

Co-diagnoses of spondylolysis and femoroacetabular impingement: a case series of adolescent athletes

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ABSTRACT

Locating the source of lumbopelvic–hip pain requires the consideration of multiple clinical pathways. Although low back pain has an incidence of 50% in the adolescent population, the pathophysiology in this population typically differs from that of other age groups. Dynamic mechanical impairments of the hip, such as femoroacetabular impingement, may contribute to the pathogenesis of adolescent low back pain. Eight adolescent male athletes who presented to a single provider with a primary complaint of low back pain with hip pain or motion loss on exam and were ultimately diagnosed with lumbar spondylolysis and dynamic mechanical hip issues between 2009 and 2011 were included. The age at spondylolysis diagnosis ranged from 15 to 19 years (mean \pm standard deviation: 16.3 ± 1.3 years). Seven patients had cam-type impingement, whereas one presented with pincer-type impingement. All patients demonstrated either decreased internal rotation at 90 degrees of hip flexion and neutral abduction or pain on the Flexion Adduction Internal Rotation test on at least one of hip. All eight patients were treated initially with 6 weeks of physical therapy consisting of attempted restoration of hip motion and the graduated progression of hip and spine stabilization exercises. Five patients (62.5%) returned to sport at an average of 11.2 weeks (range: 6–16 weeks). For three patients (37.5%), hip pain and motion loss persisted, thus requiring surgery. All subjects had symptoms for at least 6 weeks, with 6 months as the longest duration. This report is the first documented series of adolescent athletes with co-diagnoses of spondylolysis and femoroacetabular impingement.

Study Information: This retrospective case series was approved by the Institutional Review Board at Hospital for Special Surgery.

INTRODUCTION

Determining the source of lumbopelvic–hip pain is a challenge that requires the consideration of multiple clinical pathways [1]. In adults, axial low back pain (LBP) can be attributed to age-related degenerative changes, intervertebral disk herniation and spinal stenosis [2]. However, the pathophysiology of LBP is often different in adolescents, as it is very much related to sports and activity [3–5]. Pain originates in the lumbar spine, but dynamic mechanical impairments of the hip, such as femoroacetabular impingement (FAI) [6], can also play a role. In the young athlete, hip joint injury is most commonly observed secondary to FAI [7]. Compensatory patterns of movement due to constrained hip motion may also contribute to lumbopelvic–hip injury [8, 9]. FAI has been shown to be associated with

LBP, and patients with radiographic findings consistent with FAI have been shown to have decreased LBP-related function [10, 11]. Due to the developmental process of the lumbar spine, adolescent athletes with FAI and/or other mechanical hip issues may be especially susceptible to injuries above and below the hip in the kinetic chain, such as spondylolysis [12, 13].

Spondylolysis presents anatomically as a defect of the pars interarticularis and clinically as LBP [14]. It is a common cause of adolescent LBP and is less prevalent in adults [5, 15, 16]. Patients with symptomatic spondylolysis typically have pain during active and passive spinal extension, particularly to the side of the lesion [3, 5]. Pain is aggravated by dynamic movements, jumping and extension, but usually resolves over time [15]. Generally, spondylolysis is

considered to be a stress reaction of the pars interarticularis that can lead to lysis of the bone [14]. Pars lesions, which are a characteristic of spondylolysis, do not appear until after birth [17] and often arise in adolescents from the sports-related loading of the spine [15]. Because the posterior elements of the spine do not completely ossify until 25 years of age, late adolescents who are frequently engaged in movements that place stress on the pars are prone to spondylolysis [15]. Particularly high rates of spondylolysis are found in gymnasts, rowers and throwing athletes, with a greater incidence in males [14, 18, 19]. Furthermore, hamstring tightness has traditionally been associated with the presence of pars defects [6].

