HAYDARPAŞA NUMUNE MEDICAL JOURNAL

DOI: 10.14744/hnhj.2020.35492
Haydarpasa Numune Med J 2022;62(3):334–341

hnhtipdergisi.com

ORIGINAL ARTICLE

Frequency of Sacroiliac Joint Dysfunction (SIJD) in Patients with Failed Back Surgery Syndrome (FBSS), and Affecting Demographic and Surgical Factors

Hatun Deniz Aytaç[1], Duygu Geler Külcü[2], Nilgün Mesci[2]

[1]Department of Physical Therapy and Rehabilitation, Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye
[2]Department of Physical Therapy and Rehabilitation, Health Sciences University, Haydarpaşa Numune Training and Research Hospital, Istanbul, Türkiye

Abstract

Introduction: We aimed to investigate the frequency of "sacroiliac joint dysfunction (SIJD)" in patients who have undergone "failed back surgery syndrome (FBSS)" and surgical factors and the demographical data of the patients with or without SIJD.

Methods: In our cross-sectional study, 50 patients between the ages of 18 and 75 who have undergone to FBSS were included in the study. Patients with the positive results in at least three of the specific SIJD tests and the positive result in diagnostic injection test were diagnosed as SIJD. The frequency of SIJD was determined in patients with FBSS. The demographical data, clinical features, and surgical factors were compared in groups with or without SIJD.

Results: We found the frequency of SIJD is %30 in patients with FBSS. There was no difference that was found in demographic data and the characteristics of the patient groups ($p>0.05$).

Discussion and Conclusion: FBSS is a very important cause of disability that negatively affects the patient socially and psychologically. Therefore, it is very important to manage the treatment correctly. Patients should be evaluated in all respects and the pain should not be attributed only to surgical factors. Hip examination and the existence of SIJD should be evaluated all the times.

Keywords: Failed back surgery syndrome; sacroiliac joint dysfunction; sacroiliac joint.

Failed back surgery syndrome (FBSS) is a term that refers to persistent or recurrent low back pain with or without lumbosacral radiculopathy after one or more spine surgeries. The incidence of FBSS has been reported to be between 10-40% [1].

Sacroiliac joint dysfunction (SIJD), which is accepted as one of the causes of mechanical low back pain, refers to a change in the movement or position of any of the structures that fit the joint, which can also cause pain [2]. The prevalence of sacroiliac joint pain in patients with low back pain, determined on the basis of clinical evaluation, ranges from 15-30% [3,4]. Risk factors for the development of SIJD include scoliosis, pregnancy, leg length discrepancy, spine surgery, falls, motor-vehicle accident, heavy lifting, sustained athletic activities, seronegative spondyloarthropathies, and gait disturbances [5]. The prevalence

Correspondence (İletişim): Nilgün Mesci, M.D. Saglik Bilimleri Universitesi, Haydarpasa Numune Egitim ve Arastirma Hastanesi, Fizik Tedavi ve Rehabilitasyon Klinigi, İstanbul, Türkiye
Phone (Telefon): +90 533 629 59 98 **E-mail (E-posta):** nilgunbilgili@yahoo.com
Submitted Date (Başvuru Tarihi): 16.06.2020 **Accepted Date (Kabul Tarihi):** 10.09.2020

of sacroiliac joint pain resulting from FBSS is estimated to be 29% [6]. The sacroiliac joint is the most likely source of low back pain, especially in patients undergoing lumbar and lumbosacral fusion surgeries [7,8].

Although it is common, SIJD does not have a standard diagnosis and treatment approach. The International Association for the Study of Pain has proposed some criteria for the evaluation of patients with suspected SIJD. These criteria are; the presence of pain in the sacroiliac joint region, the emergence of pain with specific provocative maneuvers, and relief with local anesthetic injection into the sacroiliac joint [5].

