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ORIGINAL ARTICLE

Referred pain location depends on the affected section of the sacroiliac joint

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Abstract
Purpose Pain referred from the sacroiliac joint (SIJ) may originate in the joint's posterior ligamentous region. The site of referred pain may depend on which SIJ section is affected. This study aimed to determine the exact origin of pain referred from four SIJ sections.
Methods The study included 50 patients with SIJ dysfunction, confirmed by more than 70 % pain relief after periarticular injection of local anesthetic into the SIJ. The posterior SIJ was divided into four sections—upper, middle, lower, and other (cranial portion of the ilium outside the SIJ)—designated sections 1, 2, 3, and 0, respectively. We then inserted a needle into the periarticular SIJ under fluoroscopy. After the patient identified the area(s) in which the needle insertion produced referred pain, we injected a mixture of 2 % lidocaine and contrast medium into the corresponding SIJ section.
Results Referred pain from SIJ section 0 was mainly located in the upper buttock along the iliac crest; pain from section 1, around the posterosuperior iliac spine; pain from section 2, in the middle buttock area; pain from section 3, in the lower buttock. In all, 22 (44.0 %) patients complained of groin pain, which was slightly relieved by lidocaine injection into SIJ sections 1 and 0.
Conclusions Dysfunctional upper sections of the SIJ are associated with pain in the upper buttock and lower sections with pain in the lower buttock. Groin pain might be referred from the upper SIJ sections.

Keywords Sacroiliac joint · Dysfunction · Periarticular injection · Referred pain · Groin pain

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Introduction

The sacroiliac joint (SIJ) consists of an articular region and a posterior ligamentous region [1]. The structure of the articular region is not suitable for a vertical load, whereas the posterior ligaments play an important role in bearing such a load [2, 3]. These ligaments comprise the posterior sacroiliac ligament and the interosseous sacroiliac ligaments. The accessory ligaments (e.g., iliolumbar ligament, sacrotuberous ligament, sacrospinous ligament) enhance the strength of the SIJ [1].

The exact origin of SIJ-related pain has not been clarified. Repeated movements and/or accidental minor subluxation of the SIJ may damage its related structures, including the joint capsule and the posterior ligamentous region. Many studies have used intraarticular SIJ injection to identify the origin of SIJ-related pain [4–9], but only 30.2 % of these patients were confirmed to have SIJ-related pain [10]. Recent European guidelines [11] do not recommend intraarticular SIJ injection for diagnosis and treatment of SIJ-related pain because it cannot assess pain originating from periarticular ligamentous tissues. Our previous study revealed that periarticular SIJ injection was more effective than intraarticular injection for alleviating SIJ dysfunction [12]. The SIJ periarticular area, including the posterior ligamentous region, can be a significant source of SIJ-related pain [13, 14]. It is well-known that the SIJ produces pain not only in the back but also in the

buttock, groin, and lower extremities in a pattern similar to that of other lumbosacral disorders. As the posterior ligamentous region is relatively large, we hypothesized that different types of referred pain may originate from different affected areas, or sections, of the SIJ. We therefore, divided the posterior area of the SIJ into four sections, as in our previous study, and investigated the site of the referred pain in relation to those individual sections [12].

Materials and methods

The ethics committee of Sendai Shakaihoken Hospital approved this study. Written informed consent for use of the data in the study was obtained from all patients.

Sections of the SIJ

As in our previous study [12], the posterior margin of the SIJ was divided into three equal sections (i.e., upper, middle, lower), designated sections 1, 2, and 3, respectively. A fourth section, corresponding to the cranial portion of the SIJ at the ilium with an equal interval (called section 0), was designated because some posterior sacroiliac ligaments are located in that area (Fig. 1).

Patients

A total of 93 patients with nondiagnosed lumbogluteal pain with or without lower extremity pain were investigated between December 2009 and March 2011. Among them, 50 patients were definitively diagnosed with SIJ dysfunction based on the fact that they obtained more than 70 % pain relief after periarticular SIJ injection of local anesthetic into one or more SIJ sections, as shown in our previous study [12]. They became the subjects of this study. We asked a patient how much was the pain left after injection; when the patient suppose the pain before the injection to be ten, if that was less than three, we defined that more than 70 % of pain decreases. The remaining 43 patients were excluded because of their radiological and/or MRI findings and for the following reasons: in all, 9 of the 43 patients exhibited a placebo response. We defined placebo response-positive patients as those who reported more than 50 % pain relief after 1 ml of 2 % lidocaine was injected into the painful side of the paravertebral muscle around the facet joint at the L4/5 level. Another ten patients were diagnosed as having lumbosacral disease based on their response to selective root block, facet block, and/or disk block. Finally, 24 patients were diagnosed with no SIJ pain because they had less than 70 % pain relief after SIJ injection.

