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# Lumbar stress fracture in a young basketball player: from diagnosis to return to play: a case report

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## ABSTRACT

**Background**: Lumbar stress fractures are a common yet often underdiagnosed cause of low back pain in adolescent athletes, particularly those involved in sports with repetitive spinal loading. Spondylolysis, a stress fracture of the pars interarticularis, represents the most frequent etiology in this population and requires careful evaluation and management to prevent chronic pain or progression to spondylolisthesis. **Case Presentation:** A 17-year-old male basketball player presented with progressive low back pain exacerbated by sports activities, which acutely worsened during a rapid trunk rotation. Magnetic resonance imaging (MRI) revealed a unilateral stress fracture of the right pars interarticularis at L5, associated with bone marrow edema extending to the ipsilateral transverse process and paraspinal musculature. **Management and Outcome:** A conservative treatment plan was implemented, consisting of activity modification, nightly pulsed electromagnetic field (PEMF) therapy, and a structured physiotherapy program emphasizing pain-free mobility, muscle balance, and motor control. The diagnosis was established early through magnetic resonance imaging (MRI) staging, and rehabilitation was guided by objective criteria, including pain scores and functional testing. The athlete achieved complete symptom resolution and returned to full basketball participation within 11 weeks, without recurrence of pain. **Conclusion:** This case highlights the importance of early MRI-based diagnosis and individualized conservative management in adolescent athletes with lumbar stress fractures. MRI is an essential tool for early detection and staging, enabling a symptom-guided rehabilitation approach that facilitates safe and timely return to sport.

**KEYWORDS:** Basketball, Case report, Low back pain, Return to play, Stress fracture.

## Introduction

Low back pain (LBP) is a common complaint among young athletes, with a reported 12-month incidence estimate of 36% and a 12-month prevalence estimate of 42% [1, 2, 3]. Although low back pain may result from acute trauma, it frequently stems from repetitive overuse injuries caused by mechanical stress [4, 5]. Although it is still uncertain whether the type of sport affects the etiology of LBP in young athletes [6], contact sports generally lead to more acute injuries, whereas sports involving repetitive flexion, extension, and rotation—such as gymnastics—are more commonly associated with overuse lesions [2]. In adolescents, lumbar spine stress lesions—including stress fractures are more often responsible for symptoms than disc-related or idiopathic pain [4, 7]. Consequently, any presentation of LBP in a young athlete should be carefully evaluated and never underestimated [4, 8].

Lumbar stress fractures, particularly spondylolysis and spondylolisthesis, are common in pediatric and adolescent athletes [8, 9, 10]. Their often-subtle clinical presentation can lead to misdiagnosis or delayed treatment [8, 11, 12]. Spondylolysis refers to a unilateral or bilateral defect in the pars interarticularis, the weakest area of the posterior vertebral arch, most commonly affecting the fifth lumbar vertebra (L5), with an estimated incidence of up to 6% by late childhood [13, 14, 15]. It is the leading cause of LBP in young athletes [12, 15].

When spondylolysis occurs bilaterally, it may progress to spondylolisthesis, characterized by anterior displacement of one vertebra over the one below it [8]. Management of these conditions depends on the severity and symptomatology, and no universally accepted guidelines

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or recommendations are specific for adolescent athletes [10]. Conservative treatment, which includes rest, bracing, physiotherapy, and bone stimulation, typically achieves satisfactory outcomes and bone healing [4, 13, 16, 17, 18, 19, 20, 21]. Surgical intervention is generally reserved for cases of persistent symptoms and radiological signs of non-union after 9 to 12 months of conservative care [4, 5, 8].

This case report describes the clinical course, diagnosis, and conservative management of a unilateral stress fracture of the pars interarticularis of L5 in a 17-year-old male basketball player, with a specific focus on the rehabilitation strategy and return-to-play (RTP) timeline. The novelty of this case lies in the early imaging-based staging and the use of a symptom-guided, phase-based rehabilitation program with explicit, objective progression criteria, which enabled a complete, pain-free return to competitive sport.

## Case presentation

### *Patient's demographics*

The patient is a 17-year-old male basketball player enrolled in a high-level youth program. His weekly training routine consisted of six sessions, comprising weightlifting, individual technical work, team practices, and one official game per week. He was 17 years and 7 months old at the time of referral.