Sacroiliac joint pain radiate to the hip (94%), lower lumbar region (72%), lower extremity (50%), inguinal region (14%), upper lumbar region (6%), and abdomen (2%). For the diagnosis of SIJD, it is recommended to apply provocation tests as a group. The combination of at least 3 of the provocative tests was reported to be 93.8% sensitive and 78.1% specific for diagnosis. Stork test, Gaenslen's test, pelvic compression and pelvic distraction tests, thigh thrust test, FABER test, standing flexion test, and Posterior shear test (POSH) are clinical tests used to diagnose SIJD. Diagnostic sacroiliac joint block is highly recommended in the literature to aid in the diagnosis of SIJD and is considered a confirmatory test for SIJD [3,9]. The sacroiliac joint acts as an important bridge in the weight distribution from the trunk to the lower extremities. Joint characteristics, ligamentous support and muscle strength are all effective in providing load transfer from the lumbar region to the lower extremities. It acts as a shock absorber, allowing the ground reaction force to pass from the lower extremities to the trunk during the heel strike phase of gait. We think that the changing biomechanics after low back surgery increases the frequency of SIJD. In this study, we investigated whether there is a relationship between demographic characteristics and surgical factors and the development of SIJD, as well as the frequency of SIJD in patients with continuing postoperative low back pain.

Materials and Methods

The study included 50 patients diagnosed with FBSS after being evaluated in the Physical Medicine and Rehabilitation outpatient clinics of our hospital between 01.10.2019 and 01.01.2020.

Approval for our study was obtained from the local ethics committee of our hospital with the decision number HNEAK-KAEK 2019/109. Patients were informed about the study and signed the Informed Voluntary Consent Form (IVCF). The study was designed as a cross-sectional study. Adult patients aged between 18 and 75 years, patients whose pain persisted for at least three months after the surgery or whose pain reoccured and persisted for at least 1 month, patients with pain VAS (visual analogue scale) value of 4 and above, and patients with mechanical low back pain and/or hip pain, were included in the study. Patients with inflammatory low back pain (ankylosing spondylitis, psoriatic arthritis, inflammatory bowel disease, pyogenic sacroiliitis), history of malignancy (solid tumors such as multiple myeloma, colon cancer and prostate cancer with a high chance of bone metastasis, or hematological malignancies such as lymphoma), sacral stress fracture, pregnancy, cases with leg length discrepancy, neuromuscular disease, idiopathic scoliosis and bupivacaine allergy, were excluded from the study.

Demographic Characteristics

Age, sex, occupation, height, weight, body mass index (BMI), the time passed after the operation, and the number of operations of the patients diagnosed with FBSS were questioned.

Operational Characteristics

Surgical factors such as the type of operation, level of operation, presence of material, whether the pain has radiated and whether it is in the same localization as before the operation, were questioned.

Evaluation Methods

Pain intensity:

In our study, VAS (0-10 cm) was used to evaluate the severity of pain. The patient was asked to score the severity of pain on a 10 cm visual analog scale.

Physical examination:

In the lumbar examination, paravertebral spasm and tenderness, spinous process tenderness, greater trochanteric tenderness, Anterior Superior Iliac Spine (ASIS) symmetry and Posterior Superior Iliac Spine (PSIS) symmetry were evaluated. Leg lengths were measured. Anterior hand-to-floor and lateral hand-to-floor distances were measured in the evaluation of lumbar joint range of motion. Neurological examination was performed. From special tests, straight leg raise test (SLRT) and femoral stretch tests were performed.

Evaluation of the sacroiliac joint with specific tests:

To evaluate the sacroiliac joint, among the motion palpation tests, Gillet's test (Stork test) and standing flexion test were used, and among the pain provocation tests, distraction test, thigh thrust test, Gaenslen's test, FABER test (Patrick test), posterior shear test (POSH) were used [10]. Local anesthetic injection into the sacroiliac joint was performed under ultrasonography (USG) guidance to those with at least 3 positive provocation tests from the sacroiliac joint tests. After Mindray USG device was adjusted to the appropriate frequency and depth using a convex probe, the patient was placed in the prone position with a pillow under the abdomen. After detecting the sacral hiatus in the transverse image, the lateral wall of the sacrum was determined by moving the probe in the lateral direction, then the iliac bone was visualized by advancing the probe transversely in the cephalic direction. The caudal sacroiliac joint was visualized by tilting the probe, and 2 cc 1% bupivacaine was injected here with a 22 gauge needle. In patients with a 50% or more reduction in pain within 12 hours, the injection test was considered positive and SIJD was diagnosed [11].

