Journal of Orthopaedic Surgery and Research

RESEARCH

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Are sacral stress fractures in young women truly rare? a retrospective MRI analysis of 1970 patients

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Abstract

Background Sacral stress/insufficiency fractures (SSFs) are underrecognized causes of postpartum low-back/pelvic pain and are frequently misattributed to lumbar disc disease. To determine the MRI-based detection rate and clinical/imaging characteristics of SSFs in women aged 18–50 years undergoing lumbosacral MRI, with subgroup analyses for postpartum versus non-postpartum status.

Methods Retrospective review of 2400 lumbosacral MRI examinations (January 2020–December 2024) corresponding to 1970 unique women. SSFs were identified by a fellowship-trained musculoskeletal radiologist. Prespecified exclusions (chronic corticosteroid use, major pelvic trauma, incomplete follow-up) yielded the analytic cohort. Group comparisons reported effect sizes (Hedges' *g* for continuous; risk difference [RD]/odds ratio [OR] for binary) with 95% CIs.

Results Crude MRI-based detection rate: 1.52% (30/1,970; 95% CI, 1.07–2.17); analytic MRI-based detection rate: 1.17% (23/1,970; 95% CI, 0.78–1.75). Median age 34 years (range 22–49); 10/23 (43.5%) postpartum. Five cases (21.7%) were initially misdiagnosed. Fractures most often involved the sacral ala (right 12, left 10, bilateral 1). Compared with non-postpartum patients, postpartum patients had lower hemoglobin (**11.5 vs 12.6 g/dL; $p = 0.007$; Hedges' g = 1.21, 95% CI 0.34–2.09) and hematocrit (**33.9% vs 37.3%; $p = 0.007$; g = 1.21, 95% CI 0.34–2.09); vitamin D was lower but nonsignificant (**15.4 vs 20.3 ng/mL; $p = 0.204$; g = 0.53, 95% CI − 0.28–1.34). Overall vitamin D status (n = 21): deficient < 20 ng/mL 11/21 (52.4%), insufficient 8/21 (38.1%), sufficient ≥ 30 ng/mL 2/21 (9.5%). The reported frequency reflects an MRI-based detection rate within a selected cohort of symptomatic women undergoing lumbosacral MRI and should not be interpreted as the true population prevalence of sacral stress fractures.

Conclusion Sacral stress fractures in young women, particularly in the postpartum period, may be underrecognized in symptomatic patients presenting with persistent low-back or pelvic pain. Overlapping symptoms with common musculoskeletal complaints during and after pregnancy often lead to diagnostic delays. MRI remains the gold standard for early detection. Increased clinical vigilance is crucial for prompt diagnosis and effective, non-surgical management.

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Keywords Sacral stress fracture, Postpartum, Pregnancy, MRI, Bone metabolism, Fatigue fracture, Insufficiency fracture

Introduction

Sacral stress fractures (SSFs) have classically been linked to older adults with osteoporosis, yet accumulating reports demonstrate that they also occur in younger women, particularly late pregnancy and the early postpartum period [1]. In these patients, symptoms are often nonspecific and easily mistaken for lumbar radiculopathy or disc disease, which contributes to underrecognition and delayed diagnosis. Case series and reviews consistently emphasize that SSFs should be considered in the differential diagnosis of persistent postpartum low-back or pelvic pain [2, 3].

Several physiologic and biomechanical factors plausibly increase sacral vulnerability during the peripartum window. Hormonal changes (e.g., elevated relaxin) can promote ligamentous laxity and reduce load-bearing stiffness across the sacroiliac region; mechanical loading increases with gestational weight gain and altered posture; and gait adaptations/center-of-gravity shifts impose atypical cyclic loads on the sacrum, fostering microdamage even without classic risk factors [4]. These mechanisms align with clinical series in which pregnancy- or postpartum-related SSFs are reported despite the absence of overt trauma or baseline metabolic bone disease [5, 6].

From an imaging standpoint, MRI is widely regarded as the preferred modality for suspected SSF because it detects marrow edema and early fracture patterns that are often occult on radiographs and can be underestimated on CT. Contemporary cohorts—though heterogeneous in case mix—report MRI sensitivities approaching ~ 90–100%, supporting its role as first-line advanced imaging in appropriate clinical contexts. This position is reflected in the 2024 ACR Appropriateness Criteria® on stress (fatigue/insufficiency) fractures, which highlight MRI's superior performance for radiographically occult injuries [7–9].

