J Korean Neurosurg Soc 38 : 338-343, 2005

Selective Neurotomy of Sacral Lateral Branches for Pain of Sacroiliac Joint Dysfunction

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Objective : The sacroiliac joint complex is often related with functionally incapacitating pain in old aged people. The purpose of this study is to delineate the investigation strategies and to determine the long-term effect of radiofrequency (RF) neurotomies for pain arising from sacroiliac joint dysfunction(SIJD)

Methods : Sixteen patients were diagnosed as having chronic pain from SIJD by comparative controlled blocks on L5 dorsal rami, sacroiliac joints and deep interosseous ligaments. After confirming the positive response (more than 50% of pain relief), sensory stimulation was applied to detect the 'pathological' branches. Subsequently, RF neurotomies were performed on the selected nerve branches. Surgical outcome was graded as successful, moderate improvement, and failure after a 6month follow-up period.

Results : Stimulation intensity was 0.45V to elicit pain response in the L5 dorsal rami and lateral sacral branches. The number of RF-lesioned nerve branches was 6per patient. The average number of lesions for each branch was 1.3. Most commonly selected branches were L5 dorsal ramus (88%) and S2-upper division (88%). Ten patients (63%) reported a successful outcome according to the outcome criteria after 6months of follow-up, and five patients (31%) reported complete relief (100%). Five patients (31%) showed moderate improvements. One patient reported failure.

Conclusion : RF neurotomy of lateral sacral branches is an excellent treatment modality for the pain due to SIJD, provided that comparative controlled block shows a positive response.

KEY WORDS : Pain · Sacroiliac joint · Radiofrequency · Neurotomy.

Introduction

Sacroiliac joint dysfunction(SIJD) has been frequently revisited as a structural cause of low back pain throughout this century. However, the sacroiliac joint has been less understood from the standpoint of clinical findings, imaging diagnosis, and therapeutic intervention, compared to intervertebral disk and zygapophyseal joint diseases[15,16]. Recent investigation highlighted the importance of SIJD whose prevalence is around 15~30% among patients with chronic low back pain[11,17]. Anatomical details of the sensory innervation in the sacroiliac joints were recently described, which consequently broadened our understanding of the pain generation in this joint and improved the management of patients with low back pain[7,10,20].

Specific structural etiologies of low back pain including discogenic cause, zygapophyseal joint arthropathy, and sacroiliac joint pain are increasingly identified by evidence-based diagnostic methods[4,14]. Therefore, structure-specific diagnosis should be considered when selecting the most appropriate diagnostic options, and hence, the best treatment. In particular, intra-articular block in the sacroiliac joint and interosseous ligament injection on comparative block bases is being widely adopted for objective investigation, which confirms that chronic and intractable joint pain due to SIJD can be improved by denervation of the sacroiliac joint complex. In this regard, RF neurotomy of sacral lateral branches has recently been gaining close attention with in-depth understanding of anatomical innervation around the sacroiliac joint[2,20].

The purpose of this study was to validate the usefulness of RF neurotomy of lateral sacral branches in the management of sacroiliac joint pain. In addition, various factors were evaluated to determine better therapeutic strategies in this clinical setting.

• Received : March 22, 2005 • Accepted : July 5, 2005
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Materials and Methods

Patient population

Between October 2003 and October 2004, a total of 16 patients underwent RF neurotomies for their sacroiliac joint pain at our hospital. Patients who had chronic low back pain for more than 3months, pain intensity of greater than 5 in the visual analogue score(VAS), and primary source of pain in the sacroiliac joint complex, were included in this study. Thorough clinical and neurological examination, and simple x-rays were routinely performed. All patients were interviewed by a pain-specialized nurse, who recorded the pain distribution pattern, nature of pain, pain-related dynamic factors, and factors influencing life pattern and daily activities. Pain distribution patterns were divided into type A, B, and C (Fig. 1) : Type A shows the pain distribution in the low back, gluteal region, and lateral aspect of the thigh; Type B is similar to type A, but with the addition of groin pain; Type C demonstrates the pain in low back and posterior aspects of the thigh. No patients reported lower extremity pain below the knee joint. Excluded are the patients who had objective evidence of lumbosacral radiculopathy with signs of myotomal weakness, sensory disturbances, and loss of reflexes. Patients who had collagen, vascular, or rheumatologic diseases were also excluded.