Statistical analysis

As a result of the power analysis using G*Power to determine the minimum number of patients to be included in the study, the minimum number of samples determined for power:0.80 and 0.05 was n:46. Fifty patients diagnosed with FBSS who applied to our clinic participated in the study. IBM SPSS statistics 22 (IBM SPSS, Turkey) program was used for statistical analysis. While evaluating the study data, the conformity of the parameters to the normal distribution was evaluated with the Shapiro–Wilk test. While evaluating the data of patients with and without SIJD, in addition to descriptive statistical methods (Mean, Standard deviation, frequency), Student's t-test was used for comparisons of normally distributed parameters between two groups, and Mann-Whitney U test was used for comparisons of non-normally distributed parameters between two groups. Chi-square test was used to compare qualitative data. Significance was evaluated at the $p<0.05$ level. Correlation with demographic data in patients with SIJD was assessed with the Pearson or Spearman test.

Results

Sixty-three patients who applied to our clinic between 01.10.2019-01.01.2020 were evaluated and 50 patients who met the study criteria were included in the study. The mean age of the patients was 52.84+9.8 years. 60% (n=30) of the patients were female and 40% (n=20) were male. Demographic and characteristic features of the patients are shown in Table 1.

Table 1. Characteristics of the patients

Characteristics (n=50)	Values
Age (years), Mean±SD	52,84±9,8
BMI (kg/m^2), Mean±SD	29,58±4,4
Time passed after the operation (months), median (min-max)	48 (3-344)
Number of operations, median (min-max)	1 (1-3)
Sex, n (%)	
Male	20 (%40)
Female	30 (%60)
Occupation, n (%)	
Housewife	21 (%42,0)
Retired	9 (%18,0)
Officer	9 (%18,0)
Laborer	11 (%22,0)

SD: Standard deviation; BMI: Body mass index; min: minimum; max: maximum.

The clinical findings of the patients, which were evaluated by detailed physical examination and special tests, are summarized in Table 2, and the information about the type of operation, level of operation and pain distribution are summarized in Table 3.

SIJD was found in 30% of failed back surgery cases. There was no statistically significant difference between patients with and without SIJD in terms of demographic and characteristic features (Table 4), clinical findings (Table 5), and operative data (Table 6) ($p>0.05$).

In patients with SIJD, when the relationship between the side with SIJD and positive examination findings and the side with laminectomy were examined, it was observed that paravertebral spasm, greater trochanteric tenderness, SLRT and femoral stretch tests were positive on the side with SIJD. Sacroiliac joint dysfunction seen in right laminectomy cases was on the right side, and of 5 cases with left laminectomy, SIJD was found to be on the right in 2, and 3 of them were left SIJD.

Discussion

In our study in which we investigated the incidence of SIJD in patients diagnosed with FBSS and the demographic and surgical factors affecting it, we found the incidence of SIJD to be 30%.

It has been reported in the literature that one of the etiological causes of SIJD is previous spine surgery. The prevalence of sacroiliac joint pain resulting from failed back surgery is estimated to be 29%. There are studies suggesting that the sacroiliac joint is the most likely source

