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Clinical Studies

Posterior oblique technique for sacroiliac joint fusion leads to greater pain relief and similar improvement in function compared to the lateral technique: A retrospective, comparative study

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ABSTRACT

Background: Management of chronic sacroiliac joint (SIJ) pain among patients who do not respond to nonsurgical treatment is increasingly turning toward minimally invasive SIJ fusion. There are different techniques available to perform this procedure, with the lateral technique being more commonly studied than the posterior oblique technique. This study examined the effects of these techniques on pain relief and functional improvement, both preoperatively and at a 12-month follow-up.
Methods: This retrospective cohort study analyzed data from 45 patients who underwent SIJ fusion. Included patients were ≥50 years old, nonresponsive to conservative treatment. Subjects were divided into 2 cohorts based on the SIJ fusion technique. Primary outcomes were pain relief, measured by Visual Analog Scale (VAS), and functional improvement, determined by the Oswestry Disability Index (ODI); both were recorded and assessed at baseline, postoperative, and the change from pre- to postoperative. Additionally, data regarding patient demographics, previous lumbar fusion, operative time, and duration of hospital stay were collected and analyzed.
Results: Baseline demographic and clinical variables exhibited no significant differences in distribution between groups. The posterior oblique cohort demonstrated a substantial reduction in operative time (over 50%) and duration of hospital stay compared to lateral cohort. Pain relief (postoperative VAS: lateral 3.5±1.7 vs. posterior oblique 2.4±1.5 [p=.02]) and functional improvement (postoperative ODI: lateral 29.6±7.3 vs. posterior oblique 21±5.7 [p≤.001]) were significantly better in the posterior oblique group. Pre- to postoperative improvement analysis indicated greater reduction in pain (VAS: lateral −4.4±1.9 vs. posterior oblique −6.1±1.5 [p=.002]) in the posterior oblique group.
Conclusions: Compared to the lateral technique group, patients undergoing minimally invasive SIJ fusion through the posterior oblique technique experienced greater pain relief and demonstrated a trend toward better functional improvement, with shorter operative times and duration of hospital stay. The posterior oblique technique may be more efficient and beneficial to manage patients suffering from chronic SIJ pain through joint fusion.

Background

Lower back pain accounts for 27% of musculoskeletal-related disabilities and chronic pain instances, establishing it as a major public health concern [1]. Research has demonstrated that the sacroiliac joint (SIJ) is a significant contributor to lower back pain, with incidence estimates ranging from 10% to 38% [2–5]. SIJ pain can be attributed to various well-documented factors, including SIJ degeneration/arthrosis, SIJ dysfunction, postpartum instability, and SIJ trauma, representing 60%, 18%, 7%, and 6% of cases, respectively [6].

Failed back surgery syndrome (FBSS), characterized by persistent or emergent lumbar/lumbosacral spinal pain postsurgery, is increasingly

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recognized as a common cause of low back pain following lumbar fusion [2,7–10]. The SIJ is a potential origin of FBSS, and its fusion has been considered as a viable treatment strategy [2,7–10]. Supporting this, Rudolf's study demonstrated the effectiveness of minimally invasive SIJ fusion in patients with prior lumbar fusion [11].

Management of chronic pain originating from the SIJ remains a topic of discussion. While SIJ fusion is recognized as a treatment method, its adoption as a first-line therapy for SIJ pain is still being debated. Typically, the procedure is reserved for cases where conservative treatments fail, with the decision largely dependent on the diagnostic criteria for SIJ pain [6,12]. However, a systematic review conducted by Chang et al. [12] suggests that minimally invasive SIJ fusion might be superior to conservative management in pain reduction, opioid use, and enhancements in physical function and quality of life over a 6-month period for carefully selected patients.

Sacroiliac joint fusion can be executed using either open or minimally invasive surgical (MIS) techniques, with a current preference for MIS techniques due to their lower surgical site morbidity and better patient-reported outcomes (PROs) [13–17]. Several techniques have been proposed since the introduction of minimally invasive procedures, including lateral, posterior, and posterior oblique. Despite this, most research has focused on the lateral technique, leaving the remaining techniques underexplored [18,19].