### *Patient's clinical history*

The patient reported persistent low back pain during sports activities for approximately one month. The pain escalated into an acute episode during a basketball practice, following a rapid trunk rotation to the right. He described hearing a "popping" sensation in the lower back at the time of injury. Notably, in the week preceding this episode, the patient had participated in a youth tournament, playing three games within four days, representing a significant peak in cumulative training load.

### *Physical examination*

On physical examination, the patient reported localized low back pain and radiating pain to the right leg during routine activities of daily living (ADLs). Pain was exacerbated by lumbar flexion, extension, right lateral flexion, and right rotation.

The FABER test (flexion, abduction, external rotation of the hip) reproduced the patient's symptoms and revealed reduced right hip mobility compared to the contralateral side. The Straight Leg Raise (SLR) test, performed actively and passively in the supine position with the right leg, elicited familiar neuropathic pain along the leg.

A complete neurological examination was unremarkable, with normal muscle strength, reflexes, and sensation in both lower limbs.

### *Imaging*

Given the suspected bony pathology, a high-field magnetic resonance imaging (MRI) of the lumbar spine was immediately performed. The report included the following findings (Figure 1):

- Mild loss of physiological lumbar lordosis
- Normal vertebral alignment
- High signal intensity (edema) in the right pedicle (pars interarticularis) of L5, with partial cortical discontinuity suggestive of a stress fracture
- Associated edema in the right transverse process and adjacent paraspinal soft tissues
- No significant abnormalities in vertebral body morphology or disc signal
- Normal appearance of the spinal canal, conus medullaris, and cauda equina

These findings were consistent with a subacute stress response, reinforcing the clinical suspicion of a pars fracture.

**Figure 1** Sagittal STIR (T2-weighted) MRI image of the lumbar spine (3.0 T scanner) showing hyperintense signal in the right pars interarticularis of the L5 vertebra (white arrow), consistent with a stress fracture. Associated bone marrow edema extends to the adjacent transverse process and paraspinal soft tissues.

### *Diagnosis*

According to the MRI classification proposed by Hollenberg et al. (2002) [22], the lesion was graded as grade 3, indicating a cortical fracture line with surrounding bone marrow edema in the right pars interarticularis of the 5th lumbar vertebra.

### *Management*

***Treatment approach*** A conservative treatment plan was adopted, given the unilateral nature of the stress fracture and absence of neurological deficits. The patient immediately withdrew from team activities, including basketball practice and weightlifting.

The treatment protocol included:

- Pulsed Electromagnetic Field (PEMF) Therapy: The patient was instructed to apply magnetic therapy every night during sleep and for at least four additional hours daily over four weeks. Although its efficacy remains debated, several studies have demonstrated potential benefits in accelerating bone remodeling and pain reduction in stress fractures [23, 24]
- Physiotherapy: A structured rehabilitation program focused on:
    - Restoring pain-free mobility of the lower back, right hip, and right leg
    - Re-establishing muscle balance and motor control

Initial physiotherapy consisted of three sessions per week (30 minutes each), combined with a daily home exercise plan. Manual therapy techniques aimed at improving hip and lumbar mobility were implemented, including Mulligan mobilization with a belt to enhance hip range of motion and lumbar mobilization to reduce low back pain.

Progression was guided by objective criteria, including:

- Pain level on a 0–10 Visual Analog Scale (VAS)
- Functional performance during FABER and SLR tests

- Pain-free execution of routine activities of daily living (ADLs)

As symptoms progressively improved—particularly during ADLs, FABER, SLR, and combined lumbar extension with right inclination and rotation—the program advanced to active motor control and conditioning exercises, including:

- Pelvic tilts in supine and prone positions
- Segmental lumbar movements emphasizing flexion, extension, and rotation
- Trunk rotation exercises coordinated with upper and lower limb movements

After approximately one month, as pain decreased during the one-legged hyperextension test, squat, and forward bending (VAS $\leq$1/10), the patient began a two-week phase of core and lumbar strengthening (three sessions per week) under the supervision of a sports physiotherapist. Once pain-free performance was achieved on single-leg squat and single-leg deadlift, the athlete progressed to a reathletization phase of five supervised sessions per week. When single-leg vertical and horizontal hop tests were asymptomatic and symmetrical, he was gradually reintroduced to team practice, culminating in full competitive return.