Although pars defects may arise due to self-limiting posterior element overload, hip abnormalities have also been linked to the development of spondylolysis [6]. Dynamic issues, such as FAI, result in an impingement between the femur and pelvis, often affecting the motion at the hip joint. FAI is categorized as femoral in origin (cam), acetabular in origin (pincer) or mixed type [20]. Cam impingement is more common in males [21]. Both cam and pincer impingement limit hip flexion and internal rotation of the hip, resulting in compensatory motions and changes in muscle forces across the lumbar spine, sacroiliac joint and pubic symphysis [8, 9, 20]. Other dynamic hip issues involved in femoral torsion can cause similar limitations and impingements [20].

Wong and Lee have shown a strong correlation between reduced hip flexion, LBP and reduced lumbar range of motion (ROM) [22]. They stressed the importance of clinically assessing the relationship between spine and hip movements when diagnosing lumbar abnormalities, as lumbar pathology can often originate from abnormal hip anatomy and a resulting lumbopelvic rhythm that predisposes patients to unnatural patterns of loading of the lumbar spine [22]. Although often undocumented, reduced hip motion may predispose adolescents who play sports involving trunk rotation and/or hip flexion/extension to spine injuries, such as spondylolysis.

This case series includes patients who presented to a single physician with LBP and hip pain or motion loss on exam from June 2009 to December 2011 and met the following criteria: (i) male; (ii) age 15–19 years at the time of diagnosis; (iii) diagnosis of hip impingement or labral tear; (iv) diagnosis of spondylolysis and (v) active participation in sports, including tennis, soccer, football, lacrosse, hockey, basketball or golf. Clinical data were collected from office visit records. Imaging data were collected from radiographic, magnetic resonance imaging (MRI) and/or computed tomography (CT) notes, and

were also used to confirm the presence and location of spondylolysis.

CASE DESCRIPTIONS

Eight athletic adolescent males presented with a primary complaint of LBP with or without listing hip pain between 2009 and 2011 and were ultimately diagnosed with both lumbar spondylolysis and dynamic mechanical hip issues. The majority of patients (6/8; 75%) were between 15 and 16 years old at the time of diagnosis (mean \pm standard deviation: 16.3 ± 1.3 years). All patients were competitive athletes who participated in various sports. Seven patients presented with cam-type FAI on plain film, MRI and/or CT imaging, whereas one patient presented with pincer-type FAI. Seven of the eight patients reported concurrent complaints of hip pain. The other patient presented predominantly with LBP and was diagnosed with FAI upon physical examination. Their symptoms lasted for at least 6 weeks, with the longest duration being up to 6 months.

The physical examination included the execution of properly performed internal and external rotation with the pelvis stabilized, as shown in Fig. 1. All 8 patients (100%) demonstrated either decreased internal rotation at 90 degrees of hip flexion and neutral abduction or pain on the Flexion Adduction Internal Rotation test on at least one hip, and 6 (75%) patients demonstrated both on at least one hip. Seven patients (87.5%) had decreased internal rotation of at least one hip on physical examination, and 7 patients (87.5%) tested positive on the Flexion Adduction Internal Rotation test on at least one hip. Two patients (25%) tested positive on the Flexion Adduction Internal Rotation test on both hips. Internal rotation ranged from 0–25 degrees, with an average of 11 degrees across all hips. External rotation ranged from 15–60 degrees.

Clinical evaluations with radiologic confirmation demonstrated that all 8 patients had pars stress fractures to the lumbar spine ranging from L4 to S1. The laterality and levels affected are presented in Table I.

RESULTS

All patients were treated initially with 6 weeks of physical therapy, which concentrated on core stabilization and the restoration of hip ROM when possible. These physical therapy sessions consisted of a graduated progression of stabilization exercises, culminating in sport-specific activities. The programs were specifically tailored to each patient's specific impairments and addressed decreases in muscle length, impairments in motor performance and impairments in motor patterning, as needed. Five patients (62.5%) were successfully treated with physical therapy



Fig. 1. Images showing internal and external rotation of the hip with the pelvis stabilized and the limb controlled.