Hence, this retrospective cohort study aims to compare the pain and functional outcomes of SIJ fusion using the lateral and posterior oblique techniques, preoperatively and at a 12-month follow-up. The study hypothesizes that no significant differences will be observed in postoperative function and pain scores between the 2 techniques.

Methods

Study design

A retrospective analysis was conducted on prospectively obtained data. Information was retrieved from a registry of 45 patients who underwent SIJ fusion at a single institution between January 2020 and December 2022, with a minimum follow-up of 12 months. Included patients were at least 50 years old, which was an incidental finding, and had not responded to conservative treatments of 6 months physical therapy and a positive joint block. The study excluded patients with active systemic infection, history of autoimmune disease or immunosuppression, osteomyelitis, or recent pelvic trauma. A single fellowship-trained spine surgeon performed all surgeries. Subject allocation was chronological, reflecting the surgeon's gradual transition from the lateral to the posterior oblique technique. Prior to the study, institutional review board approval was secured, and informed consent was obtained from all participating patients.

Study variables

Variables analyzed in this study included demographic data, such as age and gender, and clinical data, specifically the history of prior lumbar fusion. This variable was evaluated to control for potential confounding effects on clinical outcomes. The primary endpoints were PROs measured at baseline and at 12-month postoperative follow-up using the Visual Analog Scale (VAS) for pain and the Oswestry Disability Index (ODI) for functionality. Other recorded surgical variables included operative time and duration of hospital stay.

Statistical analysis

Continuous variables were reported as mean±standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Both demographic and clinical variables were stratified by surgical technique for descriptive analysis. Likewise, surgical variables were descriptively compared, further stratified by whether the procedure was unilateral or bilateral.

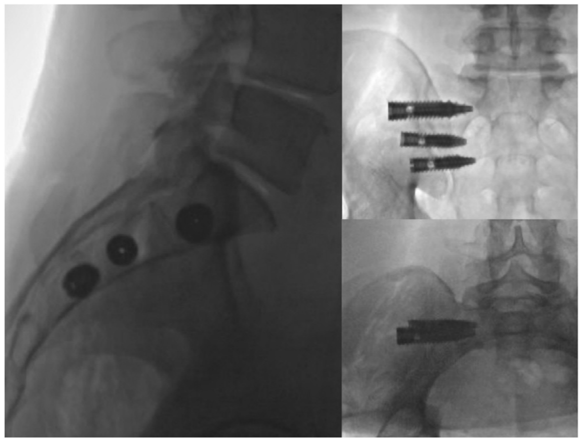

Fig. 1. Lateral fusion of the sacroiliac joint. Series of images demonstrating different placements of the screw system using the lateral technique for sacroiliac joint fusion. The three-screw system illustrates the alignment and positioning applied in the conventional lateral technique for SIJ fusion.

The primary endpoints, namely VAS and ODI scores, were evaluated preoperatively, postoperatively, and for changes (improvements) from pre- to postoperative stages between cohorts, using unpaired t-tests for comparisons at each time point.

A separate statistical analysis was performed to assess the impact of prior lumbar fusion on SIJ fusion outcomes at the same time points, to identify any confounding effects on the results. Again, unpaired t-tests were used for comparisons at each time point.

All statistical analyses were conducted with a p-value threshold of .05 to denote statistical significance, using R (version 4.2.2) and RStudio (version 2022.12.0+353).

Surgical technique

The lateral technique for SIJ fusion and its respective screw system (Fig. 1) is well documented in the literature. However, the posterior oblique technique is relatively new. Hence, we provide a detailed description of the posterior oblique technique as implemented in this study, building on the technique used by Raikar et al. [20]. Both groups underwent SIJ fusion using the Sacrix system (SpineFrontier SIJFuse) manufactured by Sacrix, LLC, Malden, MA. In the lateral technique, 3 screws per side were used in each surgery, whereas the posterior oblique technique utilized 2 screws per side.

The posterior oblique technique, a minimally invasive procedure for sacroiliac joint fusion, is typically performed on an outpatient basis. Essential preoperative planning involves the use of computerized tomography (CT) scans of the SIJ to determine the appropriate implant size and trajectory, taking into account the patient's individual anatomy and bone quality.