The study patients included 25 men and 25 women with a mean age of 58 years (range 19–84 years). All patients suffered from lumbogluteal pain. In addition, 22 patients complained of groin pain (44 %), six patients reported lateral thigh pain (12 %), and three patients (6 %) had lateral lower leg pain.

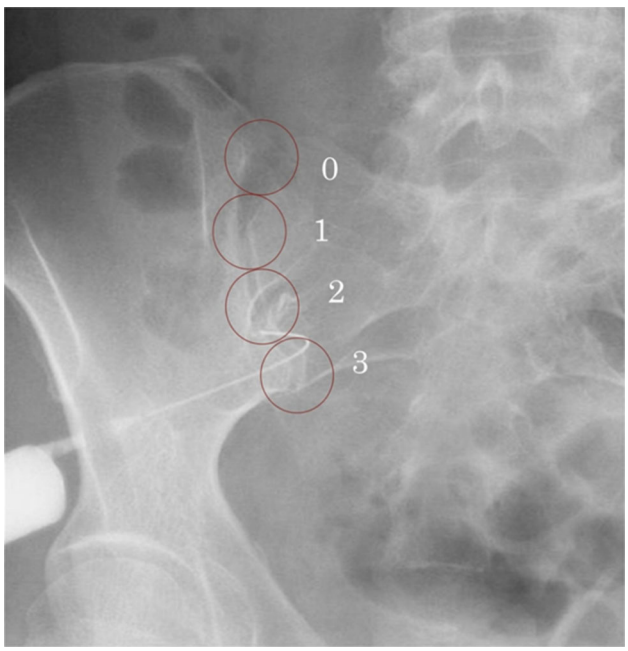

Fig. 1 Posterior area of the sacroiliac joint (SIJ) was divided into four sections (*0*, *1*, *2*, *3*). Needle insertion and contrast medium injection were performed in section 2

Methods for periarticular insertion of SIJ and identifying pain

Periarticular needle insertion was performed in all sections under fluoroscopy to detect the exact origin of the SIJ-referred pain, as in our previous study [12]. Briefly, the patient was positioned prone-oblique with the involved side down so the margin of the SIJ could be clearly detected. A 90-mm, 23-gauge spinal needle was inserted into each SIJ section under fluoroscopic guidance. When pain was referred by the needle insertion, the patient identified the area(s) affected, pointing to it with one finger [15]. If the referred pain was located in the distal position of the lower extremity, the patient verbally identified the area. The identified pain area was then mapped on pictures of body figures. After pain provocation, a mixture of 2 % lidocaine and contrast medium (mixture ratio 1:1) was injected into the identified SIJ section for pain relief. We confirmed that this mixture did not spread to other SIJ sections (Figs. 2, 3).

Intensity map of the referred pain from the SIJ

We superimposed the drawings of the areas of referred pain from each section and constructed an intensity map.

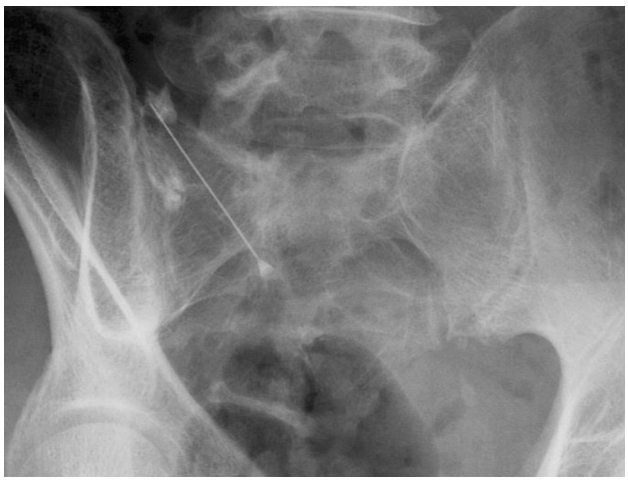

Fig. 2 Needle insertion and contrast medium injection in SIJ section 0 after SIJ section 1