Table 2. Clinical findings of the patients

	Mean±SD	Median (min-max)
Anterior hand-to-floor distance (cm)	17,68±12,81	16 (0-52)
Lateral hand-to-floor distance (cm), right	13,91±4,14	14 (7-24)
Lateral hand-to-floor distance (cm), left	13,87±4,38	13 (6-23)
VAS-pain (0-10 cm)	6,92±1,82	7 (4-10)
	n (%)	
Paravertebral spasm	26 (%52) (17:right, 9:left)	
Spinous process tenderness	15 (%30)	
Pelvic asymmetry	0 (%0)	
Greater trochanteric tenderness	7 (%14) (2:right, 5:left)	
SLRT	16 (%32) (11:right, 5:left)	
Femoral stretch test	15 (%30) (11:right, 4:left)	
Gillet (Stork) test	10 (%20)	
Standing flexion test	16 (%32)	
Distraction test	8 (%16)	
Sacral thrust test	15 (%30)	
Gaenslen test	16 (%32)	
Faber (Patrick) test	23 (%46)	
Posterior shear test	14 (%28)	

SD: Standard deviation; min: minimum; max: maximum; VAS: Visual Analogue Scale; SLRT: Straight leg raise test.

Table 3. Operational data of the patients

n=50	n (%)
Operation type	
Microdiscectomy	12 (%24)
Discectomy	11 (%22)
Right laminectomy	8 (%16)
Left laminectomy	11 (%22)
Bilateral laminectomy	2 (%4)
Microdiscectomy and partial laminectomy	3 (%6)
Posterior fixation	3 (%6)
Operation level	
L5-S1	14 (%28)
L4-L5	23 (%46)
L3-L4	2 (%4)
Multi level	11 (%22)
Is the pain radiating?	
Yes	46 (%92)
No	4 (%8)
Areas of radiation of pain	
Hip	11 (%22)
Knee	18 (%36)
Heel	17 (%34)
Pain in the same localization as before the operation	
Present	21 (%42)

of low back pain in patients undergoing lumbar and lumbosacral fusion surgeries [7,8].

Our hypothesis in the study design was that impaired spinal biomechanics may lead to sacroiliac dysfunction in patients with ongoing pain after spinal surgery. It was also to show whether demographic and surgical factors affect this frequency.

Guan et al. [12] in their study, which included 472 patients who had discectomy or posterior lumbar interbody fusion surgery and had regular follow-up for 2 years, they defined patients as SIJD who defined pain below L5 level, had positive at least three of the provocation tests, and whose pain improved significantly after sacroiliac joint block, and found the SIJD rate as 13.8%. In our study, this rate was 30%. Rates varying between 10-40% have been reported in the literature [1]. In the study of Guan et al., similar to our study, the development of SIJD was not correlated with age and sex. While no significant relationship was found between the type and level of operation and the development of SIJD in our study, the incidence of SIJD was found to be significantly higher in patients who underwent posterior lumbar interbody fusion (PLIF) in the study of Guan et al. [12] in which they compared discectomy and PLIF. In our study, when patients who had discectomy, microdis-

Table 4. Comparison of the characteristics of patients with and without SIJD

	SIJD present (n=15, %30)	SIJD absent (n=35, %70)	p
Age (years), Mean±SD	56,07±7,8	51,46±10,4	0,179
BMI (kg/m^2), Mean±SD	29,8±5,12	29,4±4,1	0,703
Time passed after the operation (months), median (min-max)	60 (3-240)	24 (4-344)	0,057
Number of operations, median (min-max)	1 (1-2)	1 (1-3)	0,686
	n (%)		
Sex			
Male	3 (%20)	17 (48,6)	0,059
Female	12 (%80)	18 (%51,4)	
Occupation			
Housewife	9 (%60)	12 (%34,3)	0,527
Retired	3 (%20)	6 (%17,1)	
Officer	2 (%13,3)	7 (%20)	
Laborer	1 (%6,7)	10 (%28,6)	

SIJD: Sacroiliac joint dysfunction; SD: Standard deviation; min: minimum; max: maximum; BMI: Body mass index.

