Retrospective Study

A Retrospective Analysis of Sacroiliac Joint Pain Interventions: Intraarticular Steroid Injection and Lateral Branch Radiofrequency Neurotomy

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Background: Sacroiliac joint (SIJ) pain is a common etiology of chronic lower back pain. Treatment of persistent sacroiliac joint pain may entail intraarticular steroid injections and lateral branch radiofrequency neurotomy.

Objectives: This study evaluates the efficacy of SIJ intervention treatments by comparing intraarticular steroid injections with lateral branch radiofrequency neurotomy.

Study Design: Retrospective cohort study.

Setting: We reviewed electronic medical records of patients with SIJ pain at Massachusetts General Hospital from 2006 through 2016 and identified 354 patients who received 930 SIJ intraarticular injections and 19 patients who received 41 SIJ lateral branch radiofrequency neurotomies.

Methods: The Numeric Rating Scale (NRS) score for pain and the Eastern Cooperative Oncology Group (ECOG) Performance Status were measured prior to intervention and on follow-up. A mixed effects model was used to evaluate the duration of treatment effect.

Results: Patients who received an SIJ intraarticular steroid injection reported lower pain scores following treatment with a mean (standard deviation) NRS reduction from 6.77 (2.25) to 2.72 (2.81). SIJ lateral branch radiofrequency neurotomy resulted in NRS reduction from 5.96 (2.39) to 3.54 (3.14). A linear mixed model analysis suggests SIJ intraarticular steroid injections provided an estimated mean (CI 95%) of 38 (30-46.3) days of pain relief. Lateral branch radiofrequency neurotomy provided 82 (39.4-124.8) days of pain relief. The mean preprocedure ECOG score was 1.22 for both interventions and trended toward improvement with a post SIJ intraarticular injection score of 1.05 and SIJ lateral branch radiofrequency neurotomy score of 1.03.

Limitations: There was variable follow-up reporting among patients. The small size of the lateral branch radiofrequency cohort limited intergroup comparisons.

Conclusion: Both SIJ intraarticular steroid injections and SIJ lateral branch radiofrequency neurotomy demonstrated significant pain relief for patients with SIJ pain. SIJ lateral branch radiofrequency neurotomy provided a longer duration of pain relief (82 days) versus SIJ intraarticular steroid injection (38 days).

Key words: Sacroiliac joint pain, sacroiliac intraarticular steroid injection, lateral branch radiofrequency neurotomy

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Sacroiliac joint (SIJ) pain is a common cause of persistent low back pain (1,2). SIJ pain is clinically defined as pain in the region of the sacroiliac joint where provocative clinical maneuvers stressing the joint can reproduce pain or selective infiltration of the joint with local anesthetic relieves pain (1). The overall prevalence of SIJ pathology responsible for persistent low back pain ranges from 10%-25% (3,4) with increasing prevalence until age 70 (5).

The SIJ complex is a synovial joint between the sacrum and ilium, allowing for load transfer between the axial spine and lower extremities with additional support from posterior sacral ligaments (6). It is innervated dorsally by the L5 dorsal ramus, S1, S2, and S3 lateral nerve branches (7) and ventrally by the lumbopelvic rami (6). SIJ pain can arise from trauma, degenerative arthropathy, or inflammatory arthropathies affecting the joint itself or sacroiliac ligaments (6-9). Risk factors include repetitive sports injury, leg length discrepancy or asymmetrical pelvic loading, and a history of lumbar fusion (10-12). Clinically, patients with SIJ pain may describe low back pain, buttock pain, groin pain, tenderness over the posterior superior iliac spine, or pain when sitting on a chair (9,13). SIJ provocative maneuvers include flexion abduction external rotation, thigh thrust, Gaenslen test, sacral distraction, sacral thrust, and lateral compression. However, physical exam maneuvers have conflicting predictive values with studies demonstrating a lack of diagnostic value individually (14,15) and in combination (15). Other studies suggest a combination of tests offer a greater sensitivity and specificity (16,17) or utilize scoring systems incorporating history and specific exam maneuvers (13,18).