### *Objective Criteria for Progression and Return to Play (RTP)*

Advancement between rehabilitation phases and RTP clearance required all the following:

1. Pain $\leq$1/10 on the VAS during ADLs and lumbar/hip movements
2. Negative SLR and FABER tests
3. Pain-free single-leg squat and deadlift with symmetrical control
4. Pain-free single-leg hop tests with <10% side-to-side asymmetry
5. Tolerance of basketball-specific drills (cutting, deceleration, jump-landings) during and 24–48 h after training

Full RTP was authorized after meeting all criteria across two consecutive sessions without symptom recurrence. Table 1 outlines the phase-based rehabilitation protocol and criteria used to guide return to sport.

***Rationale for chosen approach*** The decision to pursue a conservative management strategy was supported by multiple factors, consistent with evidence in the literature [7, 12, 25, 26].

- Unilateral fracture without displacement
- Absence of neurological signs or radicular symptoms
- Early-stage presentation, with MRI findings suggesting active bone edema and potential for healing

Bracing was not included, in line with emerging data suggesting that it does not significantly improve outcomes when used routinely [13, 16, 26]. The chosen approach emphasized individualized load management, progressive rehabilitation, and objective monitoring of pain and function.

### *Follow-up*

At the 6-week follow-up, the patient reported complete resolution of pain (0/10 on VAS) during ADLs and during sport-specific functional tests, including single-leg horizontal and vertical hop tests. Clinical assessments—hip and trunk range of motion, FABER, SLR, and one-legged hyperextension tests—were all negative. A gradual return to sport was initiated with progressive load and movement control exercises. At 11 weeks post-injury, the athlete had resumed full participation in basketball activities, including competition, without recurrence of symptoms.

## Discussion

This case highlights a unilateral lumbar stress fracture of the pars interarticularis in a high-level adolescent basketball player—a condition that, despite being relatively common in this population, remains frequently underdiagnosed or misattributed to nonspecific low back pain. The distinctiveness of this case lies in the early imaging-based diagnosis and the structured, individualized rehabilitation program that enabled a complete, pain-free return to sport within 11 weeks. This report emphasizes the value of MRI staging and progressive, criterion-based rehabilitation in facilitating a safe and efficient recovery among adolescent athletes.

### *Epidemiology*

Spondylolysis most commonly affects the fifth lumbar vertebra, accounting for 71–95% of cases and tends to be bilateral in 80% of patients [7, 12, 26, 27]. Pars stress injury is more frequently observed in sports involving repetitive lumbar flexion, rotation, and hyperextension, such as tennis, cricket, rowing, athletics, football, gymnastics, diving, baseball, and increasingly, basketball—especially as modern training demands have intensified [4, 11, 14, 28, 29].

The patient's history of progressive onset of symptoms and an acute exacerbation during trunk rotation aligns with typical risk factors for bone stress injuries in young athletes [3, 5, 27]. Such injuries occur when mechanical loading exceeds the bone's ability to remodel, resulting in microdamage that can progress from periosteal edema to cortical disruption if not promptly managed [30].

### *Diagnosis*

Initial diagnostic workup in suspected cases of spondylolysis typically begins with plain radiographs, especially anterior-posterior and lateral views [14, 26]. Computed tomography (CT) remains highly specific for visualizing cortical fracture lines and neural arch anatomy (including 3D reconstructions) but is less sensitive in early stress reactions and exposes adolescents to ionizing radiation; hence, we reserved CT for equivocal or refractory cases [30, 31, 32]. MRI, which was used in this case, provides a radiation-free alternative with high sensitivity and specificity (81% and 99%, respectively) for detecting bone and soft tissue edema and early bone stress changes [14, 30, 31, 33]. Although Yamaguchi et al. (2012) reported that MRI may occasionally miss spondylolysis in adolescents [14], subsequent systematic reviews (e.g., Dhouib et al., 2018 [32]; Expósito Jiménez et al., 2024 [31]) have demonstrated markedly improved diagnostic accuracy with modern high-field MRI techniques. MRI also allows for injury staging, facilitating tailored treatment decisions [7]. Evaluating signal changes in the fluid-sensitive sequences (T2 or STIR) as well as morphological changes in the T1-weighted images allows the identification of 5 evolutionary grades. It enables the distinction between stress response and active or inactive spondylolysis [22]. Based on Hollenberg et al.'s MRI grading system [22], this case corresponded to grade 3, indicating a cortical fracture line with surrounding bone edema-justifying a conservative, non-operative strategy [7].

