reasons. The lateral branches of the sacral dorsal rami do not run in a constant plane [7,8]. They may run on the dorsum of the sacrum, between various laminae of the dorsal sacroiliac ligament, and superficial or deep to the dorsal sacroiliac ligament. A needle placed at just one depth, such as on the dorsal surface of the sacrum, may fail to subsequently infiltrate the target nerves that happen to run more superficially, by one bevel length or more. Additionally, the lateral branches do not emerge from the posterior sacral foramina in a consistent location. They can radiate cephalad, transversely, or caudad. An injection placed at just one location, therefore, may fail to infiltrate nerves that run at other locations.

Consonant with this anatomy, single-site, single-depth blocks fail to anesthetize sacroiliac structures consistently [23].

When performed in cadavers the multi-site, multi-depth technique was able to stain 91% of the nerves targeted. This provided a sound anatomical foundation for testing the technique in normal volunteers.

Active blocks protected 70% of normal volunteers from pain evoked from the interosseous and dorsal sacroiliac ligaments, and from puncture of the sacroiliac joint. This proportion was significantly different from that observed in the volunteers who received placebo injections. This difference establishes that active LBBs have an attributable effect that is substantial.

On the one hand, the success rate of 70% seems clinically acceptable, that is, sacral LBBs have a substantial degree of face validity. However, operators and consumers need to understand that the complementary 30% failure rate warns of possible false-negative responses, if these blocks are used in clinical practice to detect sacroiliac ligament pain.

A challenge will be to reduce this 30%, or to identify which patients have a false-negative response. Buttock numbness might be considered a sign of successful blockade, for the sacral lateral branches form the medial cluneal nerves, which innervate the skin of the buttock. However, the present data refute this application. Only one of four subjects who obtained buttock numbness after LBBs had insensate interosseous and dorsal sacroiliac ligaments. Thus, buttock numbness does not provide assurance that the lateral branches are adequately anesthetized.

What was conspicuous in the present study was the small proportion of subjects who were protected by LBBs from sacroiliac joint pain. The proportions were low following either active or placebo blocks, which suggests that they amount to no more than placebo responses or random effects. The implications of this observation are twofold.

Firstly, the inability of LBBs to anesthetize the sacroiliac joint refutes the conjecture that the joint is exclusively innervated by sacral dorsal rami. Other structures innervated by these nerves were demonstrably anesthetized, but the joint itself was not. This indicates that the joint must have an innervation, or an additional innervation, that is not through the sacral lateral branches. A ventral source seems the most likely [3,4].

Secondly, the sparing of the sacroiliac joint indicates that LBBs can be used as a test specifically for pain stemming from the posterior sacroiliac ligaments. In that regard, they do not replace, but complement intra-articular blocks. Intra-articular blocks test for joint pain, and LBBs test for ligament pain. This revelation resolves one of the earlier concerns about intra-articular blocks: that they do not test for ligament pain [26]. The

two diagnostic tests can now be used systematically to assess for pain possibly stemming from separate parts of the entire sacroiliac complex, or from all parts of it.

A third clinical implication arises. Sacral lateral branch radiofrequency neurotomy has been used to treat sacroiliac joint pain. Primarily, intra-articular blocks have been used to select patients for this treatment. In the light of the present data, intra-articular blocks are no longer an appropriate test for this procedure. More compelling, and consonant with the present data, would be relief of pain following controlled blocks of the sacral lateral branches. In principle, this diagnostic test should yield more robust outcomes from lateral branch neurotomy than have been reported to date.

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