Current treatment recommendations include conservative management with analgesics and physical therapy to correct gait and postural biomechanics (19). SIJ injections with local anesthetic and steroids, lateral branch radiofrequency neurotomy, and sacroiliac joint fusion have demonstrated variable success in treating SIJ pain (20,21). Treatment guidelines by the Spine Intervention Society recommend proceeding with local anesthetic and steroid injections for patients with significant pain and functional limitation. Targeting either the superior pole or inferior pole of the sacroiliac joint likely yields similar results (22). Lateral branch radiofrequency neurotomy is recommended only after 2-3 months of symptom persistence (20).

Currently, SIJ therapeutic injections have moderate evidence of efficacy (4), typically providing short to intermediate pain reduction (23,24). Lateral branch radiofrequency denervation has the potential for extending treatment effect with continued pain reduction at 6 months (25,26), but there remains limited research regarding the efficacy of lateral branch radiofrequency neurotomy for SIJ pain (27). The purpose of our study was to evaluate the efficacy of therapeutic sacroiliac intraarticular steroid joint injections and lateral branch radiofrequency neurotomy in a retrospective cohort study design conducted at a single site.

Methods

Study Design and Population: This was a retrospective, observational, cohort study of patients with SIJ pain who were treated with intraarticular steroid (IAS) injection or lateral branch radiofrequency neurotomy (LBRFN). We reviewed cases of SIJ pain treated at the Massachusetts General Hospital outpatient pain clinic in Boston, MA during a 10-year period from January 2006 through July 2016. The study was approved by the Institutional Review Board of Massachusetts General Hospital. Data were collected and reviewed from December 2016 through August 2017. Cases were defined as adult patients > 18 years old who were diagnosed with SIJ pain and who received either IAS injection or LBRFN intervention. A total of 373 patients with SIJ pain were included in the study cohort: 354 patients received IAS injections and 19 patients received LBRFN. Patients who received LBRFN were required to have persistent SIJ pain of > 3 months and to have failed prior SIJ IAS injections. Additional demographic information obtained included age, gender, marital status, employment, disability, litigations, active tobacco use, history of alcohol abuse, history of drug abuse, and opioid use.

Treatment modalities compared in this study were fluoroscopy-guided SIJ IAS injections and SIJ LBRFN. SIJ IAS injections were performed per individual clinician standards with local anesthetic: 1-2 mL of either lidocaine 1-2% and/or bupivacaine 0.25-0.5% with addition of particulate steroid (1 mL of 40 mg/mL triamcinolone). SIJ IAS injection needle placement was typically performed at the inferior pole (Fig. 1) while some providers also elected to inject the superior pole. SIJ LBRFN involved L5 dorsal ramus denervation and S1, S2, S3 lateral branch denervation (Fig. 2). The specific LBRFN technique such as conventional, bipolar, cooled radiofrequency, needle localization, and number of lesions at each site was performed per individual clinician preference.

Outcome Measures

The primary outcome was the self-report pain score, which was measured by the numeric rating scale (NRS) 0-10/10 and the secondary outcome was the functional score as measured by the Eastern Cooperative Oncology Group (ECOG) performance scale (28) 0-5/5. A functional score of 0 is rated as fully active, with higher scores indicating greater disability up to 5, which is defined as death. Data were obtained at various time points including pre-

treatment and immediately posttreatment, as well as during routine clinic follow-up visits, to evaluate the duration of treatment effect.

Power Analysis

There was no a priori power analysis to guide sample size estimation for this study. The size of the study cohort was decided based on the number of available clinical cases within Massachusetts General Hospital's electronic medical records system during the defined period.

Statistical Analysis

Descriptive analyses were conducted using means and standard deviations for continuous variables (or medians and quartiles based when data distributions were not normal), and frequencies and percentages for categorical variables. Univariate analyses of patient characteristics and outcomes were conducted using 2-independent sample t-tests for continuous variables and χ^2 tests for factor variables. Standardized Mean Differences (SMD) were reported. Variables with SMD > 0.1 were considered as having a significant difference and were included in multivariable analyses for adjustment.