Preoperative diagnostic block

All patients had diagnostic blocks in the operating room under a C-arm intensifier. To decrease the false positive rate, diagnostic blocks were performed more than twice for all patients. A needle was introduced in the intraarticular joint capsule, and contrast dye was injected to demonstrate the joint space. If the joint preserved the synovial joint cavity and did not show any leak, 1cc of 0.5% bupivacaine, 4% lidocaine, or saline was separately injected. If any leak was demonstrated or an arthrogram did not show the joint cavity, the needle was withdrawn and was again introduced into the deep interosseous ligament (DIOL) while local anesthetic was injected (Fig. 2). In summary, combinations of diagnostic blocks were grouped as follows : A) L5 dorsal ramus block + intra-articular injection of sacroiliac joint type, B) L5 dorsal ramus block + DIOL, C) lumbar medial branch block + L5 dorsal ramus block + intra-articular injection of sacroiliac joint. After injecting local anesthetics, patients were instructed to indicate the change in their usual pain as either complete relief, nearly complete relief, 50% reduction of pain, slight reduction of pain, or no change every 30minutes for 3days. If the patients

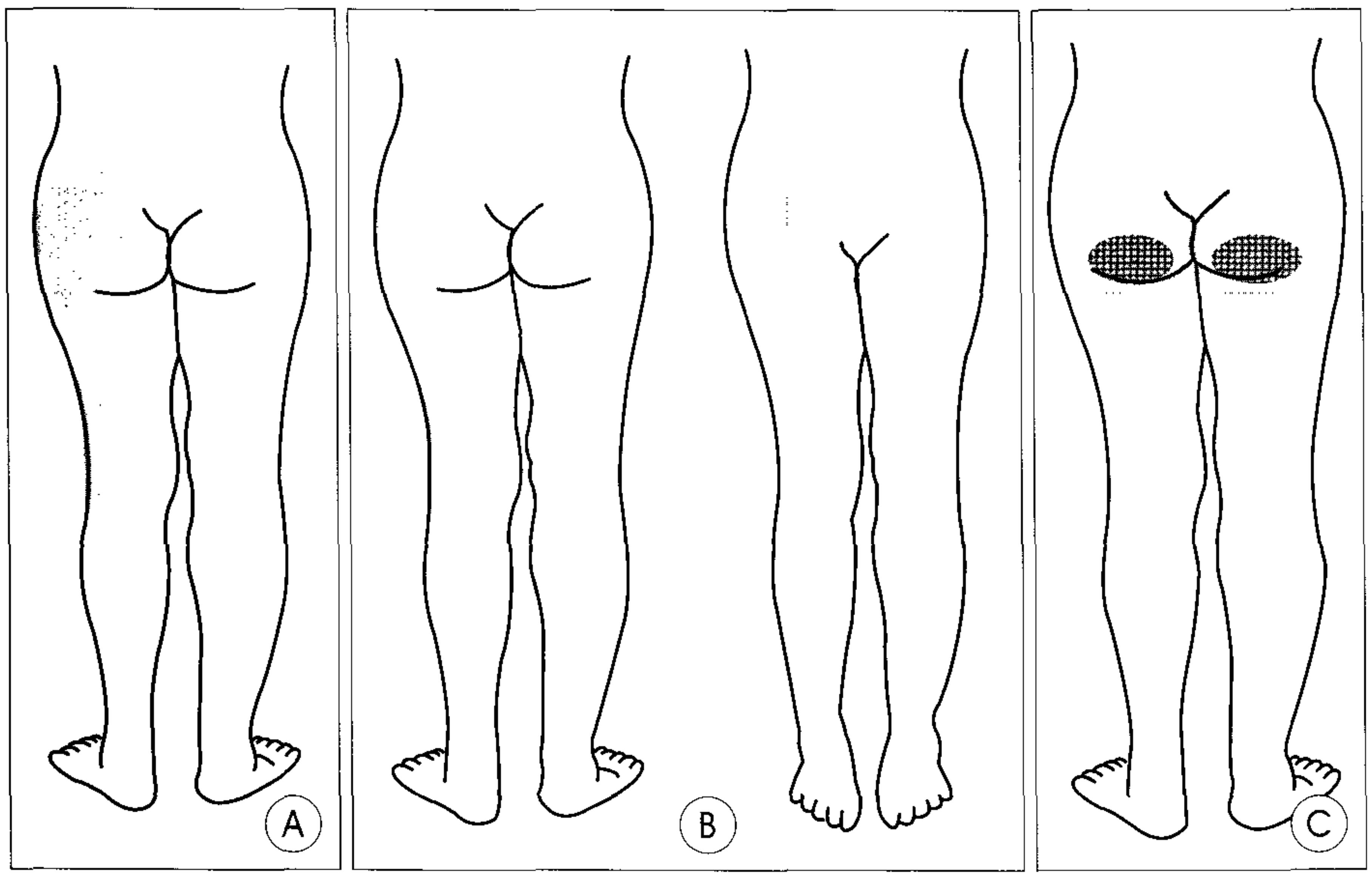

Fig. 1. Pain distribution patterns (Type A, B and C) in the patients with sacroiliac joint dysfunction.

Fig. 2. A : Schematic drawing demonstrating L5 dorsal ramus and lateral sacral branches innervating the sacroiliac joint and neighboring deep interosseous ligaments. The needles show the targets of blocks for interosseous ligaments (upper) and sacroiliac synovial joint (lower). B : Arthrogram of sacroiliac joint showing the contrast-filled space in. the joint. C : Oblique view of lower lumbosacrum shows dye spread pattern during the deep interosseous ligament injection. IOL : interosseous ligament, SLB: sacral lateral branch, SN : sacral nerve, SIJ : sacroiliac joint.