Table 5. Comparison of clinical findings of patients with and without SIJD

	SIJD present (n:15,%30)	SIJD absent (n:35,%70)	p
Anterior hand-to-floor distance (cm), median (min-max)	17,5 (1-42)	16 (0-52)	0,780
Lateral hand-to-floor distance (cm), right, Mean±SD	13,91±4,14	14,36±3,7	
Lateral hand-to-floor distance (cm), left, Mean±SD	13,87±4,38	13,97±4,2	
VAS-pain (0-10 cm), median (min-max)	8 (4-10)	6 (4-10)	0,567
	n(%)		
Paravertebral spasm	8 (%53,3) (5:right, 3:left)	18 (%51,4) (12:right, 6:left)	0,574
Spinous process tenderness	5 (%33,3)	10 (%28,6)	0,493
Pelvic asymmetry	0 (%0)	0 (%0)	
Greater trochanteric tenderness	3 (%20) (1:right, 2:left)	4 (%11,4) (1:right, 3:left)	0,348
SLRT	3 (%20) (2:right, 1:left)	13 (%37,1) (9:right, 4:left)	0,197
Femoral stretch test	6 (%40) (4:right, 2:left)	9 (%25,7) (7:right, 2:left)	0,248

SIJD: Sacroiliac joint dysfunction; SD: Standard deviation; min: minimum; max: maximum; VAS: Visual Analogue Scale; SLRT: Straight leg raise test.

cectomy, laminectomy, microdiscectomy+partial laminectomy and posterior fixation operation were compared, no significant difference was found in terms of SIJD development. Again, in their study, the frequency of SIJD was found to be higher in patients who had multiple segment surgery. In our study, however, there was no significant difference between patients operated on a single level and patients operated on multiple levels. Also, there was no significant difference between the level of operation and SIJD development. While Guan et al.'s study included patients who were followed up for 2 years after the operation, the mean time after the operation was 4 years in our study. In addition, since the number of patients in Guan et al.'s study was quite high, the comparison data of different operation types and levels in terms of SIJD development may have given safer results than our study.

In the study by Lee et al., [13] a series of 317 patients who underwent lumbar fusion surgery in 5 years were reviewed. All patients were followed for 12 months, and they found the incidence of new-onset sacroiliac joint pain after lumbar fusion to be 12%. The relationship between age, sex, the number of segments included in the operation, and the inclusion of the sacrum in the fusion with the development of SIJD were examined. As in our study, no significant dif-

Table 6. Comparison of operative data of patients with and without SIED

	SIJD present (n:15,%30) n (%)	SIJD absent (n:35,%70) n (%)	p
Operation type			
Microdiscectomy	3 (%20)	9 (%25,7)	0,542
Discectomy	2 (%13,3)	9 (%25,7)	
Right laminectomy	2 (%13,3)	6 (%17,1)	
Left laminectomy	5 (%33,3)	6 (%17,1)	
Bilateral laminectomy	1 (%6,7)	1 (%2,9)	
Microdiscectomy and partial laminectomy	1 (%6,7)	2 (%5,7)	
Posterior fixation	1 (%6,7)	2 (%5,7)	
Operation level			
L5-S1	5 (%33,3)	9 (%25,7)	0,380
L4-L5	5 (%33,3)	18 (%51,4)	
L3-L4	0 (%0)	2 (%5,7)	
Multi level	5 (%33,3)	6 (%17,1)	
Is the pain radiating?			
Yes	14 (%93,3)	32 (%91,4)	0,334
No	1 (%2,0)	3 (%8.6)	
Areas of radiation of pain			
Hip	4 (%26,7)	7 (%21,9)	0,793
Knee	4 (%26,7)	14 (%43,8)	
Heel	6 (%40)	11 (%31,4)	
Pain in the same localization as before the operation			
Present	4 (%26,7)	17 (%48,6)	0,130

SIJD: Sacroiliac joint dysfunction.

ference was detected. In addition, there was no significant difference in the development of SIJD between the cases where the sacrum was included in the fusion and the cases where it was not.

Cho et al. [14] in their study investigating the sagittal sacropelvic morphology and balance of patients with sacroiliac joint pain after lumbar fusion, they compared factors such as age, BMI, number of levels involved in the operation, whether the sacrum was included in the fusion, and found no significant difference between patients with and without SIJD. The results of this study are also similar to the results of our study. In addition, in this study, it was shown that the pelvic tilt angle, one of the lumbopelvic parameters, increased significantly in patients with SIJD.

