Observational Study

Endoscopic Radiofrequency Treatment of the Sacroiliac Joint Complex for Low Back Pain: A Prospective Study with a 2-Year Follow-Up

Richard Ibrahim, MD[1], Albert E. Telfeian, MD, PhD[2], Karl Gohlke, BS[1], and Oleg Decker, BS[1]

From: [1]Orthopadische Praisklinik, Munich, Germany; [2]Department of Neurosurgery, Brown University, Providence, RI, USA

Address Correspondence:
Albert E. Telfeian, MD, PhD
Department of Neurosurgery,
Rhode Island Hospital, Brown University
593 Eddy St
Providence, RI 02903
E-mail: atelfeian@lifespan.org

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Background: The sacroiliac joint complex (SIJC) is considered a major sources of chronic low back pain. Interventional procedures for sacroiliac (SI) joint pain tend to be short-lived and surgical treatment usually involves a fusion procedure.

Objectives: To determine the clinical efficacy of endoscopically visualized radiofrequency treatment of the SIJC in the treatment of low back pain.

Study Design: Retrospective chart review.

Setting: This study took place in a single-center, orthopedic specialty hospital.

Methods: Patients received general anesthesia and under endoscopic visualization, radiofrequency ablation was performed on 1) the perforating branches that innervate the posterior capsule of the SI joint capsule, 2) along the course of the long posterior SI ligament, 3) the lateral edges of the S1, S2, and S3 foramen, and 4) the L4, L5, and S1 medial marginal nerve branches along the lateral facet margins.

Results: From January 2015 to June 2016, a total of 30 patients who met the precise inclusion criteria were treated with the endoscopic SIJC radiofrequency treatment for low back pain. The average patient was aged 56 years (19 women and 11 men), the average preoperative visual analog scale (VAS) score was 7.23, and the average Oswestry disability index (ODI) score was 44.8. VAS and ODI were measured at 3, 6, 9, 12, 15, 21 and 24 months: VAS was reduced from 7.23 at baseline to 2.82 at 24 months (61% reduction), and ODI was improved from 44.8 at baseline to 22.2 at 24 months (50% reduction).

Limitations: Small retrospective case series.

Conclusions: Full-endoscopic radiofrequency ablation of the large sensory SI joint innervation complex, that includes the sensory nerve branches along the lateral S1-3 foramina and the L4-S1 medial branches, is perhaps a minimally invasive surgical procedure that could provide significant relief of lumbar back pain in the carefully selected patient.

Key words: Endoscopic spine surgery, minimally invasive, low back pain, sacroiliac joint, radiofrequency treatment

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Chronic low back pain (CLBP) is a common complaint in health care and is associated with substantial health care costs. For those seeking treatment of CLBP, the sacroiliac joint complex (SIJC) is thought to be involved in as many as 10% to 30% of patients (1-4). The sacroiliac (SI) joint is the largest axial joint in the body connecting the sacrum to the ilium of the pelvis, and is innervated by the dorsal and ventral rami of the L5 to S4 nerve roots supplying the articular surface with both unmyelinated and myelinated A-delta and C-fibers (5-6). Degeneration of the joint with time and activity is thought to be the cause for SI joint

pain, and there is no gold-standard approach to the diagnosis of SI joint pathology as the cause for CLBP, as diagnosis is based on clinical presentation, imaging, physical exam, and injections.

Current interventional and surgical treatment options for SI joint pain include intraarticular or periarticular injection, radio frequency ablation, and SI joint fusion. The described interventional procedures are simple procedures and provide quick pain relief, but the effect is often short-lived. In addition, SI joint fusion is an invasive surgical procedure, even in its minimally invasive form, and should be reserved for refractory intractable pain of the SI joint.