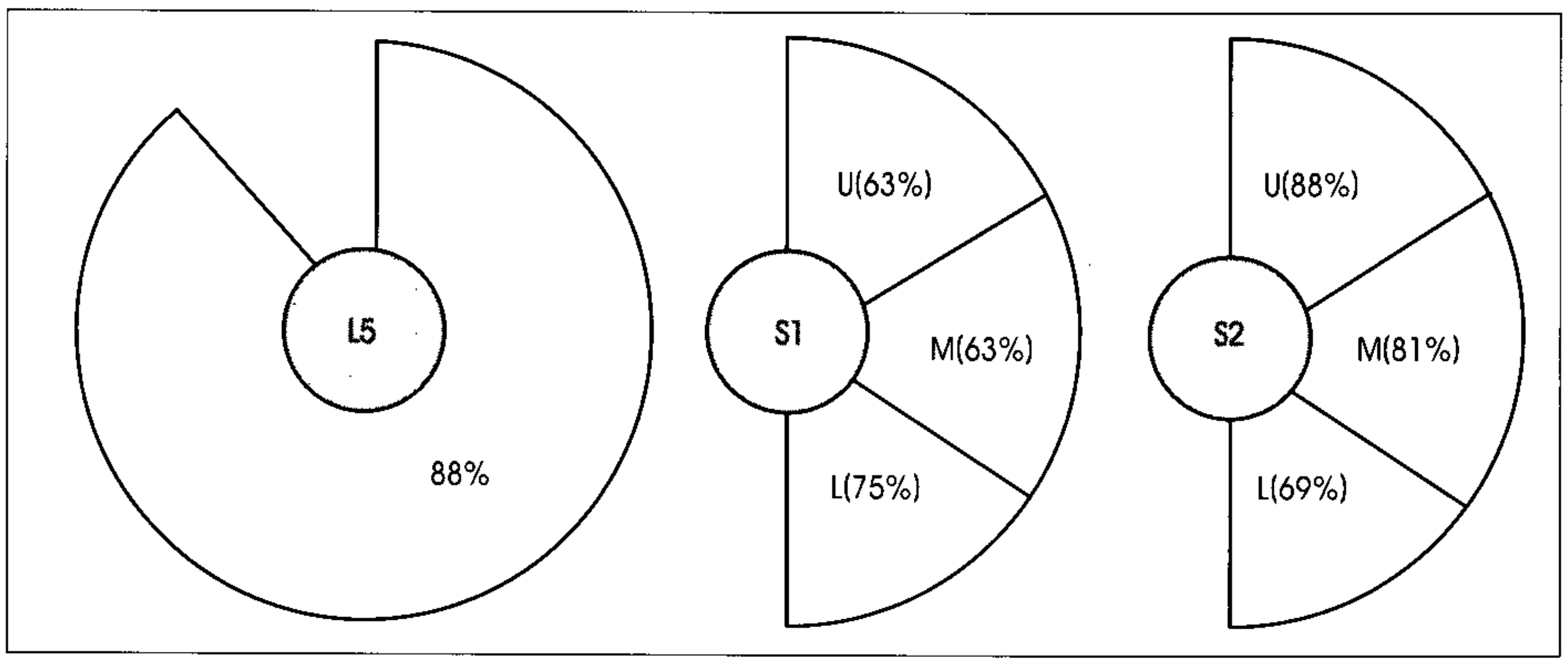

Fig. 3. Schematic diagram representing the involvement of nerve branches during radiofrequency neurotomies for sacroiliac joint pain. U : upper