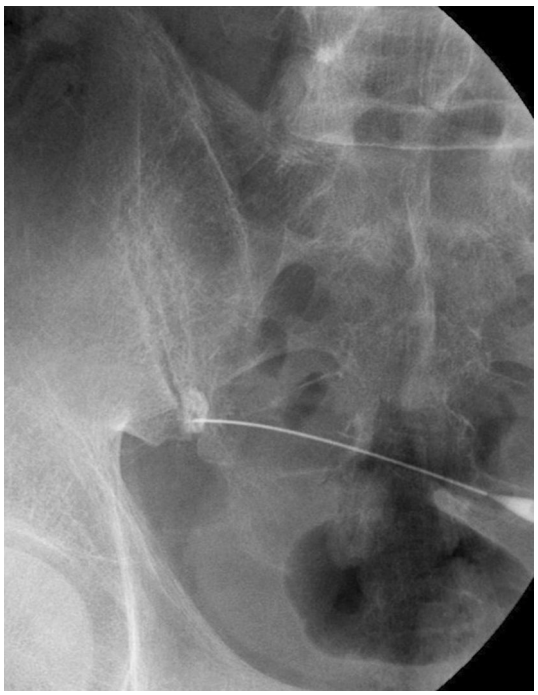

Fig. 3 Needle insertion and contrast medium injection in SIJ section 3

Usually, the pain was located only on one side. However, when a patient experienced pain on both sides, we evaluated the worse side.

We defined the areas of the buttock as follows: (1) around the posterosuperior iliac spine (PSIS); (2) middle buttock area: between the horizontal line of the PSIS bottom and the line connecting the PSIS bottom with the tip of the great trochanter of the hip; (3) upper buttock: above the middle buttock area including the iliac crest but excluding the PSIS; (4) lower buttock: below the middle buttock area.

Statistical analysis

To clarify the correlation between the referred pain areas and the SIJ sections, statistical analyses were performed using Fisher's exact test and residual analysis. A value of $p < 0.05$ was considered significant. The sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio were calculated, respectively, by comparing the most related section with other sections on each buttock area.

Results

Referred pain areas by needle insertion

Overall, six patients exhibited referred pain from only one SIJ section and 44 patients had pain in multiple sections induced by periarticular needle insertion. No patients reported referred pain on the side opposite that of the injection. The SIJ sections corresponding to the referred SIJ-induced pain are shown in Table 1: overall, 88 % (22/25) of the patients had pain located in the upper buttock that was referred from section 0. Referred pain at the PSIS was mostly (96 %) originated from section 1. In all, 69 % of the middle buttock pain has come from section 2, and 86 % of the lower buttock pain was referred from section 3. Statistical analysis proved that each of section 0 through 3 was related to pain in a particular area of the buttock. The diagnostic use of recognizing the relations of these two entities—the SIJ section and the area of referred pain—is shown in Table 2. There were significant

Table 1 Sections of the sacroiliac joint corresponding to areas of referred pain from that joint

Referred pain area after needle insertion	Section of the posterior area of the SIJ				p*
	0	1	2	3	
Upper buttock	22	3			<0.001
PSIS	1	23			<0.001
Middle buttock	2	8	22		<0.001
Lower buttock		1	3	24	<0.001
Groin		1			NS
Lateral thigh	3	2	1		NS
Lateral lower leg		1	1		NS
Posterior thigh			1		NS
Calf and toe				1	NS
Toe		2			NS
Total cases	28	41	28	25	

SIJ sacroiliac joint, *PSIS* posterosuperior iliac spine

* Fisher's exact test

Table 2 Diagnostic use of each affected section with each area of buttock pain

Referred pain area	Section	Sensitivity (%)	Specificity (%)	LR+	LR−
Upper buttock	0	88	94	14.2	0.13
PSIS	1	96	82	5.2	0.05
Middle buttock	2	69	93	10.3	0.33
Lower buttock	3	86	99	77.9	0.14