New full-endoscopic radiofrequency procedures of the SIJC or facet complex neuronal structures have been used in the treatment of CLBP in a few clinical reports (7-10) with favorable results. In this study, we present our results in the treatment of a select group of patients with endoscopic radiofrequency treatment of the sensory nerve complex of the SIJC: 1) the perforating branches that innervate the posterior capsule of the SI joint capsule, 2) along the course of the long posterior SI ligament, 3) the lateral edges of the S1, S2, and S3 foramen, and 4) the L4-5 and L5-S1 medial marginal nerve branches along the lateral facet margins.{AU: Please clarify the numbered list at the end of the sentence beginning, "In this study, we present our results in the treatment…" were these part of one procedure? How do these connect with the beginning of the sentence?}

Methods

Patients

The institutional review board at our institution approved this study. The medical records of 30 consecutive patients who underwent endoscopic SIJC ablation for SI joint arthropathy and CLBP between January 2015 and June 2016 were reviewed. The inclusion criteria for this treatment were as follows: patient with predominant back pain (CLBP) and signs and symptoms of SI joint involvement on physical examination and radiologic tests, such as computed tomography scan and magnetic resonance imaging scan; unresponsive to conservative therapy including oral analgesics and physical or osteopathic therapy; persistent CLBP despite previous lumbosacral decompressive surgery and/or interventional pain management.

SIJC pathology as the main cause of CLBP is difficult to diagnose because of overlapping patterns with other sources of CLBP and varying patterns of pain between individuals. There are numerous physical examination maneuvers that have been suggested to diagnose SI joint pain, but provocative tests have been reported to have more reliability in numerous reports (11-12). To confirm the SI joint pain as the main source of CLBP, 3 separate intraarticular SI joint and multisite medial branch blocks of the lower facet joints (L4-S1) were performed under fluoroscopic control at least 3 weeks before. If the patient experiences 50% or higher improvement in pain in < 2 weeks from baseline according to visual analog scale (VAS) after the procedure, SIJC was considered the main pain generator. Endoscopic SIJC radiofrequency treatment would then be scheduled. Patients with tumors of the SI joint, rheumatologic diseases, and other severe comorbid diseases and medical conditions were excluded. All patients were followed a minimum of 24 months after the procedure.

Operative Technique

Endoscopic SIJC radiofrequency treatment was performed in the operating room with patients under general anesthesia. Patients were discharged home 3 days after the procedure. Patients were followed up in the outpatient clinic at 3, 6, 9, 12, 15, 21, and 24 months after the procedure.

Patients were positioned prone on the radiolucent Jackson table. Anteroposterior (AP) fluoroscopy was used throughout the case (Fig. 1.) . After infiltration with local anesthetic and using fluoroscopic guidance, an 18-gauge 15-cm spinal needle was placed over the inferior aspect of the posterior SI joint and docked onto the interosseous ligament over the posterior SI joint. A guide-wire was placed in the needle, a 5-mm incision was made over the needle, and the needle was removed. Sequential dilators were placed over the guide-wire until the final beveled working cannula (7.9 mm diameter) was placed. The Joimax working channel endoscope (6.9 mm x 5.6 mm) was placed in the working cannula, and its position was confirmed by AP and lateral fluoroscopy. Under endoscopic visualization, the posterior SI ligaments, capsule, synovia, and overlying soft tissue could be identified. The Joimax Legato monopolar or Vaporflex (Joimax, Germany) bipolar radiofrequency probes were then introduced through the working channel endoscope and used to ablate the perforating branches that innervate the posterior capsule of the SI joint, along the course of the long posterior SI ligament as it ascends in a cranial direction, and the lateral nerve branches around the sacral foramina (Figs. 2,3). Purisole (mannitol/sorbitol solution) was used as an irrigation solution. A bipolar probe was used in patients who had pacemakers or who previously had undergone