Multivariable regression analyses were conducted for primary and secondary outcomes (i.e., pain scores, functional status measures) before and after treatment procedures (LBRFN or SIJ IAS injection). Linear mixed effects models (LME) were utilized having variables of treatment group, time points (pre and post), age, marital status, employment, substance abuse history (i.e., alcohol, illicit drugs) and opioid drug usage status as fixed effects. Random intercept LME models were used, and patient identifiers were used as random intercepts. Missing data in the NRS and functional scores in preprocedure and postprocedure timepoints were imputed using the Multiple Imputation with Chained Equations method and modeling estimations were pooled among 5 imputed datasets. Missing data in the follow-up visit data were handled using the Last Observation Carried Forward method and the treatment effective period were calculated as the length of time from date of procedure to the first relapse of pain condition (NRS score back to ≥ 4 after procedure, including the posttreatment visit if not effective). Similar LME analyses were conducted. Fixed effects included the treatment group and the aforementioned demographic variables (if significant from the pre-post LME model) and random intercepts were patient identifiers.

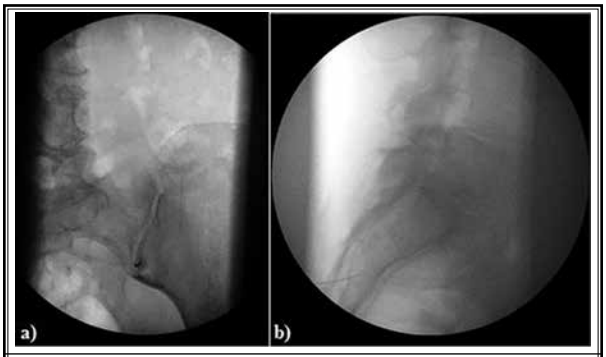

Fig. 1. *Right SIJ IAS with* a) *anteroposterior and* b) *lateral views.*

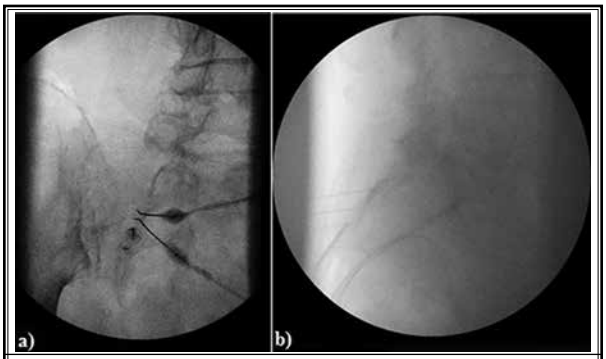

Fig. 2. *Left SIJ lateral branch radiofrequency neurotomy with a) anteroposterior and b) lateral views.*

Model estimations from mixed effects models were reported using difference in means estimates along with their corresponding 95% CI. All tests were 2-tailed, and alpha was set to 0.05. R statistical Software (Rstudio PBC) was used for data management and analyses.

Results

Study Population

During the 10-year review period, 354 patients underwent SIJ IAS injections for a total of 930 injections; 19 patients received a total of 41 SIJ LBRFN procedures (Fig. 3). Among the patients receiving SIJ IAS injections, 196 patients received a single SIJ IAS injection. One hundred fifty-four patients received serial SIJ IAS injections, averaging 4.76 procedures each. Patients in the SIJ LBRFN group received an average of 3.72 SIJ IAS injections prior to their radiofrequency intervention.

The average age was 41-years-old in the IAS injection group and 54-years-old in the LBRFN group. Patients were predominantly women in both groups. There was a higher rate of employment in the LBRFN

group (47.1%) compared to the IAS group (34.6%). There was a higher occurrence of tobacco use (38.9% versus 18.4%), alcohol use (17.6% versus 3.1%), and illicit drug use (23.5% versus 0.9%) in the LBRFN group compared to the IAS group. Opioid medication use was more prevalent in the IAS group (33.1%) compared to the LBRFN group (26.3%). A statistical difference was noted between the groups in terms of age, marital status, employment, active smoking or tobacco use, alcohol and drug abuse, and opioid use. There was no significant difference between the groups for gender, disability, and litigation history (Table 1).