Clinical relevance if LR+ >2 and LR− <0.5

LR+ positive likelihood ratio, *LR−* negative likelihood ratio

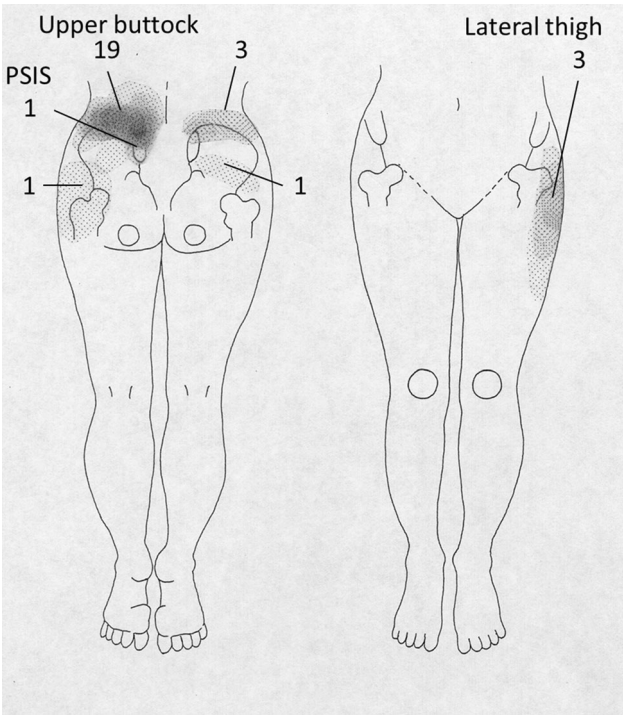

Fig. 4 SIJ section 0-referred pain in the upper buttock along the iliac crest

correlation between section 0 and upper buttock pain, section 1 and PSIS pain, section 2 and middle buttock pain, and section 3 and lower buttock pain.

Referred pain had spread to the groin and lower extremities in only a few patients: one described groin pain, six had lateral thigh pain, two had lateral lower leg pain, one had posterior thigh pain, one had calf and toe pain, and two had only toe pain. Figures 4, 5, 6 and 7 are intensity maps of the pain referred from each SIJ section that were constructed based on these data.

Pain relief by injection

In all of the patients, the lumbogluteal pain was reproduced by needle insertion into the SIJ section and was relieved by periarticular injection of local anesthetic into the same section. The reproduced pain correlated with relieved pain. Groin pain was reproduced in one patient

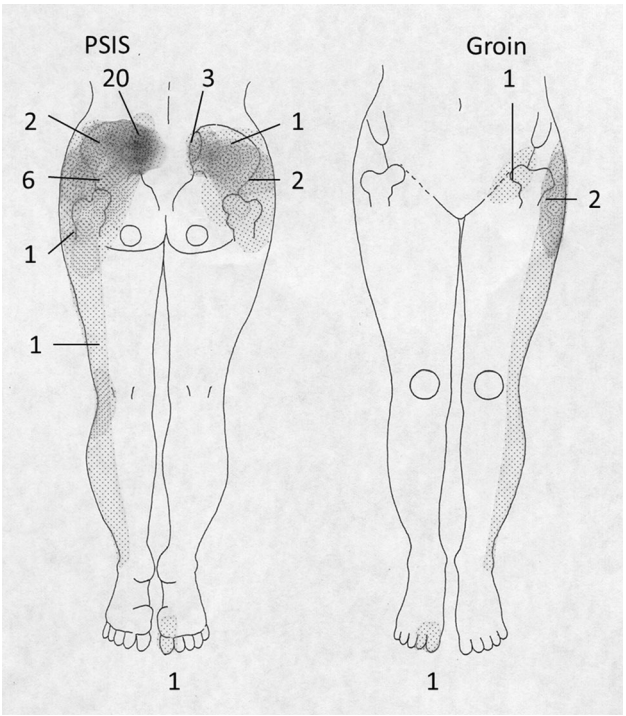

Fig. 5 SIJ section 1-referred pain around the posterosuperior iliac spine and groin