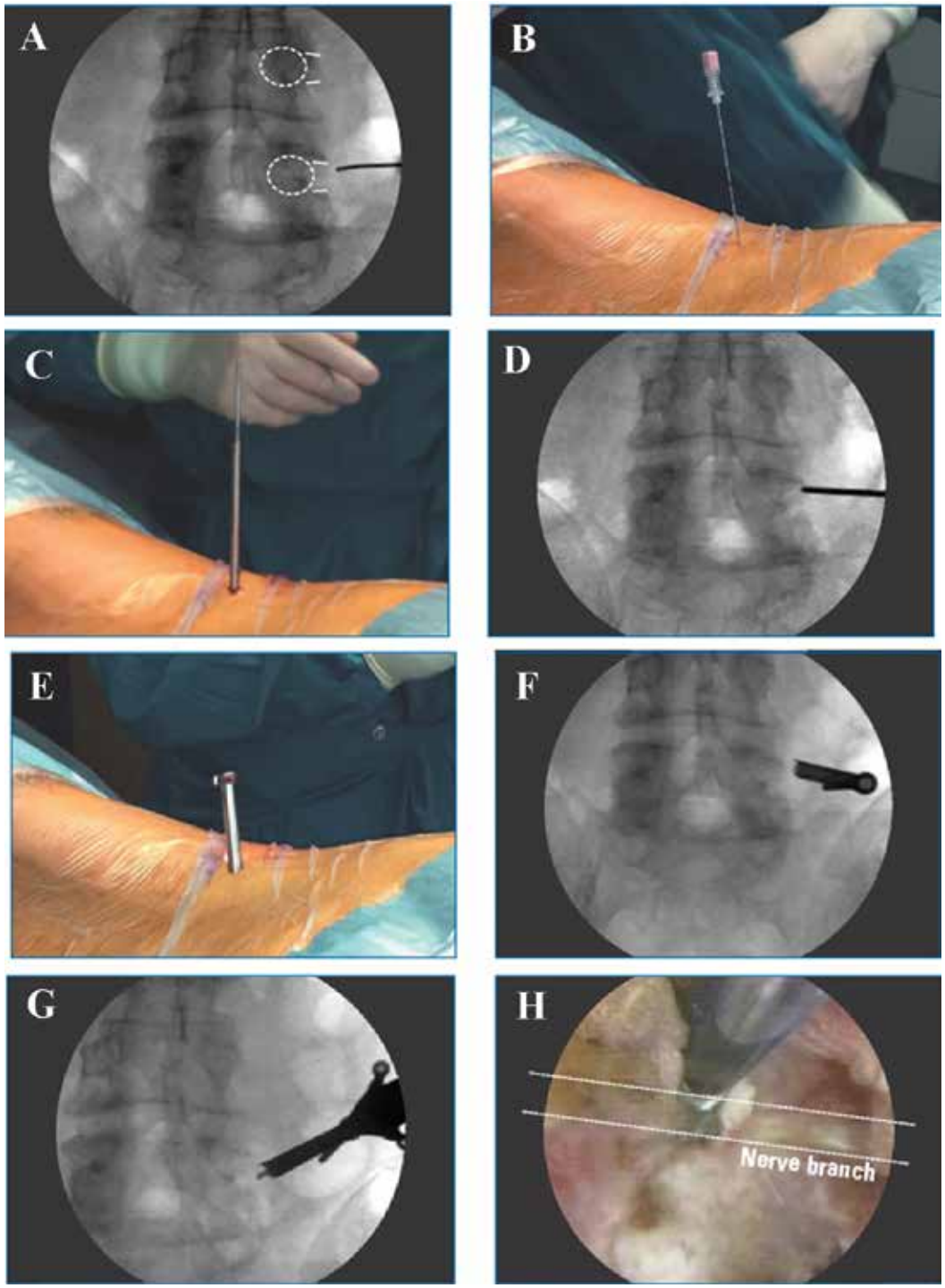

Fig. 1. *Endoscopic electrothermic surgery procedure: step by step. (A) AP fluoroscopic image demonstrating the 18-gauge 15-cm spinal needle being advanced to its target along the junction of the L5 transverse process and facet. (B) Photograph taken of the spinal needle advanced with the patient in the prone position on the Jackson table. (C) Photograph of the sequential dilators placed over a K-wire. (D) AP fluoroscopic image of the first dilator placed at the junction of the transverse process and facet. (E) Photograph of beveled working cannula in position. (F) AP fluoroscopic view of beveled working cannula in position. (G) AP fluoroscopic image of the bipolar electric probe, endoscope, and working cannula in position. (H) Endoscopic camera (Camsource) image of the Joimax Vaporflex bipolar electric probe performing a medial branch rhizotomy (the nerve branch is marked).*