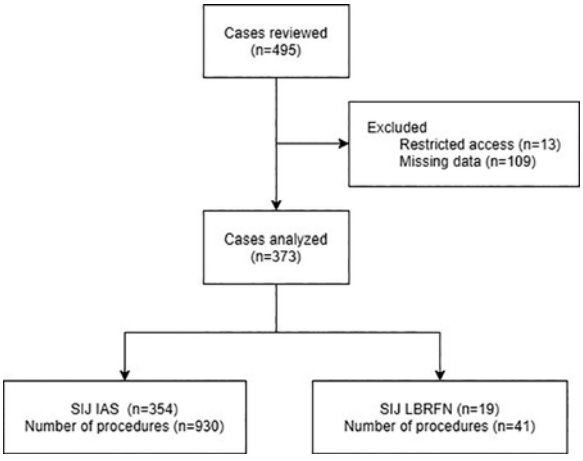

Fig. 3. *Study flow diagram*.
IAS – intraarticular steroid injection; LBRFN – lateral branch radiofrequency neurotomy

Table 1. *Baseline Characteristics*

	Patients Receiving IAS Injection n = 354	Patients Receiving LBRFN n = 19	SMD
Age (mean, SD)	41.31 (15.20)	54.00 (13.24)	0.890*
Men (%)	101 (28.5)	5 (26.3)	0.050
Married (%)	173 (53.9)	8 (47.1)	0.696*
Employment (%)	98 (34.6)	8 (47.1)	0.255*
Disability (%)	73 (28.1)	4 (28.6)	0.011
Litigations	0	0	0.001
Tobacco Use (%)	61 (18.4)	7 (38.9)	0.465*
Alcohol Use (%)	10 (3.1)	3 (17.6)	0.493*
Illicit Drug Use (%)	3 (0.9)	4 (23.5)	0.735*
Opioid Use (%)	117 (33.1)	5 (26.3)	0.150*

*SMD values > 0.1

IAS Injection Versus LBRFN

Pain score measured by the NRS decreased following both IAS injection and LBRFN interventions. IAS injection preprocedure mean (SD) pain score was 6.77 (2.25) and was reduced to 2.72 (2.81) postprocedure. LBRFN preprocedure mean (SD) pain score was 5.96 (2.39) and was reduced to 3.54 (3.14) postprocedure (Fig. 4). The mean (SD) preprocedure ECOG score for IAS injection was 1.22 (0.82) and for LBRFN it was 1.22 (0.42). Postprocedure ECOG showed improvement with IAS injection average scores of 1.05 (0.63) and LBRFN of 1.03 (0.16). Our secondary outcome was functional scores as measured by ECOG. ECOG functional scores postprocedure for the IAS injection cohort trended toward improvement, but were not statistically significant. No procedure complications were documented in the SIJ IAS group or the SIJ LBRFN group.

Statistical analysis with a linear mixed model suggests patients received estimated mean (CI 95%) of 38 (30-46.3) days of significant pain relief with SIJ IAS injections. Patients receiving LBRFN had longer lasting pain relief with an estimated mean (CI 95%) of 82 (39.4-124.8) days (Fig. 5). The overall estimated mean difference between the IAS injection cohort and the LBRFN cohort was 44 days (P = 0.0426).

Discussion

SIJ pain is a frequent cause of persistent low back pain and can be challenging to treat. If a patient fails conservative management with analgesics and physical therapy and has significant pain and functional limitation, SIJ injections and radiofrequency ablation are important modalities to consider for pain control. The Spine Intervention Society suggests initial treatment with SIJ intraarticular injection with local anesthetic and steroid. Chronic SIJ pain can be treated with serial SIJ IAS injections or LBRFN (20). The decision to pursue repeat SIJ IAS injections or SIJ LBRFN may not be self-evident. Current literature suggests SIJ IAS injections provide short to intermediate relief, whereas LBRFN potentially provides longer duration relief. However, there is significant variability in reported SIJ radiofrequency treatments' efficacy (27,29). In this study, we reviewed a total of 373 patients who had either received SIJ IAS injection or SIJ LBRFN at a single study site.