This procedure is executed with the patient under general anesthesia, positioned prone. Fluoroscopic guidance is employed throughout the procedure to ensure precise implant placement. Initially, fluoroscopic views including lateral, inlet, and outlet-oblique views, are used to mark the skin. The superior edge of the sacral ala is marked transversely, and the lateral edge of the ilium is marked vertically. Optional markings for the SIJ and the inferior edge of the sacral ala can also be made. The starting point for needle insertion is identified approximately one finger width below the superior edge of the sacral ala and one finger width lateral to the ilium marking.

Subsequently, a bone needle is positioned at the marked starting point and is then inserted at an angle of approximately 5° to 20° relative to the horizontal plane, targeting the upper outer surface of the

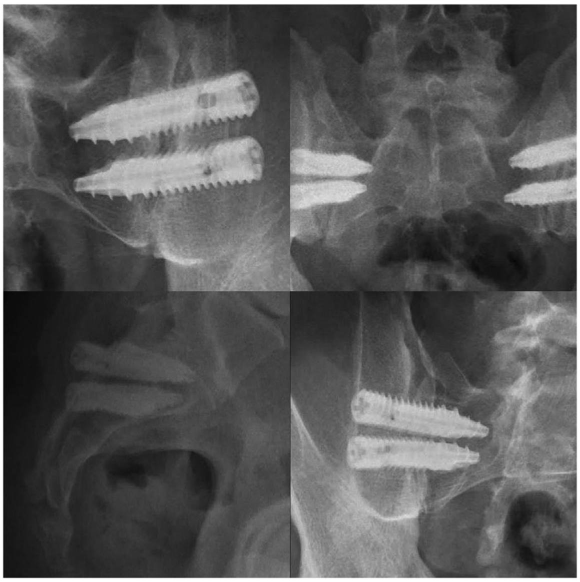

Fig. 2. Posterior oblique fusion of the sacroiliac joint. Series of images demonstrating different placements of the screw system using the posterior oblique technique for sacroiliac joint fusion. Two screws are appropriately positioned to follow the trajectory towards the anterior superior surface of the sacral ala. The superior screw is shown alongside the other screw, positioned approximately 1.5 cm caudal to the first, indicating the parallel arrangement.

iliac crest and aligning with the superior surface of the sacral ala. The needle is advanced through the ilium and SIJ, guiding it toward the anterior superior corner of the sacral ala. Needle placement is confirmed using the three fluoroscopic views. Afterward, the inner stylet of the bone needle is removed, and a guidewire is advanced through the needle's outer sleeve until the tip of the guidewire extends past the tip of the bone needle. The depth and trajectory of the guidewire are confirmed with fluoroscopy (Video 1). After this verification, the outer sleeve of the bone needle is then removed.

A 1.5 cm longitudinal incision is made inferior to the guidewire. Then a tissue dilator is introduced over the guidewire, followed by the advancement of a tissue protector over the tissue dilator. Once the tissue dilator is removed, a self-tapping screw embedded with bone graft is inserted through the SIJ, directed toward the anterior superior surface of the sacral ala, through the tissue protector and over the guidewire. Correct implant placement is validated through fluoroscopy. A second implant is approximately 1.5 cm caudal to the first implant through the same incision, in a parallel trajectory (Fig. 2). After placing both screws, the whole system is checked via fluoroscopy (Video 2).

Finally, the incision is closed. The patient is monitored post-procedure until they have fully recovered from anesthesia. Given the outpatient nature of the procedure, patients are typically discharged on the same day. Postoperative care instructions and indications are provided, and follow-up appointments are scheduled as needed.

Results

Demographics and clinical characteristics of the sample

A total of 45 patients met the inclusion criteria and were available for a 12-month postoperative follow-up. No patients were lost to follow-up. The demographic and clinical characteristics of the study population, stratified by surgical technique (lateral vs. posterior oblique), are displayed in Table 1. The sample consisted of 28 males (62%) and 17 females (38%). The lateral group (n=22) had 16 males (73%), while the posterior oblique group (n=23) had 12 males (52%), making distribution between groups balanced (p=.25). Age distribution was comparable across groups, with a mean age of 62.9±7.8 years in the lateral group and 62.3±8.2 years in the posterior oblique group (p=.8). Nearly half of patients (56%) in the total sample had undergone a prior lumbar fusion, with no significant difference between the groups (lateral group 59% vs. posterior oblique group 52%; p=.6).