This study aims to evaluate the MRI-based detection rate and clinical characteristics of SSFs in women aged 18–50 years, based on a retrospective analysis of lumbosacral MRI scans, with particular emphasis on identifying risk factors and distinguishing postpartum-related cases.

Methods

This study was approved by the Ethics Committee of Hisar Intercontinental Hospital (Decision No: 23–45, dated September 22, 2023). This study was retrospective and was not registered in a clinical trial registry.

We conducted a patient-level analysis. Among 2400 lumbosacral MRI examinations performed between January 2020 and December 2024, 1970 unique female patients aged 18–50 years were identified and constituted the denominator for all MRI-based detection rate estimates. Patients who underwent more than one MRI during the study window were counted once**;** the index MRI was defined as the first eligible scan within the inclusion period. The MRI-based detection rate was calculated as the proportion of patients with MRI-confirmed sacral stress/insufficiency fracture among all unique patients who underwent lumbosacral MRI. Patients were excluded if they had a history of major pelvic trauma, known malignancy, metabolic bone disease, prior spinal or pelvic surgery, or long-term corticosteroid use, due to their potential confounding effects on bone integrity.

All MRI images were evaluated by a board-certified musculoskeletal radiologist with over 10 years of experience. The radiologist was blinded to the patients' clinical and laboratory data during initial image assessment. Imaging findings were systematically reviewed for features consistent with sacral stress or insufficiency fractures, including fracture location (e.g., sacral ala), laterality (unilateral or bilateral), and associated bone marrow edema on STIR and T2-weighted sequences. Imaging findings were considered diagnostic of sacral stress/insufficiency fracture when a fracture-compatible low-signal linear or band-like abnormality was identified within the sacrum, typically in the sacral ala, together with adjacent bone marrow edema on STIR and/or T2-weighted fat-suppressed sequences. Bone marrow edema alone was not considered sufficient for diagnosis because of its limited specificity and potential overlap with alternative causes such as sacroiliitis or mechanical overload [10]. Because the present study focused on MRI-detected sacral stress/insufficiency fractures rather than acute traumatic sacral injuries, fractures were characterized descriptively by location, laterality, and associated marrow edema, and no formal Denis classification was applied.

Demographic and clinical data were retrospectively extracted from the hospital's electronic medical record system. Variables collected included age, parity, postpartum status, time since delivery (if applicable), delivery mode, symptom duration, body mass index (BMI), hemoglobin, hematocrit, serum vitamin D levels, and blood type.

As part of the initial clinical evaluation, sacroiliac joint–related pain was also considered in the differential diagnosis, and SIJ provocation maneuvers (e.g., FABER, compression, distraction, thigh thrust, and Gaenslen tests) were performed in routine practice to help

distinguish sacroiliac-region pain from other potential pain generators.

The postpartum period was defined as the interval from delivery up to 12 months**.** Patients imaged within this window were classified as postpartum; those imaged > 12 months after delivery (or without a delivery in the prior 12 months) were classified as non-postpartum [11].

The interval from delivery to MRI was recorded in weeks and summarized as median [IQR].

All patients with confirmed sacral fractures were followed up clinically, and treatment outcomes were documented. No interventional or surgical procedures were performed as part of this study protocol.

Continuous variables (hemoglobin, hematocrit, vitamin D) were also summarized by Hedges' g with corresponding 95% confidence intervals, calculated in R 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria) using the "effsize" package.

For the binary outcome of anemia (hemoglobin < 12 g/dL), we computed the risk difference and odds ratio (OR) between postpartum and non-postpartum groups, with 95% CIs via the "epiR" package in R."

Results

Between January 2020 and December 2024, 2,400 lumbosacral MRI examinations were reviewed. After restricting the cohort to women aged 18–50 years, 1,970 unique patients remained eligible for analysis. Among these, 30 patients had MRI findings consistent with sacral stress/insufficiency fracture, corresponding to a crude MRI-based detection rate of 1.52% (30/1,970; 95% confidence interval [CI], 1.07–2.17). After excluding 4 patients with chronic corticosteroid use, 1 with major trauma, and 2 with incomplete follow-up, 23 patients were included in the final analysis, yielding an analytic MRI-based detection rate of 1.17% (23/1,970; 95% CI, 0.78–1.75). The median age of the study cohort was 34 years (range, 22–49), and 10 of 23 patients (43.5%) were in the postpartum period. Among postpartum patients, the median interval from delivery to MRI was 24 weeks (interquartile range, 12–36).