Our clinical reasoning prioritized early MRI to confirm diagnosis and guide individualized rehabilitation.

### *Treatment strategy*

There is no universally accepted protocol for managing pars interarticularis defects [7, 9, 12], but conservative treatment remains the first-line approach for most unilateral, non-displaced lesions. Standard protocols often include [6, 21, 34, 35]:

- Cessation of aggravating activities
- Bracing (optional)
- Targeted physiotherapy
- Nutritional support and bone health optimization
- Bone stimulators (e.g., magnetic therapy)

In this case, bracing was intentionally excluded—consistent with emerging evidence indicating no significant improvement in healing or recurrence rates compared with non-braced protocols—and given the patient's low

**Table 1** Rehabilitation program of the injured player

| Phases (weeks) | Criteria for progression | Physical therapy | S&C activity | Basketball practice |
|---|---|---|---|---|
| **1 (0–2)** | Absence of pain during ADLs; negative neurodynamic (SLR) and FABER tests; absence of pain during bending | Mulligan mobilization for the hip; coordination exercises for the lower lumbar spine | — | — |
| **2 (3–6)** | Absence of pain during side bending, rotation, and extension | Lumbar mobilization; mobility and stability exercises for the lumbar spine | — | — |
| **3 (7–8)** | Absence of pain in all clinical and functional test | Strengthening of the core and posterior chain; functional exercises | Functional exercises | — |
| **4 (9–10)** | Absence of pain in any clinical and functional test and after S&C training | — | Progressive S&C training and metabolic conditioning | Individual practices |
| **5 (11)** | Pain-free performance in all sport—specific tasks | — | Continued S&C training | Full team practice and competition |

S&C: strength and conditioning, ADLs: routine activities of daily living, SLR: straight leg raise, FABER test: flexion-abduction-external rotation test for the hip.

pain levels during ADLs [13, 16, 25]. Bracing may be considered in bilateral or chronic defects, or when symptoms limit early motor control work. Emphasis was placed on motor control, muscle balance, and progressive re-loading, aligning with current best practices.

Symptom resolution is the leading factor in returning to sport and resuming training loads after a pars interarticularis stress injury.

Discrepancies between clinical symptoms and radiological findings can complicate return-to-play decisions. Return-to-play (RTP) timelines vary depending on the severity of the injury and the chosen treatment modality. Literature suggests an average RTP time of 3.7 months for conservative treatment and 7.9 months for surgical cases, with a return-to-sport rate of over 90% in unilateral lesions [7, 12, 25, 26]. In this case, the structured, phase-based rehabilitation emphasizing motor control and gradual load progression resulted in complete symptom resolution and competitive RTP within 11 weeks, aligning with or surpassing outcomes reported in the literature. This outcome supports the effectiveness of individualized, criterion-driven rehabilitation programs in optimizing both recovery and athletic performance.

### *Limitations and future directions*

Although clinically informative, this case report represents a single subject and may not be generalizable to broader athlete populations or different sports. Nonetheless, it underscores the value of early diagnosis, MRI-based staging, and noninvasive management strategies. Future research should explore long-term outcomes, recurrence rates, and functional performance after RTP in larger cohorts.

## Conclusion

This case demonstrates that early MRI-based detection and individualized conservative management can lead to full and timely recovery in adolescent athletes with lumbar pars interarticularis stress fractures. A structured, criterion-driven rehabilitation program—emphasizing motor control, gradual load progression, and objective pain-free testing—enabled a complete, symptom-free return to competitive basketball within 11 weeks.

The integration of early MRI staging, functional monitoring, and personalized rehabilitation may serve as a practical model for clinicians managing similar overuse spinal injuries in young athletes, ensuring both safe return to sport and long-term spinal health.

## Statement and declaration

### *Authors' contribution*

[Insert authors' contribution statement]


### *Acknowledgments*

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### *Data availability statement*

[Insert Data availability statement]

### *Competing Interests*

None.

### *Ethics and reporting*

This case report adheres to the CARE guidelines. Written informed consent for publication (including clinical details and MRI image) was obtained from the patient and his legal guardian. No ethical approval was required for this single-patient case report according to institutional policies.


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