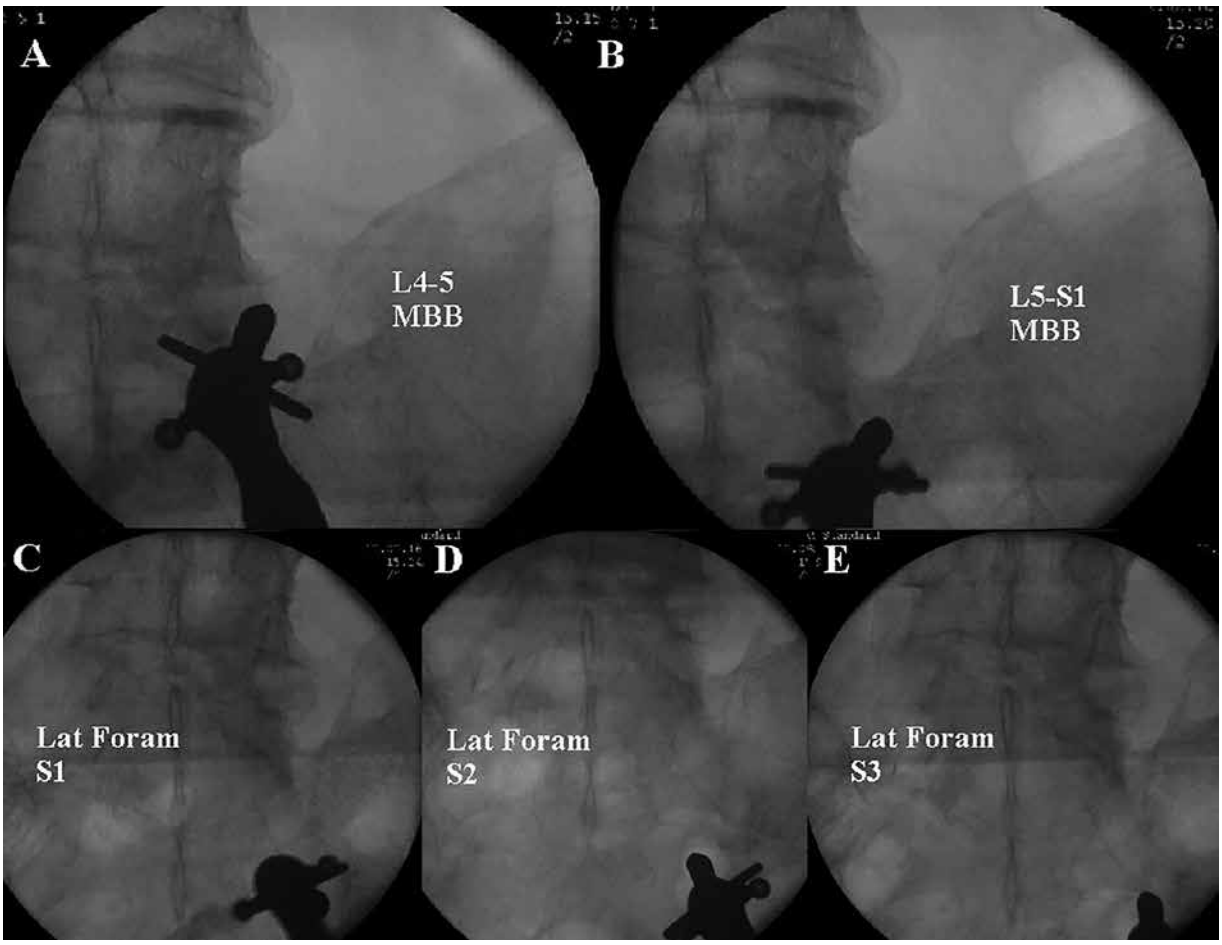

Fig. 2. *Endoscopic electrothermic SIJC ablation: fluoroscopic views. (A-E) AP fluoroscopic images of the beveled working cannula and endoscope in position for electrothermic ablation at the, (A) L4-5 medial branches, (B) L5-S1 medial branches, (C) S1 lateral foramen, (D) S2 lateral foramen, and (E) S3 lateral foramen.*