The most common presenting complaints were low back pain, gluteal pain, and radicular leg pain. Fractures most frequently involved the sacral ala, with right-sided fractures in 12 patients (52.2%), left-sided fractures in 10 (43.5%), and bilateral fractures in 1 (4.3%). Bone marrow edema on STIR/T2-weighted sequences was present in all patients. Five of the 23 patients (21.7%) were initially misdiagnosed, most commonly as having discogenic or radicular pain (Table 1; Fig. 1A–D).

Laboratory results were available for 21 patients. Overall, vitamin D deficiency (< 20 ng/mL) was present in 11 of 21 patients (52.4%), vitamin D insufficiency (20–29 ng/mL) in 8 of 21 (38.1%), and sufficient vitamin D levels (≥ 30 ng/mL) in 2 of 21 (9.5%). Anemia was present in 11 of 21 patients (52.4%). All patients were managed conservatively, and none required surgical treatment.

To distinguish these descriptive cohort-level findings from between-group comparisons, postpartum and non-postpartum patients were analyzed separately below.

In an exploratory subgroup analysis, postpartum and non-postpartum patients with sacral stress fracture were compared with respect to demographic and laboratory parameters (Table 2). Age and BMI were comparable between groups. However, postpartum patients had significantly lower mean hemoglobin levels than non-postpartum patients (11.5 vs 12.6 g/dL; $p = 0.007$; Hedges' g = 1.21, 95% CI 0.34–2.09). Similarly, mean hematocrit values were significantly lower in postpartum patients (33.9% vs 37.3%; $p = 0.007$; Hedges' g = 1.21, 95% CI 0.34–2.09). Mean vitamin D levels were also lower in the postpartum group (15.4 vs 20.3 ng/mL), although this difference did not reach statistical significance ($p = 0.204$; Hedges' g = 0.53, 95% CI – 0.28 to 1.34). Anemia was more frequent among postpartum patients than among non-postpartum patients (8/10 [80.0%] vs 3/11 [27.3%]; $p = 0.048$), corresponding to a risk difference of 0.53 (95% CI, 0.17–0.89) and an odds ratio of 10.65 (95%

Table 1 Baseline characteristics and laboratory results by postpartum status

Characteristic	Overall (n = 23)	Postpartum (n = 10)	Non-postpartum (n = 13)	*p*-value	Effect size	95% CI
Age, years (median, range)	34 (22–49)	30.3	30.3	0.895	–	–
BMI, kg/m^2 (mean)	–	27.8	26.9	0.551	–	–
Time since delivery, weeks (median, IQR)	–	24 (12–36)	–	–	–	–
Hemoglobin, g/dL (mean)	–	11.5	12.6	0.007	Hedges' g = 1.21	0.34–2.09
Hematocrit, % (mean)	–	33.9	37.3	0.007	Hedges' g = 1.21	0.34–2.09
Vitamin D, ng/mL (mean, n = 21)	–	15.4	20.3	0.204	Hedges' g = 0.53	–0.28–1.34
Anemia (Hb < 12 g/dL), n (%)	11/21 (52.4%)	8/10 (80%)	3/11 (27.3%)	0.048	RD = 0.53; OR = 10.65	0.17–0.89; 1.39–82.0