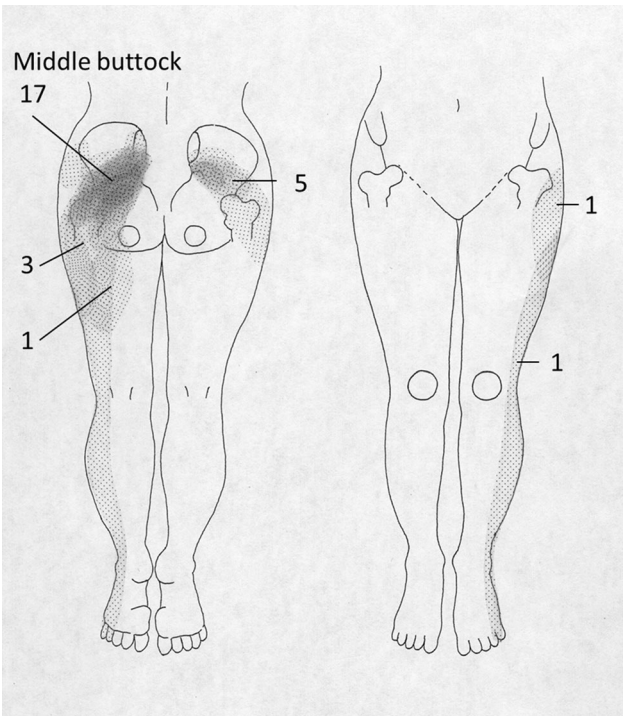

Fig. 6 SIJ section 2-referred pain in the middle buttock

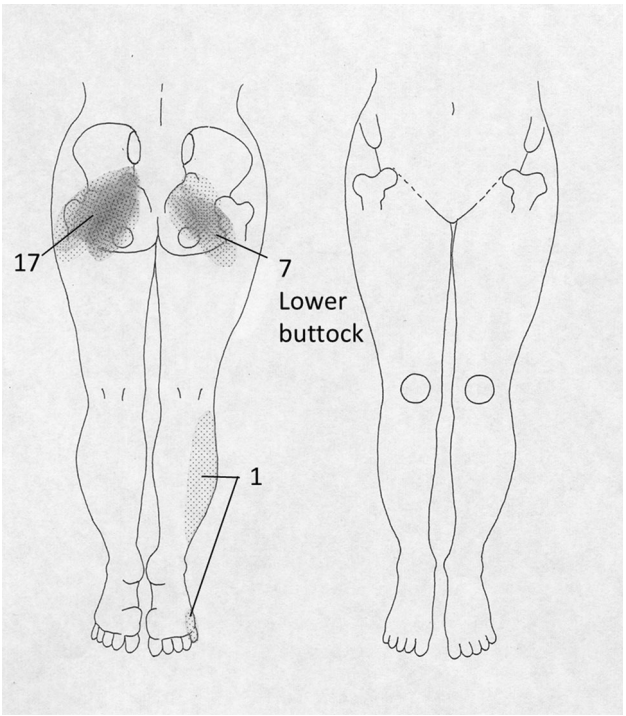

Fig. 7 SIJ section 3-referred pain in the lower buttock

Table 3 Patients in whom pain was reproduced by needle insertion and those whose pain was relieved by injection of local anesthetics

Complained pain area with lumbogluteal pain	Number of cases (%)	Reproduced by needle insertion	Pain relief by injection
Groin	22 (44)	1	22
Lateral thigh	6 (12)	4	6
Lateral lower leg	3 (6)	2	3

only but was relieved by periarticular injection of the SIJ in all 22 patients with this complaint. Among the six patients who complained of lateral thigh pain, four experienced pain reproduction by needle insertion, which was relieved by periarticular SIJ injection. Lateral lower leg pain was described by three patients and was reproduced in two of them by needle insertion. The pain was relieved in all three patients by periarticular SIJ injection (Table 3).

Sections for groin pain

The SIJ sections responsible for groin pain are shown in Table 4. Most of the patients required multi-section injection to relieve the pain: SIJ section 0 received an anesthetic injection in 13 patients, section 1 in 19 patients, section 2 in 14 patients, and section 3 in nine patients.

Table 4 Sections of the sacroiliac joint responsible for groin pain relief

Combination of the SIJ section				Groin pain relief (no. of cases)
0	1	2	3	
○	○	○	○	5
○	○	○		5
○	○			3
	○	○		2
	○			2
	○		○	2
		○	○	1
		○		1
			○	1
				Total = 22

Discussion

Our study is the first to assess the relation between the referred pain area and sections of the SIJ using the periarticular injection technique in patients with diagnosed SIJ dysfunction. Because the anesthetic was injected into a limited section of the ligamentous region, we were able to investigate more precisely the relation between various sections of the SIJ and the site of the referred pain.