Unoki et al. [8] conducted a study with 262 patients who underwent lumbar or lumbosacral fusion between 2006 and 2009, in which they separated patients with sacroiliac joint pain with preoperative clinical evaluation and completed their follow-up for a 2-year period, they investigated whether the development of sacroiliac joint pain after fusion was related to the inclusion or exclusion of the sacrum in the fusion, and the number of segments. Newly developed low back pain was found in 66 of 262 patients whose preoperative findings improved during follow-up, and sacroiliac joint pain was detected in 42.4% of them. Patients with pain in the lower lumbar region, two positive provocation tests, and more than 70% reduction in pain in the diagnostic injection test, were considered to have SIJD. The mean duration of developing SIJD was 6.6 months. There was no significant difference in the development of SIJD between the cases in which the sacrum was included and the cases that were not. However, the incidence of SIJD in patients who underwent multiple segment fusion (at least three) was found to be significantly higher than those who underwent single segment fusion. As in our study, they did not find a significant difference between those with SIJD and those without SIJD in terms of demographic characteristics [8]. The reasons for the higher rates of SIJD in this study compared to our study may be due to the fact that they included patients with only two positive provocation tests and patients who underwent multiple fusions. In addition, while the mean age was 52.84 in our study, it was 66.7 years in this study. We included patients with at least three positive provocation tests, as is frequently suggested in the literature.

All these studies show that the frequency of SIJD increases after fusion surgery. Theories of pain generation in the sacroiliac joint include ligament or capsular tension resulting in inflammation and pain, extraneous pressure or shear forces, hypomobility or hypermobility, abnormal joint mechanics, and imbalances in the myofascial or kinetic chain. There are three possible causes of sacroiliac joint pain after lumbar fusion. The first is increased load transfer to the sacroiliac joint after fusion, the second is bone grafting from the iliac crest close to the joint, and the third is that SIJD was present before the fusion and could not be diagnosed. Numerous clinical and experimental studies have shown that after fusion procedures, circulation is increased in the upper or lower levels of adjacent segments, and stress in the facet and disc adjacent to the mobile segment is increased. In the case of lumbosacral fusion, the sacroiliac joint is adjacent to the fused segment, and the same biomechanical responses can be considered. After lumbar fusion and laminectomy, SPECT showed increased involvement of the sacroiliac joint, and it was concluded that this was due to the change in spinal mechanics [15].

Considering that the mechanical load on the sacroiliac joint would increase in non-fusion surgeries, we conducted a study that included all operation types. We came across only one study comparing many operation types as in our study. In this study, it was found that the localization of pain in patients with SIJD was at lower level than in the group without SIJD, and neurological deficit was more common. We did not include cases with neurological deficits in our study. In this study by Çakıt et al., [16] SIJD was found with a higher rate of 41.5%. We think that they found this rate higher because they used only the provocation tests when diagnosing SIJD and they did not confirm with the diagnostic injection.

The most important limitation of our study, in which we examined the frequency of SIJD and related factors in patients with FBSS, and other studies in the literature on the same subject, is that preoperative SIJD was not evaluated in detail with provocation tests and diagnostic injection. Only in Çakıt et al.'s study and in our study, preoperative pain localization was questioned and compared with postoperative localization and pain distribution site. In our study, the localization and radiation of preoperative pain and postoperative pain were on the same side in 26% of patients, and on the opposite side in 74% of patients. Guan et al. and Unoki et al. questioned preoperative sacroiliac joint pain and excluded those with pain. However, many studies in the literature have proven that only anamnesis and clinical features are unreliable for the diagnosis of SIED [17]. Therefore, it is not known whether they had preoperative SIJD and have undergone an operation without this treatment, and whether FBSS has developed because of this. Studies on the development of postoperative SIJD can be planned in patients with preoperative planning and ongoing postoperative follow-up, in whom SIJD was not detected preoperatively.