division, M ; middle division, L : lower division.

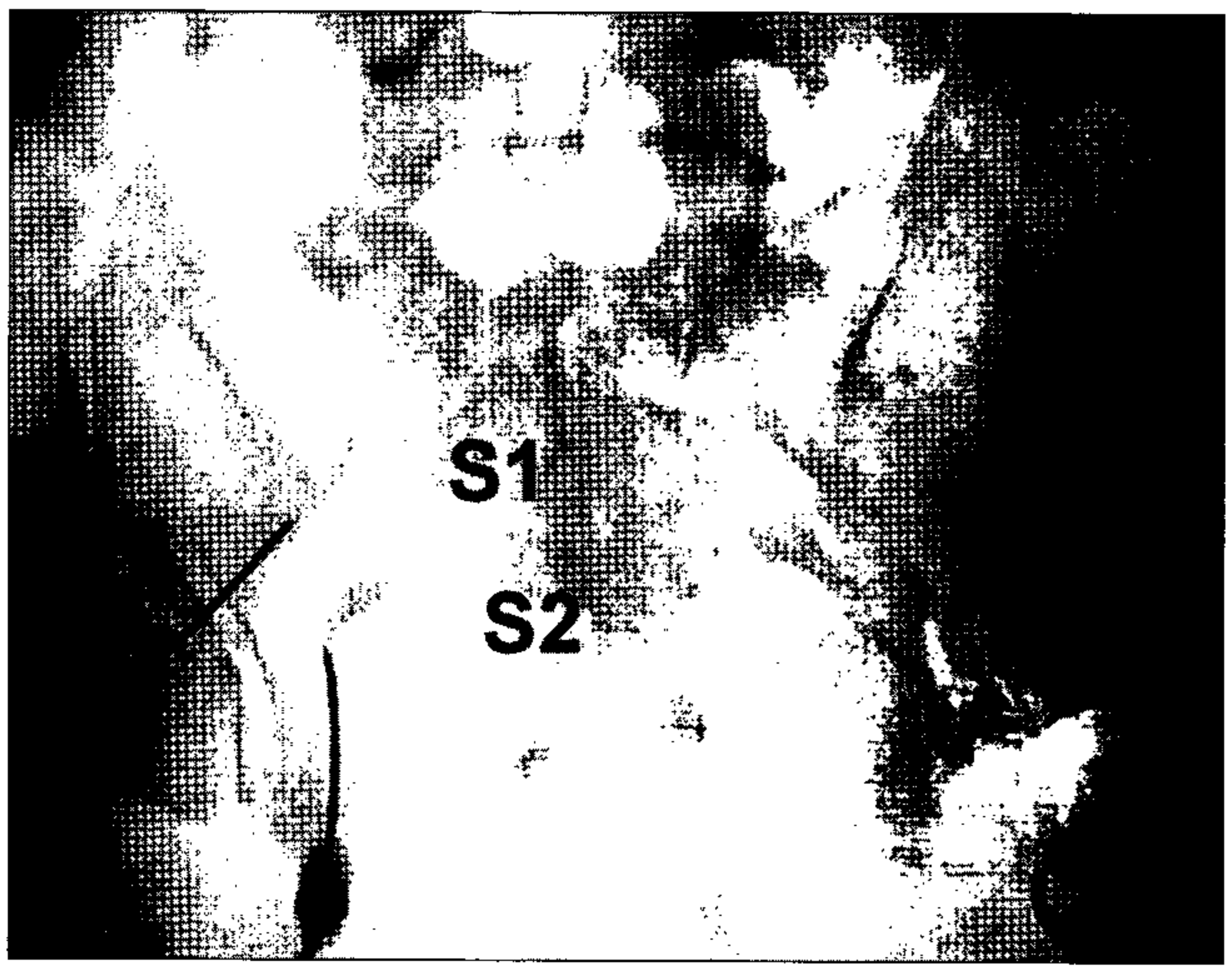

Fig. 4. Intraoperative photography during radiofrequency thermocoagulation of lateral sacral branches.