The results of this study are interesting. Upper sections of the SIJ tend to refer pain to the upper part of the buttock pain, and lower SIJ sections refer pain to the lower buttock. Once the patient with SIJ dysfunction pinpoints the pain to those areas, the SIJ region that is referring the pain can be identified using our referred-pain maps.

All lumbogluteal pain was reproduced by needle insertion and relieved by periarticular SIJ injection of local anesthetic. Hackett [16] stated that the irritation caused by the needle in the ligament alone could reproduce the usual local pain and referred pain. In our study, the irritation of the needle alone to the periarticular SIJ area also was able to reproduce the pain, with patients stating, "That is my pain." Also, injection of local anesthetic relieved that pain. This finding indicates that most SIJ-related pain appears to be linked to the periarticular ligamentous region. An electrophysiological study showed that nociceptor exists in the ligamentous region of the SIJ [17]. We speculate that the nociceptors in the ligament are hypersensitive under abnormal conditions such as SIJ dysfunction.

Careful attention should be paid to groin pain as a possible symptom of SIJ dysfunction. In this study, 22 of 50 patients (44 %) reported groin pain. Other studies have reported that groin pain affects 9.3 % [18] or 14.0 % [19] of patients with SIJ dysfunction diagnosed by intraarticular injection. Groin pain, however, was not always reproduced by needle insertion, nor were lateral thigh pain and lateral

lower leg pain. We speculated that irritation by needle insertion alone may not be a sufficient stimulus for triggering these specific pains. If each section was stimulated using hypertonic saline via needle insertion, such pains might be reproduced [20]. However, this study involved a therapeutic case series, and we therefore did not adopt a provocative method using hypertonic saline because such an injection is of no benefit to the patient.

The mechanism for referred pain from the SIJ is unknown. The innervation of the SIJ has previously been investigated, and the posterior ligaments were found to be supplied by the lateral branches of the posterior primary rami from L4 to S3 [1]. However, we were unable to account for the referred pain area from the SIJ observed in this study based on any known nerve root dermatome. Hackett [16] showed that the relation between a ligament and the referred pain area is not coincident with a particular nerve root dermatome. Feinstein et al. [21] studied the pattern of deep somatic pain referral using paravertebral injections of hypertonic saline and showed that sympathetic and somatic (plexus) blocks did not interfere with the produced referred pain. Considering the differing referred pain areas from ligaments and/or deep somatic tissues, we should recognize specific pain areas from different nerve root dermatomes.

There are several limitations in this study. Referred pain is definitive when the pain is reproduced by stimulating the origin using a needle and then relieved by injecting a local anesthetic. This study revealed the relation between the SIJ section that is referring the pain and the site of the referred pain. We were unable, however, to clarify entirely the area of the patient's pain and the SIJ section that most contributed the referred pain because multiple SIJ sections were the corresponding in most cases, and anesthetics were injected into each. The ideal laboratory condition would be to inject the anesthetic into only one SIJ section per session and assess its effect. Because we were working in a clinical situation, however, we could not withhold medication. Another limitation was that although we accurately delineated the referred pain area on a medical chart and created intensity maps, the maps differed according to each patient's body configuration. More definitive information could be acquired if the patients pointed out the reproduced pain area under continuous exposure to radiation, but that was difficult with fluoroscopic timing. Still another limitation was that this study had no control group in regard to stimulating the periarticular SIJ region by needle insertion.

This study clearly showed that there were significant correlations between SIJ sections and the buttock areas experiencing the referred pain. The underlying reasons for these findings are not known. However, these findings can help us identify which section(s) of the SIJ should be injected initially to treat a particular area experiencing pain. Our findings might also help manual therapist treat SIJ dysfunction [22, 23] in regard to finding the area that requires adjustment.

Conclusions

1. The posterior margin of the SIJ was divided into four sections: upper, middle, and lower portions of the SIJ (sections 1, 2, 3) and an extracranial portion of the SIJ (section 0). Referred pain from each SIJ section was investigated using the periarticular injection technique.
2. Section 0 was associated with pain in the upper buttock, section 1 with pain around the PSIS, sections 2 with pain in the middle buttock, and section 3 with pain in the lower buttock.
3. Groin pain was characteristic of SIJ dysfunction and originated from all four SIJ sections. It had a slight tendency to be more often from sections 1 and 0.