The chosen primary outcome of this study, the self-reported pain score as measured by the NRS, showed significant, immediate SIJ pain relief in both the IAS injection group and the LBRFN group. Preintervention

and postintervention assessments showed IAS injections decreased reported pain on average from 6.77 to 2.72 postprocedure. LBFRN reduced mean reported pain scores from 5.96 to 3.54. Longitudinal data obtained during clinic follow-up visits evaluated by linear mixed model analysis suggested IAS injections provided pain reduction for an estimated mean of 38 days, whereas LBRFN provided extended relief with an estimated mean of 82 days.

The duration of pain relief with SIJ IAS injections (38 days) was consistent with prior studies that suggest likely pain relief for the initial weeks to months (4). In a small randomized controlled trial, 10 patients with sacroiliitis were randomized to either placebo or corticosteroid injection. In this trial, 85.7% of corticosteroid injections led to a significant pain reduction at one month, which subsequently was reduced to 62% at 3 months and 58% at 6 months (30). In another prospective study of corticosteroid injection for SIJ pain without spondyloarthropathy, two-thirds of patients received significant pain relief for 6 weeks, whereas one-third received minimal benefit, with pain reduction lasting 4.4 weeks (31). In patients who received immediate relief with an SIJ injection with local anesthetic and corticosteroids, there is a greater likelihood for continued pain relief at 2 and 4 weeks (24). Furthermore, in a 54 patient retrospective chart review, there was short-term efficacy with corticosteroid SIJ injection, with a greater reduction in NRS scores at 2 weeks and attenuated improvement at 8 weeks following SIJ injection (23).

With an LBRFN intervention, our study demonstrated estimated mean pain relief of 82 days, providing an additional 44 days of pain relief when compared to SIJ IAS injection. Of note, the longitudinal response to LBRFN was highly variable as compared to the response to SIJ IAS injection. The 95% CI for SIJ IAS was 30-46.3 days of significant pain relief, whereas the 95% CI for LBRFN spanned 39.4-124.8 days. The wider variability in LBRFN results compared to IAS injection results may be related to factors including LBRFN technique variation by different providers and the smaller number of patients receiving LBRFN in the study (IAS injection, n = 354, LBRFN, n = 19).. Additionally, SIJ pain in the LBRFN cohort may be more challenging to treat; often these patients have already received prior serial SIJ IAS procedures with an unsatisfactory response. The LBRFN group also had higher rates of unemployment, tobacco use, alcohol use, and illicit drug use compared to the IAS injection group.

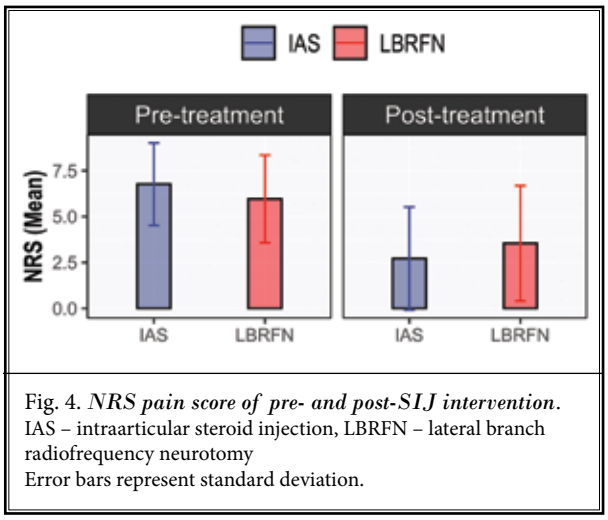

Fig. 4. *NRS pain score of pre- and post-SIJ intervention.* IAS – intraarticular steroid injection, LBRFN – lateral branch radiofrequency neurotomy
Error bars represent standard deviation.