Table 1. Clinical characteristics in 16 patients with sacroiliac joint pain

Pt No	Age	Sex	Pain Dura'	VAS	Pain Distribu'	Aggravating Factors	Relieving Factors	Past Event
1	67	F	10y	7	C	Fl,T,W,L,S	R,L	
2	57	M	10y	7	C	S	L	
3	50	F	1y	5	A	L,S	W	
4	76	F	4y	10	A	S,D,Sd	L,W	
5	76	M	4y	7	A	L,W,B	–	
6	41	M	18y	7	A	Sd,WB	R,L	
7	55	M	3m	7	A	L,Sd	–	
8	36	F	3m	8	C	Fl,Sd,W,B	R	
9	37	F	12y	8	C	Fl,L,W,B	R	
10	76	F	40y	8	B	Fl,S,B,T,Sd,W,H	E,R,SL	HNP op
11	83	F	10y	5	C	E,Sd,W,H	Fl,R,L	Vertebroplasty
12	68	F	20y	7	C	E,T,Sd,W	Fl,L	
13	58	F	30y	9	A	Fl,T,Sd,S,W	R,L	
14	73	M	3m	8	B	Sd,W,B	L	
15	56	M	10y	8	A	Sd,W	–	Multiple spine op
16	47	F	9m	5	B	E,Sd,W,S,B	L,R	

*Pt: patient, VAS : visuoanalogue scale, Dura : duration, Distribu: distribution, F : female, M : male, Fl : flexion, T : transitional change of posture, W ; walking, E : extension, L : lying or sleeping, Sd : standing, H : heavy–lifting, R : rest, B : business–working, HNP : herniated nucleus pulposus, op : operation

demonstrated concordant pain relief better than '50% of pain reduction' on separate injections, they were considered candidates for RF neurotomies.

RF neurotomies

RF neurotomies were performed in an aseptic manner in the operating room. Patients were placed prone on the table with EKG & BP monitoring. A C-arm fluoroscopic unit (OEC, U.S.A and Madison, Korea) was used to visualize the target. To localize the "pathological branches" which are responsible for pain generation, a sensory-stimulation method was adopted. The L5 dorsal ramus and lateral sacral branches arising from S1, S2, and S3 sacral foramina were explored with sensory stimulation using a lesion generator (Leibinger N50, Germany). Each branch of the lateral sacral branch was divided into upper (12 o'clock to 2 o'clock zone), middle (2 o'clock to 4 o'clock zone), and lower divisions (4 o'clock to 6 o'clock zone) in the right side or upper (12 o'clock to 10 o'clock zone), middle (10 o'clock to 8 o'clock zone), and lower divisions (8 o'clock to 6 o'clock zone) in the left side (Fig. 3). To reach the L5 dorsal ramus, a 21-gauge RF cannula with 10mm active tip was introduced under fluoroscopic guidance at a superior aspect to the sacral alar. After checking for contact with the bone, the cannula was redirected slightly more cephalad until contact was lost, where the L5 dorsal ramus is presumably located. Sensory stimulation at 50Hz was performed until the minimum voltage of stimulation was obtained. Same cannula were introduced at the lateral edge of dorsal sacral foraminae of S1 and S2 (sometimes S3) to reach the lateral branches of sacral dorsal rami (Fig. 4). Using 50Hz frequency of stimulation with 1ms duration, stimulation of every division of lateral sacral branches was performed to locate the pathological branches. Stimulations usually elicit a tingling sensation, electrical pain, and a feeling of heaviness. If the pain response is the same as that of the usual pain with lower than 0.6 V stimulation, cannula was maintained for RF coagulation of the branches.