Surgery-related variables

Table 2 outlines the surgery-related variables by surgical technique, further stratified by procedure type (unilateral/bilateral). Among the lateral technique group, 14 out of 22 patients underwent bilateral surgeries, whereas 9 out of 23 patients in the posterior oblique group underwent bilateral surgeries. The operative time for bilateral surgeries in the lateral technique group had an average of 73.4 minutes, while posterior oblique group had an average of 33.8 minutes. When comparing the operative time for unilateral cases between the 2 groups, the lateral technique group averaged 35.6 minutes, while the posterior oblique group averaged 15.3 minutes. The average duration of hospital stay for the lateral group was 1.92 days, while the posterior oblique group averaged a hospital stay duration of 1.1 days.

Baseline functional outcomes

Preoperative VAS and ODI scores (PROs) for patients who underwent surgery using either lateral or posterior oblique technique are shown in Table 3. The mean preoperative VAS score was comparable between groups (VAS: lateral group 8.1±0.6 vs. posterior oblique group 8.5±0.7 [p=.1]). As per ODI scores, there was a statistically significant difference in means (ODI: lateral group 46.3±6.8 vs. posterior oblique group 42.3±5.7 [p=.04]).

Postoperative functional outcomes

Postoperative VAS and ODI scores (PROs) are shown in Table 3. Mean postoperative scores for both groups, that is, lateral versus posterior oblique techniques, were significantly different for VAS (VAS: 3.5±1.7 vs. 2.4±1.5, respectively [p=.02]) and ODI (ODI: 29.6±7.3 vs. 21±5.7, respectively [p<.001]).

Pre- to postoperative change (improvement) in functional outcomes

Pre- to postoperative improvement in VAS and ODI scores is seen in Table 3. The mean change in VAS score was significantly different between groups, that is, lateral versus posterior oblique technique (VAS: −4.4±1.9 vs. −6.1±1.5, respectively [p=.002]). However, improvement in ODI scores was similar for both lateral and posterior oblique techniques (ODI: −16.6±9.6 vs. −21.3±6.5, respectively [p=.07]).

Outcomes based on prior lumbar fusion

Table 4 displays preoperative, postoperative, and improvement of VAS and ODI scores based on history of previous lumbar fusion. Preoperative data for the VAS and ODI scores were comparable groups (p=.34 and p=.8, respectively). Postoperative VAS and ODI scores also showed no significant difference between groups (p=.4, p=.08, respectively). Finally, pre- to postoperative improvement for both VAS and ODI was also similar regardless of previous lumbar fusion (p=.67, p=.06, respectively).

Safety and complications

The study observed minimal complications associated with both the lateral and posterior oblique techniques. Only one complication was reported in the lateral group, where a patient experienced an invasion of the S2 foramen necessitating repositioning of the screw. No infections were reported in either group.

Table 1
Demographic and clinical characteristics of the sample stratified by surgical technique (lateral vs. posterior oblique).

Variables	Lateral (n=22)		Posterior oblique (n=23)		p
Age					
Years (Mean, SD)	62.9	7.8	62.3	8.2	.8
Gender					
Male (n, %)	16	73%	12	52%	.25
Previous lumbar fusion					
Yes (n, %)	13	59%	12	52%	.6

Table 2
Surgery-related variables stratified by surgical technique (lateral vs. posterior oblique) and procedure type (unilateral/bilateral).

	Lateral (n=22)		Posterior oblique (n=23)	
	Unilateral	Bilateral	Unilateral	Bilateral
Number of cases (n)	8	14	14	9
Average operative time (m)	35.6	73.4	15.3	33.8
Average duration of hospital stay (d)	1.92		1.1	

m, minutes; d, days.

Table 3
Comparison of preoperative, postoperative, and improvement in PROs based on surgical technique (lateral vs. posterior oblique).

	Lateral (n=22)		Posterior oblique (n=23)		
	Mean	Std. Dev.	Mean	Std. Dev.	p
Preoperative—PROs					
VAS	8.1	0.6	8.5	0.7	.1
ODI	46.3	6.8	42.3	5.7	.04
Postoperative—PROs					
VAS	3.5	1.7	2.4	1.5	.02
ODI	29.6	7.3	21	5.7	<.001
Improvement—PROs					
VAS	−4.4	1.9	−6.1	1.5	.002
ODI	−16.6	9.6	−21.3	6.5	.07

VAS, Visual Analog Scale; ODI, Oswestry Disability Index; PROs, patient-reported outcomes.