**RD* risk difference, *OR* odds ratio.*

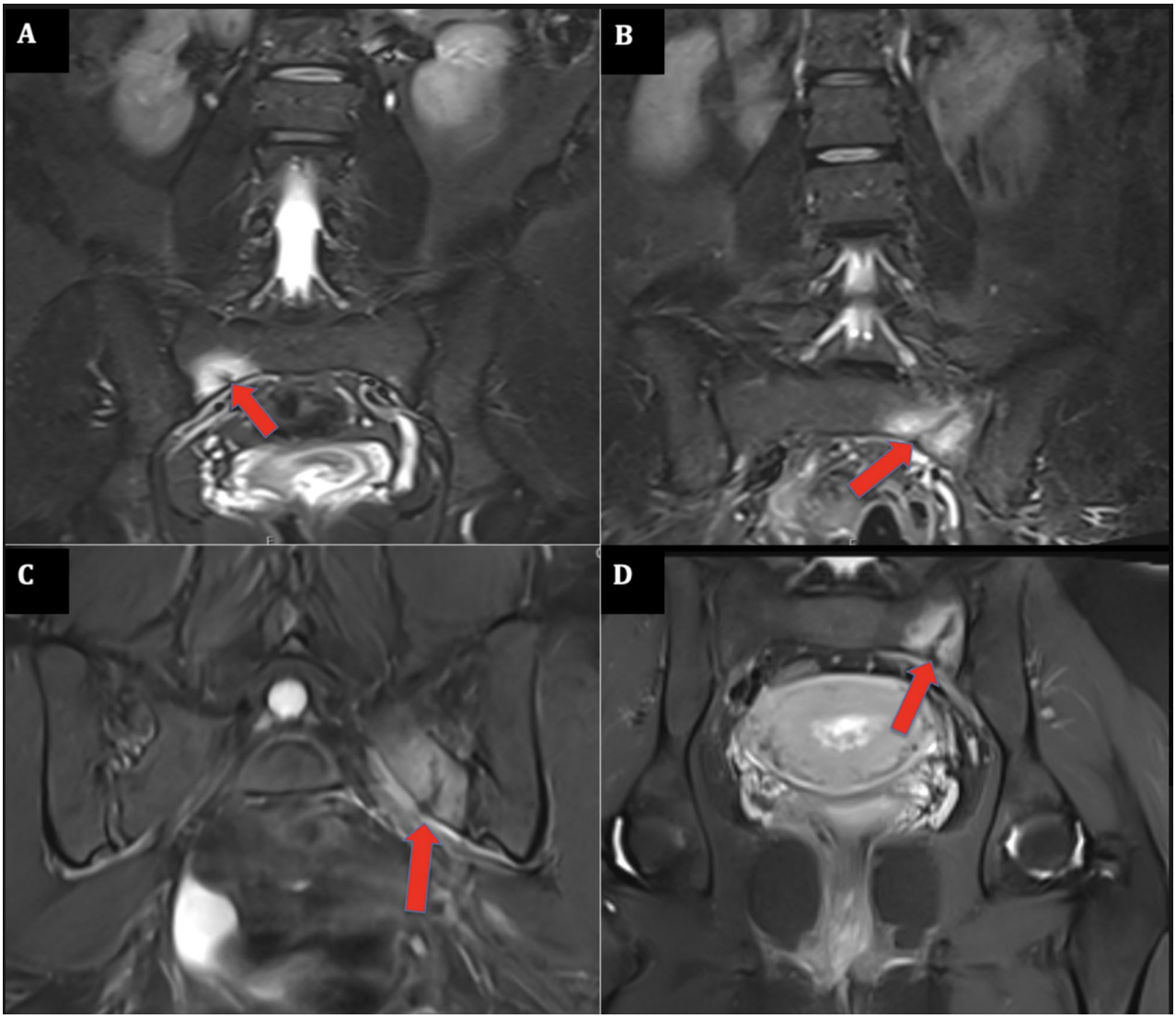

Fig. 1 Representative coronal fat-suppressed T2-weighted MRI images demonstrating sacral stress/insufficiency fractures. **A** Right sacral ala fracture with a hypointense fracture line extending from the inferior cortex, accompanied by surrounding marrow edema. **B** Vertical hypointense fracture line in the left inferolateral sacrum with extensive adjacent bone marrow edema. **C** Hypointense fracture line extending superiorly from the inferior aspect of the left inferolateral sacrum, associated with surrounding medullary marrow edema. **D** Irregular low-signal fracture line in the left inferolateral sacrum extending cranially from the inferior cortical surface, with extensive surrounding marrow edema. Arrows indicate the fracture line

CI, 1.39–82.0). These subgroup findings should be interpreted cautiously in view of the limited sample size.

All 23 patients were treated conservatively—activity modification and analgesic therapy—and none required surgical intervention. Clinical improvement was documented in every case during outpatient follow-up.

Discussion

Sacral stress fractures (SSFs), traditionally associated with elderly osteoporotic populations, are increasingly reported among younger women, especially during the peripartum period. Our study, encompassing 1970 women aged 18–50 who underwent lumbosacral MRI, identified 23 cases of SSFs, with 10 occurring in the postpartum period. In this selected cohort of symptomatic women undergoing lumbosacral MRI, the observed MRI-based detection rate was 1.17%, which should not be interpreted as the true population prevalence of sacral stress fractures [1, 12, 13]. Accordingly, any interpretation of frequency should be limited to this selected symptomatic imaging cohort rather than extrapolated to the broader postpartum or non-postpartum population.