If the pathological branches were confirmed, RF neurotomies were performed. After introduction of 1cc of 2% lidocaine, a RF electrode was inserted through the RF cannula. A RF lesion was created on the L5 dorsal ramus with 60°C for 90seconds and lateral sacral branches with 80°C for 90seconds. Multiple lesions were produced for lateral sacral branches; meanwhile, a single lesion was produced for the L5 dorsal ramus. After RF Lesioning, 1cc of a mixture of 0.5% bupi-

Table 2. Result of Provocative test and RF neurotomies in 16patients with sacroiliac joint pain

Pt	Provocative Test				RF neurotomy		Surgical outcome
No	Type	Response			Site of Lesioning	Range of Stimulation(V)	(% improvement)
		1st	2nd	3rd			
1	A	50%	50%		Lt, S1(UML), S2(UML)	0.3 −0.69	86%
2	A	75%	100%		R, L5, S2(UML)	0.34−0.4	57%
3	A	75%	75%		R, L5, S2(UML)	0.48−0.58	100%
4	A	75%	75%		R, L5, S1(ML), S2(UM)	0.23−0.3	50%
5	C	75%	75%		R, L5, S1(UML), S2(UML)	0.5	100%
6	A	50%	50%		Lt, S1(UML), S2(UML)	0.61−0.65	86%
7	A	75%	100%		R, L5, S1(UM)	0.42−0.6	100%
8	A	75%	75%		B, L5, S1(UML)	0.5	88%
9	A	50%	50%		B, L5, S1(UML), S2(UML)	0.5	70%
10	B	75%	0%	75%	Lt, L5, S1(UML), S2(UML)	0.1 −0.4	75%
11	B	100%	50%		R, L5, S1(UML) S2(UML)	0.4 −0.47	50%
12	A	75%	25%		B, L5, R,S2(UM) Lt,S1(L)	0.3 −0.48	29%
13	B	75%	100%		R, L5, S1(L), S2(UML)	0.46−0.6	89%
14	A	60%	100%		R, L5, S1(UML), S2(UML)	0.43−0.63	100%
15	A	50%	50%		R, L5, S1(L), S2(U)	0.3 −0.5	63%
16	C	75%	50%		Lt, L5, S1(UL), S2(UML)	0.5 −0.65	100%

*Provocation test : type A : to L5 dorsal ramus block + intra−articular injection of sacroiliac joint type, Type B : L5 dorsal ramus block +deep interosseous ligament injection, Type C: lumbar medial branch block + L5 dorsal ramus block + intra−articular injection of sacroiliac joint, Lt : left, R ; right, B : both, S : lateral sacral branch, U : upper division, m : middle division, L : lower division

vacaine and 8mg/ml of triamcinolone was injected on the lesioned area to decrease postoperative pain and adhesions.

Follow-up and surgical results

Patients were monitored for a minimum of 6months after RF neurotomies. Patient outcome was measured with VAS score at 1month, 2months, 3months, and 6months after operations. Outcome was arbitrarily graded as a successful outcome (more than 75% improvement), moderate improvement (between 50 and 75% improvement), and failure (less than 50% improvement).

Results

Clinical characteristics of pain

Table 1 summarizes the clinical characteristics. Patients consisted of 6males (38%) and 10females (63%). Age at the time of evaluation and surgery ranged from 36 to 83years (mean 60.4years). Duration of pain prior to surgery ranged from 3months to 40years (mean 10.5years). Preoperative severity of pain ranged from 5 to 10 (mean 7.3) in VAS. Analysis of pain distribution pattern showed type A in 7 (44%), type B in 3 (19%), and type C in 6 (38%) (Fig. 1). Two patients were operated on their spines for similar pains, and one patient underwent vertebroplasty because of her compression fracture in the T8 level. Pain-aggravating factors were mostly related to weight-bearing posture and movement, including walking (75%), standing (63%), working (50%), sitting (44%), and lifting. Pain relieving factors were mostly related to the reduction of weight-bearing such as lying down (56%), resting (50%), and sleeping (38%).