As a result, since FBSS is a very important cause of disability that affects the person socially and psychologically, correct diagnosis and treatment is extremely important. Patients with FBSS should be evaluated in all aspects, current clinical findings and pain should not be attributed only to factors related to the operation, hip examination and examination for SIJD, clinical and diagnostic tests should be performed in detail.

Ethics Committee Approval: Haydarpaşa Numune Training and Research Hospital Clinical Research Ethics Committee, HNEAH-KAEK 2019/109.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: D.G.K., N.M.; Design: D.G.K.; Data Collection or Processing: H.D.A., N.M.; Analysis or Interpretation: D.G.K.; Literature Search: H.D.A., N.M.; Writing: H.D.A., D.G.K., N.M.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Chan CW, Peng P. Failed back surgery syndrome. Pain Med 2011;12:577–606. [CrossRef]
2. Laslett M. Evidence-based diagnosis and treatment of the painful sacroiliac joint. J Man Manip Ther 2008;16:142–52.
3. Szadek KM, van der Wurff P, van Tulder MW, Zuurmond WW, Perez RS. Diagnostic validity of criteria for sacroiliac joint pain: A systematic review. J Pain 2009;10:354–68. [CrossRef]
4. Cohen SP, Chen Y, Neufeld NJ. Sacroiliac joint pain: A comprehensive review of epidemiology, diagnosis and treatment. Expert Rev Neurother 2013;13:99–116. [CrossRef]
5. Barros G, McGrath L, Gelfenbeyn M. Sacroiliac joint dysfunction in patients with low back pain. Fed Pract 2019;36:370–5.
6. Katz V, Schofferman J, Reynolds J. The sacroiliac joint: A potential cause of pain after lumbar fusion to the sacrum. J Spinal Disord Tech 2003;16:96–9. [CrossRef]
7. DePalma MJ, Ketchum JM, Saullo TR. Etiology of chronic low back pain in patients having undergone lumbar fusion. Pain Med 2011;12:732–9. [CrossRef]
8. Unoki E, Abe E, Murai H, Kobayashi T, Abe T. Fusion of multiple segments can increase the incidence of sacroiliac joint

pain after lumbar or lumbosacral fusion. Spine (Phila Pa 1976) 2016;41:999–1005. [CrossRef]
9. Hansen HC, Helm S 2nd. Sacroiliac joint pain and dysfunction. Pain Physician 2003;6:179–89. [CrossRef]
10. Booth J, Morris S. The sacroiliac joint - Victim or culprit. Best Pract Res Clin Rheumatol 2019;33:88–101. [CrossRef]
11. Chang WH, Lew HL, Chen CP. Ultrasound-guided sacroiliac joint injection technique. Am J Phys Med Rehabil 2013;92:278–9. [CrossRef]
12. Guan F, Sun Y, Zhu L, Guan G, Chen M, Chi Z, et al. Risk factors of postoperative sacroiliac joint pain for posterior lumbar surgery: ≥2-year follow-up retrospective study. World Neurosurg 2018;110:e546–51. [CrossRef]
13. Lee YC, Lee R, Harman C. The incidence of new onset sacroiliac joint pain following lumbar fusion. J Spine Surg 2019;5:310–4.
14. Cho DY, Shin MH, Hur JW, Ryu KS, Park CK. Sagittal sacropelvic morphology and balance in patients with sacroiliac joint pain following lumbar fusion surgery. J Korean Neurosurg Soc 2013;54:201–6. [CrossRef]
15. Yoshihara H. Sacroiliac joint pain after lumbar/lumbosacral fusion: Current knowledge. Eur Spine J 2012;21:1788–96.
16. Çakıt BD, Genç H, Balaban Ö, Nacır B, Erdem HR. Sakroiliac joint dysfunction in patients with failed back surgery syndrome. J PMR Sci 2010;13:25–30.
17. Slipman CW, Jackson HB, Lipetz JS, Chan KT, Lenrow D, Vresilovic EJ. Sacroiliac joint pain referral zones. Arch Phys Med Rehabil 2000;81:334–8. [CrossRef]