Table 4
Comparison of preoperative, postoperative, and improvement in PROs based on history of lumbar fusion.

	Previous lumbar fusion (n=25)		No previous lumbar fusion (n=20)		
	Mean	Std. Dev.	Mean	Std. Dev.	p
Preoperative–PROs					
VAS	8.4	0.8	8.2	0.6	.34
ODI	44	6.4	44.5	6.8	.8
Postoperative–PROs					
VAS	3.1	1.8	2.7	1.5	.4
ODI	27	7.8	22.9	7.4	.08
Improvement–PROs					
VAS	−5.3	1.7	−5.5	1.7	.67
ODI	−17	8.3	−21.6	8	.06

VAS, Visual Analog Scale; ODI, Oswestry Disability Index; PROs, patient-reported outcomes.

Recovery and return to work

The majority of patients reported an improved capacity to return to work within two weeks as indicated. However, patients with physically demanding jobs reported a longer recovery time, usually returning to work after 6 weeks.

Discussion

This study observed substantial enhancements in functional outcomes and pain relief among patients undergoing SIJ fusion through either the lateral or posterior oblique techniques, regardless of their prior lumbar fusion history. While both techniques led to notable improvements in ODI scores, statistical significance leaned toward the posterior oblique group for postoperative scores, implying potential clinical advantages. On the other hand, VAS indicated a stronger preference for the posterior oblique technique, exhibiting with lower postoperative scores and a greater degree of improvement. These results suggest that the choice of surgical technique can profoundly affect patient outcomes, particularly in terms of pain reduction. Additionally, a significant decrease in both operative time (over 50%) and hospital stay was observed for the posterior oblique group. Hence, at our institution, the posterior oblique technique is a viable alternative to the lateral technique, with added benefits.

Chronic SIJ pain management has been the subject of considerable debate within the medical community [6,12]. Over time, the treatment focus has gravitated toward minimally invasive SIJ fusion instead of conservative measures, a trend underscored by Chang et al.'s systematic review of 40 studies [12]. This review evidenced significant pain reduction, improved physical function, and enhanced quality of life postfusion, compared to conservative treatment at 6-month, 1-year, and 2-year follow-ups. However, it also highlighted a higher incidence of short-term adverse events in the fusion groups, with the revision surgery rate remaining relatively low (peaking at 3.8% at 2 years) [12]. This data suggests that minimally invasive SIJ fusion could be a promising option for patients unresponsive to conservative treatment, although careful patient selection is warranted due to increased short-term adverse events.

The SIJ fusion procedure was first depicted in the early 1920s by Smith-Petersen and Rogers as a viable treatment for SIJ-associated pain. Yet, it was not until the 1980s that the first screw and plate systems were introduced [15]. For many years, open surgery was the standard approach for SIJ fusion until the emergence of MIS techniques in 2008 [15]. Since then, MIS techniques for SIJ fusion have gained considerable acceptance with various screw systems introduced, facilitating significant improvements in pain reduction, functional improvement, medication reduction, and overall patient satisfaction [13–17]. Smith et al. [15] reported that MIS techniques for SIJ fusion boasted superior perioperative measures and lower reoperation rates compared to open techniques, which often led to increased morbidity and unfavorable outcomes.

Minimally invasive SIJ fusion can be performed via different techniques, including lateral, posterior, and posterior oblique [18,19]. Among these, the lateral technique is the most frequently used in clinical practice, primarily due to the extensive research undertaken on this technique, compared to the limited studies on posterior and posterior oblique techniques [18,19].

When considering the technical differences between techniques, is important to note that each—lateral, posterior, and posterior oblique—has distinct aspects. The lateral technique requires extensive dissection through the gluteal fascia, compelling the surgeon to traverse the ilium to reach the SIJ for perpendicular implant placement. Even though the posterior technique needs to cross the SIJ ligaments to place the implants longitudinally through the joint, the technique is less invasive as it offers a more direct path to the SIJ by avoiding the ilium laterally. The posterior oblique technique is unique; it doesn't involve dissection of the gluteal fascia or SIJ ligaments. Instead, the approach is taken from the outer upper surface of the iliac crest, enabling a more direct trajectory to the SIJ through the ilium [20].