Preoperative provocative test

The combination of diagnostic blocks was as follows : Type A) in 3patients (19%), B) in 2patients (13%), and Type C) in 11patients (69%). All patients obtained significant (≥50% at least) pain relief on each controlled block to be potential candidates for RF neurotomies (Table 2). At least two controlled blocks were performed in 15 of 16patients. The third test was required in one patient, because the results of her second block were not appropriate. Pain distribution pattern was not significantly correlated with the selection of diagnostic methods. However, we blocked a higher number of levels in our early trials because of a lack of experience, which were reduced later and were focused more on SIJD.

RF neurotomies and surgical outcome

Table 2 summarizes the RF neurotomies and surgical outcomes. Stimulation intensity was 0.45 V, ranging from 0.3 to 0.69, to elicit pain response in the L5 dorsal ramus and lateral sacral branches. The average number of lesions was 8per patient. The number of RF-lesioned nerve branches was 6per patient. Each branch had an average of 1.3 lesions. Most commonly involved nerve branches were L5 dorsal rami (88%) and S2-upper division (88%), followed by S1-middle division (81%), S1-lower division (75%), S2-lower division (69%), and S1-upper division (63%) and middle division (63%) (Fig. 3). Ten patients (63%) reported a successful outcome according to outcome criteria after 6months of follow-up, and five patients (31%) reported complete relief (1005) of sacroiliac joint pain. Five patients (31%) showed moderate improvements. One patient reported failure. Among three patients who had spinal procedures, one patient showed a successful outcome, and two showed moderate improvement. No patients showed identifiable complications after the procedures.

Discussion

SIJD used to be the most common diagnosis until the discovery of herniated disk in 1934[13]. As the herniated or ruptured disk was highlighted as an important cause of low back pain, SIJD was forgotten. Furthermore, the difficulty in separately diagnosing SIJD distracts the physician from concentrating on this disease. Unlike the neighboring structures including the lumbar zygapophyseal joint and lumbar discs, SIJD is lacking the clinical clues to diagnostic approaches[19].

Over 13 clinical signs, which are known to be helpful in diagnosing SIJD, have never been proven to be accurate[18]. Pain distribution that appears in patients with SIJD can also be observed in lumbar zygapophyseal and discogenic pain, because dorsal spinal rami are implicated in the nocioception of these structures. However, recent investigation demonstrated that the prevalence of intraarticular sacroiliac joint pain in patients with chronic low back pain is approximately 15 to 30 %[1,17]. This is likely to underestimate the true prevalence of SIJD, as the pain arising from the extracapular structures is not included in this investigation. Therefore, the prevalence of sacroiliac joint pain may be increased by the advent of new techniques to cover the whole spectrum of SIJD.

SIJDs are commonly caused by injury, infection, or pregnancy, which ultimately leads to degenerative arthritis of the sacroiliac joint. Direct falls, motor vehicle accidents, or other types of trauma can also strain the ligaments around the joints. Tearing of these ligaments can lead to excessive motion, which eventually leads to destruction of the joint and pain from degenerative arthritis. Injury can also cause direct injury of the synovial joint in the sacroiliac complex, which may lead to degenerative arthritis. Women are more at risk of developing sacroiliac joint problems due to childbirth. Hormones released during pregnancy allow the connective tissues to relax, which results in a hypermobile joint. Over the years, these changes can eventually lead to degenerative arthritis. The more pregnancies a woman undertakes, the higher her chances of sacroiliac joint arthropathy. In particular, whatever the cause, most patients in our series were over 60years of age, with more than 10years of pain. This strongly indicates that the recent increase in the elderly population is related to the higher incidence of sacroiliac joint arthropathy, since the aging process itself is essentially accompanied by the degenerative changes in the joint.