During pregnancy and the early postpartum period, a constellation of hormonal and biomechanical adaptations can predispose women to sacral stress fractures. The hormone relaxin, which peaks in late pregnancy and remains elevated for several months postpartum, promotes collagen remodeling and ligamentous laxity in the pelvis,

Table 2 Radiologic findings among included patients (n = 23)

Finding	Overall n (%)	Postpartum n (%)	Non-postpartum n (%)	Notes
Location: sacral ala (right)	12 (52.2%)	5 (50%)	7 (53.8%)	
Location: sacral ala (left)	10 (43.5%)	4 (40%)	6 (46.2%)	
Bilateral fracture	1 (4.3%)	1 (10%)	0 (0%)	
Bone marrow edema (STIR/T2)	23 (100%)	10 (100%)	13 (100%)	
Initially misdiagnosed	5 (21.7%)	2 (20%)	3 (23.1%)	Misinterpreted as discogenic/radicular pain

thereby increasing joint mobility but also reducing load-bearing stiffness of the sacroiliac region [14, 15].

Concurrently, maternal calcium flux—driven by increased fetal skeletal demands—has been associated with transient reductions in bone mineral density, particularly during lactation [16]. However, because breastfeeding/lactation status was not consistently available in our cohort, its potential relationship with fracture occurrence could not be examined directly.

Finally, altered gait mechanics and center-of-gravity shifts during late pregnancy and the early postpartum readjustment phase may influence stress distribution across the pelvis and sacrum, which could be relevant to sacral stress injury in susceptible individuals [17].

Taken together, these changes may create a biologically plausible setting for insufficiency fractures even in the absence of classic osteoporosis risk factors. Although altered load transfer across the pelvis and sacroiliac region during pregnancy and the postpartum period may plausibly contribute to sacral stress injury, a direct causal role cannot be established from the present data. This interpretation is consistent with prior reports describing pregnancy-related sacral stress fractures in the setting of altered pelvic mechanics and, in some cases, concomitant mechanical sacroiliac joint disease [5].

In our series, the most frequent presenting symptoms were nonspecific low back pain, gluteal or buttock discomfort, and occasionally radicular symptoms—findings consistent with prior case reports [12, 18, 19]. In many patients, the initial clinical suspicion was lumbar disc pathology, which delayed correct diagnosis. Wu et al. emphasized that radiculopathy occurs more often than previously assumed, appearing in nearly 18% of postpartum sacral stress fracture cases [13]. Five of our patients (21.7%) were initially misdiagnosed despite MRI findings, illustrating a common pitfall also noted in the literature [18, 19].

An important observation is that hip or back pain is often dismissed as a normal consequence of late pregnancy or delivery—an assumption that Hilal and Nassar, and Sucuoğlu et al. have shown contributes to diagnostic delays [1, 20]—so maintaining a high index of suspicion for SSFs in persistent, localized, or disproportionate postpartum pain is critical. In our cohort, vitamin D deficiency was highly prevalent (87% suboptimal levels), mirroring prior reports [1, 21, 22] and underscoring that, although vitamin D is integral to skeletal health, its short-term impact on SSF severity or healing remains unclear. These findings suggest that sacral stress fractures should be considered in postpartum women presenting with persistent low back or pelvic pain, and that earlier MRI evaluation may be clinically helpful in selected cases. In addition, postpartum nutritional assessment and optimization, including adequate calcium and vitamin D intake in accordance with established obstetric guidance, may represent reasonable supportive considerations, although their effect on sacral stress fracture prevention requires confirmation in prospective studies [23, 24].

In contrast, anemia was significantly more common among postpartum patients (80.0% vs. 27.3%, $p = 0.048$). This mirrors the findings of Çataltepe and Baş, who reported metabolic strain and postnatal anemia as potentially associated findings in affected patients in their 23-case series [25]. Likewise, pregnancy-related osteoporosis (PrO), although rare, was detected in individual case reports such as those by Sucuoğlu et al. and Sahin [18, 19]. In our study, densitometric data were limited, and fracture classification was based primarily on clinical context and biochemical findings.

No significant differences were observed in age or BMI between postpartum and non-postpartum groups, consistent with the findings of Nakamura et al., who noted that many affected women are otherwise healthy and not classically osteoporotic [26]. Interestingly, Sucuoğlu et al. also observed cases of sacral fracture diagnosed in the prepartum period, challenging the notion that such injuries are exclusively postpartum [20].

All fractures in our study were managed conservatively, without the need for surgical intervention. This supports prior literature emphasizing the effectiveness of rest, analgesics, and gradual return to activity as mainstays of treatment [12, 19]. Most patients showed significant clinical improvement within weeks, and complete resolution was achieved in all cases.