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Conflict of interest None declared. We attest that the authors have not received and will not receive benefits for personal or professional use from any commercial party related directly or indirectly to the subject of this article.

References

1. Bernard TN, Classidy JD (1997) The sacroiliac joint syndrome. Pathophysiology, diagnosis and management. In: Frymoyer JW (ed) The adult spine: principles and practice. Lippincott-Raven Publishers, Philadelphia, pp 2343–2363
2. Vleeming A, Mooney V, Stoeckart R (2007) Movement, stability and lumbopelvic pain. Churchill Livingstone, Edinburgh, London, New york, Oxford, Philadelphia, St Luis, Sydney, Toronto
3. Eichenseer PH, Sybert DR, Cotton JR (2011) A finite element analysis of sacroiliac joint ligaments in response to different loading conditions. Spine 36:E1446–E1452
4. Dreyfuss P, Michaelsen M, Pauza K et al (1996) The value of medical history and physical examination in diagnosing sacroiliac joint pain. Spine 21:2594–2602
5. Maigne JY, Aivaliklis A, Pfefer F (1996) Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. Spine 21:1889–1892
6. Broadhurst NA, Bond MJ (1998) Pain provocation tests for the assessment of sacroiliac joint dysfunction. J Spinal Disord 11:341–345
7. Jonathan NS, David WP (2009) How often is low back pain not coming from the back? Spine 34:E27–E32
8. Maigne JY, Planchon CA (2005) Sacroiliac joint pain after lumbar fusion. A study with anesthetic blocks. Eur Spine J 14:654–658
9. Liliang PC, Lu K, Liang CL (2011) Sacroiliac joint pain after lumbar and lumbosacral fusion: findings using dual sacroiliac joint blocks. Pain Med 12:565–570
10. Schwarzer AC, Aprill CN, Bogduk N (1995) The sacroiliac joint in chronic low back pain. Spine 20:31–37

11. Vleeming A, Albert HB, Ostgaard HS et al (2008) European guidelines for the diagnosis and treatment of pelvic girdle pain. Eur Spine J 17:794–819
12. Murakami E, Tanaka Y, Aizawa T et al (2007) Effect of peri-articular and intraarticular lidocaine injections for sacroiliac joint pain: prospective comparative study. J Orthop Sci 12:274–280
13. Borowsky CD, Fagen G (2008) Sources of sacroiliac region pain: insights gained from a study comparing standard intra-articular injection with a technique combining intra- and peri-articular injection. Arch Phys Med Rehabil 89:2048–2056
14. Luukkainen RK, Wennerstrand PV, Kautiainen HH et al (2002) Efficacy of periarticular corticosteroid treatment of the sacroiliac joint in non-spondylarthropathic patients with chronic low back pain in the region of the sacroiliac joint. Clin Exp Rheumatol 20:31–37
15. Kanno H, Murakami E (2007) Comparison of low back pain sites identified by patient's finger versus hand: prospective randomized controlled clinical trial. J Orthop Sci 12:254–259
16. Hackett GS (1958) Ligament and tendon relaxation (skeletal disability) treated by prolotherapy (fibro-osseous proliferation). Charles C Thomas publisher LTD, Springfield
17. Sakamoto N, Yamashita T, Takebayashi T et al (2001) An electrophysiologic study of mechanoreceptors in the sacroiliac joint and adjacent tissues. Spine 26:E468–E471
18. Fukui S, Nosaka S (2002) Pain patterns originating from the sacroiliac joints. J Anesth 16:245–247
19. Slipman CW, Jackson HB, Lipetz JS et al (2000) Sacroiliac joint pain referral zones. Arch Phys Med Rehabil 81:334–338
20. Palsson TS, Graven-Nielsen T (2012) Experimental pelvic pain facilitates pain provocation tests and causes regional hyperalgesia. Pain 153:2233–2240
21. Feinstein B, Langton JNK, Jameson RM et al (1954) Experiments on pain referred from deep somatic tissues. J Bone Jt Surg 36A:981–997
22. Hakata S, Sumita K, Katada S (2005) Wirksamkeit der AK-Hakata-Methode bei der Behanderung der akuten Lumbago. Manuelle Med 43:19–23
23. Kurosawa D (2011) Report from Japan—Japanese medical society of arthrokinematic approach and the AKA-Hakata method in manual medicine. Int Musculoskelet Med 33:85–86