Diagnosis of SIJD is not easy, because clinical history, physical examination, and radiological findings do not provide convincing information. We classified the pain distribution pattern in patients with SIJD. Although these patterns sometimes overlap those of zygapophyseal joint pain, they can offer helpful guidelines in the initial investigation of low back pain. It is unlikely to start the investigation of SIJD without recognizing the pain patterns. We also made it our protocol to perform controlled intraarticular injection with local anesthetics for diagnosing the SIJD. It cannot, however, cover the whole spectrum of SIJD[5,11,17]. Intraarticular anesthetic injection into the sacroiliac joint is unlikely to detect pain from ligamentous changes, which are frequently involved in the pain generation in the SIJD[20]. Furthermore, rupture of the joint capsule cannot hold the anesthetic agents, which instead leak down on the lumbosacral plexus, resulting in numbness of the affected leg. It is sometimes unfeasible to insert the needle into the joint space, since it is too narrow or sclerotic to allow its introduction. Therefore, we adopted the technique of deep interosseous ligament(DIOL) injection to specially diagnose the dorsal sacroiliac joint pain in two patients, to whom the direct intraarticular anesthetic injection was not feasible[20]. DIOL injection is likely to block nocioception from ligamentous structures as well as intra-articular structure innervated by dorsal primary rami, which are sending the branches passing through DIOL[7,8]. We believe that the DIOL injection technique is an important tool of investigation, as it can provide the information of pain source from SIJD, because previous intraarticular injection can not differentiate the pain of extracapular origin from intravascular structures.

Treatment for SIJD has been controversial throughout this century. Fusion of the sacroiliac joint was performed via an anterior, posterior, or percutaneous approach. However, fusion is currently not performed as commonly as in the 1970s to tighten the mobile sacroiliac joint[3]. Intraarticular steroid injection is also favored due to its nature of minimal invasiveness and convenience of technical accessibility, although many patients derive only short-term benefit[9,12]. However, the use of RF power was not popularized until recently, as the anatomy of nervous innervation to the sacroiliac joint and surrounding structures was not fully understood. Direct RF denervation of the sacroiliac joint with multiple electrodes was developed to achieve long-term benefit with poor outcome[6]. Although conflicting, previous reports have generally demonstrated that the posterior sacroiliac joint derives its innervation from L4 and L5 posterior rami, and lateral branches of S1-S3 dorsal rami[7,10]. Based on the anatomical studies, radiofrequency lesioning of dorsal sacral lateral branches are being promisingly adopted, because RF lesion lasts longer while retaining the nature of minimal invasiveness[2,20]. We selected L5 dorsal rami and lateral sacral branches of S1 and S2 for RF neurotomies, as they are mostly innervating the sacroiliac joint complex. We were able to confirm that sensory stimulation was crucial to find the 'pathological' branches for RF neurotomies.

In our series, 63% of patients reported a successful outcome according to outcome criteria after 6months of follow-up, and five patients (31%) reported complete relief of sacroiliac joint pain. In addition, 31% of patients showed moderate improvements. The outcome of RF denervation of the sacroiliac joint was not promising until recently. Ferrante et al reported their technique of sacroiliac joint RF denervation with 36% long-term improvement in a group of patients with sacroiliac joint pain[6]. The poor outcome is likely to be derived from the lack of detailed anatomy of nervous structure innervating the sacroiliac joint. However, Yin et al reported better success; 64% of patients in their series with functionally limiting sacroiliac joint pain experienced greater than 60% improvement in their pain beyond 6months with sensory-stimulation guided neurotomies of sacral lateral branches[20]. We were able to confirm the effectiveness of Yin et al's technique, and acquired similar results. Sensory stimulation with lower voltage was considered to be an important element of procedures to find the branches, which should be coagulated with RF thermocoagulation, as intraarticular or DIOL injection only provide the broader diagnosis of SIJD. We have never failed to detect the 'pathologic' branches with low voltage stimulation in our series.

Limitations of the present study include the small number of patients studied and insufficient data to rule out lumbar discogenic pain. However, our data clinically address the usefulness of RF coagulation of dorsal sacral lateral branches in patients with sacroiliac joint pain of intracapsular or extracapsular origin. This will further provide another treatment option for chronic low back pain. Prospective controlled study is needed to delineate the patients' selection excluding the pain from neighboring structures and to determine the variables to achieve better results from this type of treatment.

Conclusion

Results of this study indicate that RF neurotomy of lateral sacral branches is an effective and promising method for the treatment of chronic sacroiliac joint pain. Combination of L5 dorsal ramus block, intra-articular injection of sacroiliac joint and deep interosseous ligament injection was useful to delineate the candidates for RF neurotomies. Sensory-stimulation enabled us to detect the pathological branches responsible for pain generation. Analysis of surgical outcome showed significant therapeutic benefit over existing treatment modalities for chronic pain due to sacroiliac joint dysfunction.

• Acknowledgement
The authors wish to thank Ms. Jung-OK Lee for her careful pain mapping.

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