Recent evidence by Raikar et al. [20] confirmed the efficacy and safety of the posterior oblique technique as a minimally invasive SIJ fusion procedure, based on a case series of 19 patients. They proposed that the posterior oblique technique could potentially lead to less blood loss by avoiding damage to neurovascular structures, a noteworthy advantage over the lateral technique, which reportedly involves an average blood loss between 31 and 43 cc [16,17]. Furthermore, they suggested that the posterior oblique technique enables surface-bridging with screw placement, which reduces joint movement, and that the procedure requires less soft tissue manipulation [20].

There is extensive evidence supporting the efficacy of the lateral technique in minimally invasive SIJ fusion for reducing pain and improving functionality [13–17]. In a retrospective study, Abbasi et al. [21] found that the lateral technique led to a 16-point reduction in the ODI score, aligning with this study's findings (16.6). However, no studies have explicitly evaluated ODI scores for the posterior oblique technique. Despite this, a significant pain reduction of over 50% has been reported [20], similar to this study's results.

Additionally, this study revealed that patients who underwent minimally invasive SIJ fusion via the posterior oblique technique experienced a shorter hospital stay (1.1 days) compared to the lateral technique. This aligns with previous studies reporting an average hospital stay of 1.9 days for patients that underwent SIJ fusion via the lateral technique [16,17].

Notably, Abbasi et al. [21] reported an average operative time of 34 minutes for unilateral cases performed via the lateral technique, which is consistent with this study's findings. However, this study is unique in showing a reduction in operative time of over 50% for both unilateral and bilateral cases treated with the posterior oblique fusion compared to the lateral fusion.

In essence, the observed differences in outcomes between the lateral and posterior oblique groups are primarily attributed to the technical aspects of each procedure. Variances in VAS and ODI scores can be attributed to the amount of muscle dissection and soft tissue manipulation each technique requires. Notably, the posterior oblique technique necessitates less muscle dissection and soft tissue manipulation, which, in turn, facilitates recovery and enhances PROs [20]. Regarding operative time, the posterior oblique technique is more time-efficient due to faster dissection and fewer fluoroscopy projections [20]. While the total radiation dose was not directly measured in this study, it is reasonable to infer that the posterior oblique technique may be associated with a lower radiation dose, considering its requirement for less fluoroscopy time.

Previous studies have highlighted concerns about the impact of prior lumbar fusion on SIJ fusion outcomes. Biomechanical analyses have shown increased motion and stress on the SIJ's articular surface after lumbar fusion, with the onset of SIJ degeneration occurring within 5 years in 40% to 75% of cases [22,23]. Nevertheless, a study by Rudolf found significant improvement in pain and similar satisfaction levels among patients undergoing minimally invasive SIJ fusion via the lateral technique, regardless of prior lumbar fusion [11], mirroring this study's findings. At present, no studies have assessed the impact of prior lumbar fusion on minimally invasive SIJ fusion outcomes when using the posterior oblique technique. Despite this, our study found comparable improvements for both groups—those with and without a history of lumbar fusion—indicating the potential applicability of the technique across diverse patient populations.

Certain limitations should be noted: this study was retrospective, had a small sample size, and featured a short follow-up period of 12 months. Additionally, as the study was performed at a single private institution by one spine surgeon, the findings' generalizability may be limited. Lastly, although participants reported an overall improvement in their return to work, this study did not incorporate formal analytical metrics for this variable. Future research may benefit from defining and tracking formal return-to-work metrics such as the time taken to return to work, the ability to execute previous job duties, and any need for job modifications. Despite these limitations, the study offers valuable insights into minimally invasive SIJ fusion techniques, which are becoming increasingly common in contemporary orthopedic practice.

Conclusions

Compared to the lateral technique group, patients undergoing minimally invasive SIJ fusion through the posterior oblique technique experienced greater pain relief and demonstrated a trend toward better functional improvement, with shorter operative times and duration of hospital stay. The posterior oblique technique may be more efficient and beneficial to manage patients suffering from chronic SIJ pain through joint fusion.

Declarations of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2023.100259.

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