lumbar decompression surgery or had spinal cord stimulators implanted. Endoscopic visualization with fluoroscopic guidance was critical in identifying and visually confirming the long posterior SI ligament and the shiny posterior SI joint capsule, and then ablating the perforating innervating nerve branches in the cranial and lateral direction of the S1 to S3 foramen (lateral branches). An identical surgical approach was made over the junction of the L5 transverse process and facet to introduce the endoscope and working cannula. The endoscope was then directed to the L4-S1 facet complex, and the medial nerve branches were visually confirmed and ablated at the junction of the transverse process and facet. Continuous irrigation was maintained throughout the procedure to attempt to minimize thermal injury to the surrounding structures and improve visualization. After the endoscopic SIJC ablation procedure to the target points of S1 to S3 foramina and the L4-5 and L5-S1 complexes joints, the endoscope and cannula were removed. Postoperative medication included Novalgin (metamizol).

Results

From January 2015 to June 2016, a total of 30 patients who met the precise inclusion criteria were treated with the endoscopic SIJC radiofrequency treatment for low back pain. The clinical patient features and previous treatments are included in Table 1. The average patient was aged 56 years (19 women and 11

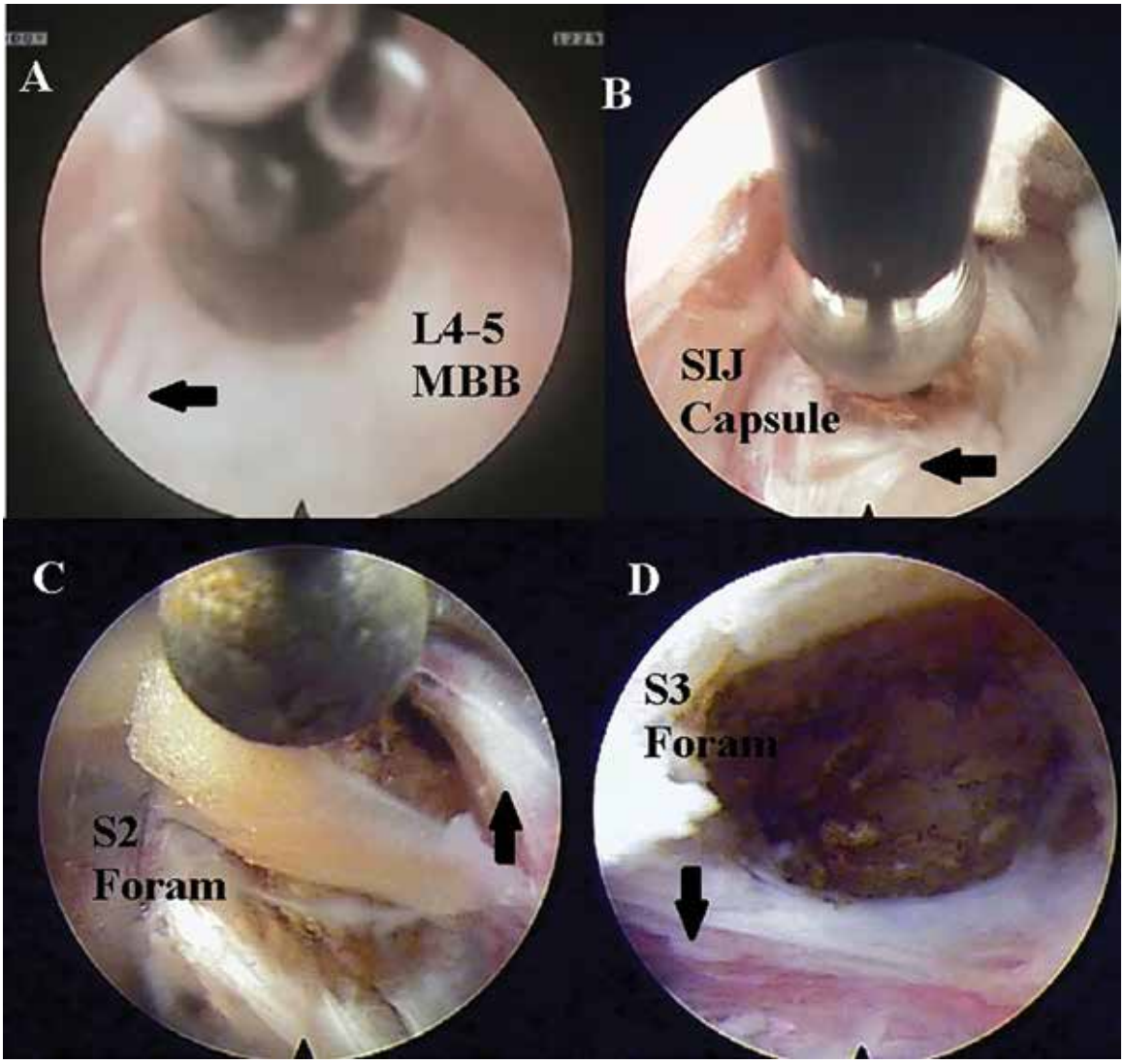

Fig. 3. *Endoscopic electrothermic SIJC ablation: endoscopic camera views. (A) L4-5 medial branch block with Joimax Legato monopolar probe (arrow indicates sensory nerve fiber). (B) SI joint capsule electrothermic ablation with the monopolar probe (arrow indicates sensory nerve fiber). (C) S2 lateral foramen electrothermic ablation with the monopolar probe. (D) S3 lateral foramen electrothermic ablation with the monopolar probe (arrow indicates sensory nerve fiber).*