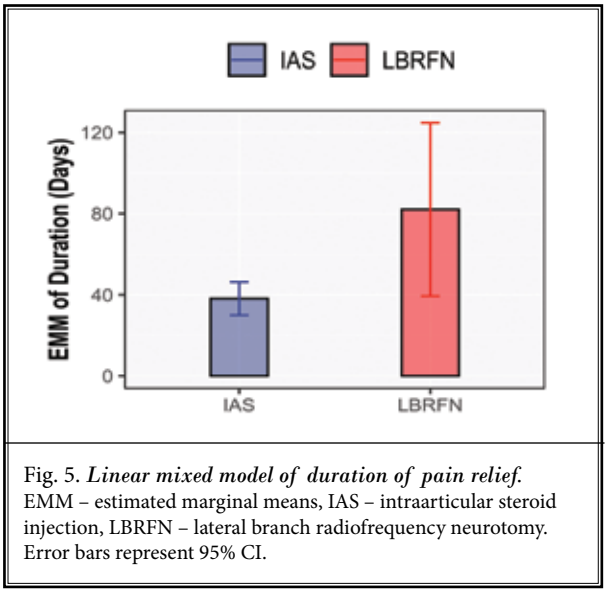

Fig. 5. *Linear mixed model of duration of pain relief.* EMM – estimated marginal means, IAS – intraarticular steroid injection, LBRFN – lateral branch radiofrequency neurotomy.
Error bars represent 95% CI.

SIJ LBRFN for persistent sacroiliac joint pain generally provides pain reduction for 3 to 6 months in a meta-analysis review of conventional, cooled, and pulsed radiofrequency (RF) (32). Two randomized placebo-controlled studies utilizing cooled RF demonstrated intermediate to long-term relief (33,34). Patients generally had the greatest response in the first 3 months of the procedure with approximately 38%-64% of patients still benefiting at 6 months. A retrospective review of cooled and conventional RF for SIJ pain provided > 50% pain reduction at 3 and 6 months (35). One retrospective study demonstrated pain relief persisting up to 20 months for some patients, and also demonstrated significant improve-

ment in quality of life and a reduction in opioid use (36). Dutta et al (25) randomized 30 patients with SIJ pain to SIJ IAS injection or pulsed RF denervation of the L4 and L5 primary dorsal rami and S1-S3 lateral branches. Both SIJ IAS injection and pulsed RF interventions provided pain reduction at one month. However, the SIJ pulsed RF group continued to report sustained pain relief at 3 and 6 months (25). In our study, the estimated mean duration of pain relief for SIJ LBRFN was 82 days (95% CI 39.4-124.8), which is below the 3 to 6 month pain reduction response demonstrated with other studies. We were not able to control for RF technique (e.g., 3 puncture method targeting the S1-S3 lateral branches, strip lesion, and leapfrog technique) or the type of RF used. Pulsed RF and cooled RF provide a larger lesion volume compared to conventional RF (37-39) and may have better outcomes compared to conventional RF which was used in our study population (26) A prior systemic review demonstrated the greatest evidence for the cooled RF technique (40).

Functional outcomes have been previously assessed for SIJ pain interventions. In a prospective cohort study with 34 patients, Schneider et al (41) demonstrated improvement with a > 30% Oswestry Disability Index (ODI) reduction observed at 2 to 4 weeks (41). Patel et al (33) performed cooled LBRFN in 51 patients (randomized 2:1 to LBRFN:sham) and measured a significant reduction in the ODI and improvement in self-reported physical functioning as measured by the Short Form Health Survey Physical Functioning (SF-36 PF) at 3 months. Our secondary outcome measure in this study, the ECOG functional score, trended toward improvement. Preprocedure and postprocedure mean ECOG scores for SIJ IAS injections decreased from 1.22 to 1.05. Preprocedure and postprocedure mean ECOG scores for SIJ LBRFN decreased from 1.22 to 1.03. There was no significant difference between groups (SMD 0.049). The retrospective design of this study did allow for a more robust and sensitive measure of functional assessment than the ECOG score. Thus, differentiating significant clinical benefit between the SIJ IAS and LBRFN groups was limited.

Limitations for our retrospective cohort study include missing data and sampling bias. Longitudinal data were only obtained with patients who presented to their follow-up appointments and these data were fit to a linear mixed model. A small number of patients in the LBRFN group limited intergroup comparison due to statistical power. Additionally, variability with intervention approach by individual pain physicians is a potential confounder. This is a single-site cohort study which may limit generalization based on patient selection and demographics.

Conclusions

SIJ pain can be effectively treated with SIJ IAS injections and SIJ LBRFN. This study suggests the duration of effective pain relief is greater for SIJ LBRFN compared to SIJ IAS (82 days versus 38 days).

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