Importantly, MRI proved crucial not only for establishing the diagnosis but also for preventing unnecessary interventions. Given its *high sensitivity* for detecting sacral stress/insufficiency fractures—often reported in the ~ 90–100% range depending on cohort and reference standard—MRI is the preferred modality, particularly in

young or postpartum women in whom avoidance of ionizing radiation is desirable. [8, 20, 27].

In light of our findings and the supporting literature, sacral stress fractures should be considered in the differential diagnosis of persistent postpartum pain. Improved awareness among radiologists, obstetricians, and primary care providers may help reduce diagnostic delay and support appropriate management. Further research with systematic assessment of bone health, nutritional status, and longitudinal clinical outcomes may help clarify the clinical context and longer-term implications of these fractures. Early recognition of SSFs may help reduce diagnostic delay and avoid misdirected lumbar-focused evaluations and treatments for presumed discogenic or radicular pathology, including repeated clinical assessments, additional lumbar imaging, and empiric management for degenerative lumbar conditions rather than the sacral lesion. However, whether earlier diagnosis translates into improved longer-term functional outcomes remains uncertain.

Limitations

This study has several important limitations. First, its retrospective, single-center design may introduce selection and referral biases, limiting the generalizability of our findings. Second, the small number of events reduces statistical power and precludes detailed subgroup or multivariable analyses. Third, all MRI examinations were interpreted by a single experienced musculoskeletal radiologist, without a second independent review or formal assessment of interobserver agreement. This may have affected the reproducibility of imaging-based fracture detection and limits the ability to assess observer-dependent variability in MRI interpretation. Fourth, bone quality was not systematically assessed in this cohort, as bone mineral density measurements and CT-based Hounsfield unit data were not available in a standardized manner. In addition, breastfeeding/lactation status was not consistently documented in the medical records. Therefore, we could not directly evaluate the contribution of impaired bone quality or lactation-related factors to fracture susceptibility. Finally, although MRI was used as the diagnostic reference standard, the lack of systematic CT or follow-up imaging may have led to under- or over-estimation of fracture prevalence. Future multicenter, prospective studies with standardized imaging protocols and dual-reader assessments are needed to validate and extend these results. Because MRI was performed only in symptomatic women who presented for imaging, the observed detection rate reflects a selected clinical population and likely overestimates the frequency of sacral stress fractures in the general postpartum population. Another limitation is that sacral morphology, including sacral dysmorphism, was not systematically assessed in this retrospective MRI-based study, and SIJ-specific symptom attribution was not standardized. Therefore, we could not determine its prevalence or evaluate whether dysmorphic sacral anatomy contributed to fracture susceptibility, sacroiliac-region pain, or symptom distribution in our cohort.

Conclusion

Sacral stress fractures in young women—particularly in the postpartum period—may be underrecognized, especially in patients presenting with persistent low-back or pelvic pain and nonspecific symptoms. Our findings, supported by recent literature, underscore the need for a high index of clinical suspicion in postpartum patients presenting with persistent low back or pelvic pain. MRI remains the diagnostic modality of choice, given its superior sensitivity for detecting early sacral bone pathology.

Notably, over one-fifth of cases (21.7%) were initially misdiagnosed, underscoring a critical gap in clinical recognition. Heightened awareness and early consideration of SSFs in postpartum women with persistent low-back or pelvic pain are imperative to avoid unnecessary interventions and morbidity.

Because prognosis is typically favorable with conservative treatment, early and accurate diagnosis is crucial to avoid unnecessary interventions and reduce the risk of prolonged disability. Increasing awareness among clinicians and radiologists is essential for improving diagnostic accuracy and outcomes in this often underrecognized condition.

Acknowledgements

Not applicable.

Author contributions

Yusuf Bayram: Study conception, data collection, manuscript drafting. Selman Doğan: Patient data review, clinical interpretation. Bestami Yalvaç: Clinical evaluation, manuscript revision. Süleyman Hilmi Aksoy: Radiological image analysis, figure preparation. Muhammed Enes Karataş: Statistical analysis, final manuscript supervision, corresponding author. All authors read and approved the final version of the manuscript.

Funding

The authors received no specific funding for this research.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This retrospective study involving human data was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Hisar Intercontinental Hospital (Decision No: 23–45, dated September 22, 2023). Informed consent was obtained from all patients included in the study.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 31 August 2025 / Accepted: 4 May 2026
Published online: 26 May 2026

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