men), and the average preoperative VAS score was 7.23 ± 1.55 and the average Oswestry disability index (ODI) score was 44.8 ± 21.73. VAS and ODI were measured at 3, 6, 9, 12, 15, 21 and 24 months: VAS was reduced from 7.23 at baseline to 2.82 ± 1.33 at 24 months (61% reduction), and ODI was improved from 44.8 at baseline to 22.24 ± 19.09 at 24 months (50% reduction). All statistics were performed using SPSS Version 24.0 (IBM Corporation, Armonk, NY). Table 2 demonstrates the preoperative and postoperative VAS and ODI results. Average operative time was 52 minutes.

Discussion

The SI joint is a complex biomechanical structure that is a joint complex with an articulating surface, ligaments, and nerves that is subject to forces in axial loading and rotation. Although not usually a simple diagnosis to make, SI joint pain is certainly a contrib-

Table 1. *Patient data*.

Patient	Age	Gender	Side of procedure	Other diagnoses	Previous Spine Procedures
1	77	F	right	L4-5 HD	Endoscopic discectomy, MBB, RF
2	57	F	left	Fibromyalgia	MMB, RF, MMPT
3	38	w	right	None	MBB, MMPT
4	86	F	right	None	MBB, MMPT
5	55	M	left	Spondylolisthesis L5-S1	MBB, RF, L4-S1 fusion, SCS , MMPT
6	54	F	left	HD L3-4	MBB, MMPT
7	66	F	right	HD L4-S1	Endoscopic discectomy, MBB
8	56	M	right	HD L4-S1	Endoscopic discectomy, MBB, MMPT
9	62	M	left	HD L5-S1	Endoscopic discectomy, MPP, MMPT
10	43	F	left	None	MBB
11	55	F	right	None	MBB
12	59	F	right	Spondylolisthesis L4-5	MBB, MMPT, RF
13	58	F	right	L5/S1 Artificial Disc	MBB, MMPT, RF
14	51	F	right	HD L4-5	MBB, MMPT, Endoscopic discectomy
15	42	F	right	None	MBB, MMPT
16	50	M	left	HD L4-S1	MBB, MMPT
17	57	F	left	None	MBB, MMPT
18	55	M	right	HD L5-S1	MBB, RF, L5-S1 fusion
19	33	F	left	HD L5-S1	MBB, MMPT, Endoscopic discectomy
20	64	F	left	HD L5-S1, Diabetic Polyneuropathy	MBB, MMPT
21	74	F	right	Decompression L4/S1	MBB, MMPT, Endoscopic discectomy, SCS
22	47	F	left	Left Knee-replacement	MBB, MMPT
23	75	F	right	Decompression L4-S1	MBB, MMPT
24	44	F	left	None	MBB, MMPT
25	46	F	left	HD L4-S1	MBB, MMPT, Endoscopic discectomy
26	78	M	bilateral	Spondylolisthesis L4-S1	MBB, MMPT, SCS
27	51	M	left	HD L4-S1	MBB, MMPT
28	75	M	left	HD L1-3	MBB, MMPT, RF, Endoscopy discectomy, SCS
29	75	M	left	HD L4-S1	MBB,MMPT
30	50	F	right	None	MBB, MMPT

uting factor in a subgroup of patients with CLBP, especially those who respond to interventional pain management treatment procedures at the SI joint, and present with the clinical symptoms and classic physical examination maneuvers used to diagnose SI joint pain. When treating the origin of pain at the SIJC, the choice is usually whether to treat the joint itself (fusion) or the innervation of the joint (radiofrequency ablation).

SI joint fusion is a significant procedure, even in its minimally invasive form, and publications on minimally invasive SI joint fusion focus on the effectiveness of the procedure, not on the complications associated with the procedure. The complication rates associated with the procedure seem to vary from 16.4% in one study with n = 77 patients (13), to 18% in another study with n = 114 patients (14), to a range of 3.5% to 5.6% (n = 5,319 patients) in an industry sponsored study (15). The specific complication of nerve impingement has been reported in one case by Araghi et al (16) (n = 50 patients), 48 cases by Miller et al (15) (n = 5,319 patients), and 3 patients by Smith et al (14) (n = 113 patients).

There are 2 randomized, placebo-controlled trials to reference regarding the use of radiofrequency ablation for the treatment of apparent SI joint pain

(17-18). One study targeted the S1-S3 foramina, and in the treatment group, 57% of patients had relief at 6 months, however, this decreased to 14% at one year (17). In the other study, ablation was also targeted at S1-S3 foramina and at 3 months, 47% of treated patients improved (12% in the control group improved), and at 1 year, 67% of the remaining patients improved (the study had significant patient drop out and cross over) (18). Choi et al (10) published their 6-month results for endoscopic electrothermic SIJC ablation in a group of 17 patients. At 6 months, they saw a reduction in VAS scores of 54% and ODI scores of 46%. In that group of 17 patients, 7 (41%) had previously undergone lumbar spine surgery (5 had undergone interbody fusion surgery). In a cadaveric study, Cox and Fortin (19) published their anatomic rationale for including the L5 dorsal rami in the treatment of SI joint pain, which was the anatomic basis for the targeting chosen here.

Table 2. *VAS and ODI outcomes.*

	VAS AVG	VAS STD	ODI AVG	ODI STD
PreOp	7.23	1.55	44.85	21.73
3 month	1.63	1.40	14.22	13.66
6 month	0.88	1.09	6.64	8.42
9 month	2.10	2.02	16.13	17.67
12 month	1.27	1.64	10.57	14.18
15 month	1.43	1.68	10.78	15.40
21 month	1.77	2.00	14.00	16.10
24 month	2.82	1.33	22.24	19.09

Conclusions

In our patient series, there were 11 (37%) patients who had previous lumbar surgery, 2 (7%) who had interbody lumbar fusions, and 4 (13%) who had spinal cord stimulators in place. All patients had tried interventional pain management prior to their endoscopic SIJC surgery. Our patient clinical demographics certainly reflect that this is a complex clinical picture that offers a challenge to the spine interventionalist. Although our 2-year results of a 61% reduction in VAS scores and a 50% improvement in ODI reflect the same trend that Choi et al (10) found in their 6-month data, our series suffers from similar limitations. There is no direct comparison with a conventional nonendoscopic radiofrequency ablation group, small case number, and diverse patient population in terms of patients who did or did not have previous lumbar surgery, fusion, or spinal cord stimulation. Adding endoscopic visualization to improve targeting the offending nerves and larger endoscopic radiofrequency ablation probes certainly seems like a logical direction to go in the treatment of SI joint pain. Further clinical studies with a larger population and a control group are necessary to better understand where fully-endoscopic SIJC electrothermic ablation stands in relation to SI joint fusion and needle radiofrequency ablation in its impact on SI joint-mediated pain.

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