Table I. Patient profiles

Subject	Age	Sport	FADIR	Internal rotation at 90° flexion	Hip mechanical issue	Spondylolysis location
1	16	Soccer	Positive bilateral	Bilateral 5°	Bilateral cam impingement	Left L4
2	17	Lacrosse, football	Positive right	Bilateral 25° (full range of motion)	Bilateral cam impingement	Left L4, right L5
3	19	Ice hockey, golf	Negative bilateral	Bilateral 0°	Bilateral cam impingement	Right L5
4	15	Lacrosse	Positive right	Right 0°, left 25°	Right acetabular retroversion (pincer impingement)	Right L4
5	16	Basketball	Positive bilateral	Right 10°, left 15°	Right cam impingement	Bilateral L5-S1
6	16	Ice hockey	Positive left	Right 25°, left 10°	Left cam impingement	Left L5
7	16	Tennis	Negative bilateral	Right 5°, left 10°	Bilateral cam impingement	Left L4
8	15	Soccer	Positive right	Right 5°, left 5°	Bilateral cam impingement	Right L5

FADIR, Flexion Adduction Internal Rotation test.

and experienced the restoration of internal rotation at 90 degrees of flexion (20–25 degrees), as well as pain resolution in both the hip and spine. These patients returned to their sporting activity within an average of 11.2 weeks (range: 6–16 weeks) without the need for surgery. Healing or reduction of edema in the bone was assumed if the patient was pain free in extension and could return to sports. Unilateral stress reactions healed, as confirmed by repeat imaging, and bilateral lysis became pain free, although defects persisted. Bracing was not utilized.

In these five patients who were successfully treated with physical therapy, LBP and hip pain recurred in two patients. In both cases, LBP and hip pain resolved with another 6 weeks of physical therapy. A third patient reported the recurrence of LBP without hip pain;

repeat imaging revealed a new finding of mild right facet arthrosis, which was deemed to be the cause of LBP recurrence.

In three patients, arthroscopic repair was necessary due to the persistence of hip pain and motion loss. Two patients demonstrated decreased strength of the affected hips during abduction, and one patient had early cartilage wear from cam-type impingement. In these cases, the treating surgeon elected to perform staged bilateral arthroscopic surgery with subspine decompression and femoroplasty, in addition to labral re-fixation. The duration of physical therapy after surgery averaged 10 weeks (range: 6–12 weeks). At post-operative follow-ups averaging 3 months (range: 1.5–6 months), each patient reported resolution of both hip and spine symptoms and significant improvements in hip ROM.

Patients were symptom free with activity. All three patients were able to return to sport within 6 months of surgery.

DISCUSSION

This case series presents eight adolescent males who had co-diagnoses of spondylolysis and FAI and were able to return to sport after treatment. The guidelines for diagnosing and treating adolescent athletes with spondylolysis are controversial with regard to activity restriction, bracing and imaging [16]. Clinicians have suggested that spondylolysis can be most efficiently diagnosed by first ruling out spondylolisthesis and other anatomical abnormalities with both anteroposterior and lateral standing views on plain radiograph [23, 24]. At our institution, standing anteroposterior and lateral views are performed on initial screen for an adolescent with LBP with extension. MRI is used over bone scans and CT scans as the second-line modality, because of its dynamic ability to see signal changes in the lesion and the concerns regarding irradiating young patients. MRI has been shown to be effective in detecting pars injuries [25] and can be used to rule out other sources of pain, including disk herniations [26]. If an MRI cannot be performed with high-resolution, 3-mm cuts through the pars region or without short T1 inversion recovery sequencing to look for edema, then a thin-cut CT scan should be used [16], as up to 13% of pars defects can be left undiagnosed on plain oblique radiographs [27]. A single-photon emission CT study can augment the sensitivity of the CT scan in ruling out the presence of other lesions [16]. MRI and CT are also helpful in assessing FAI [28].

Upon clinical examination, patients with spondylolysis may have pain on side bending with extension on the affected side or with one extension exclusively [15]. The pain is generally reproducible and may correlate with hamstring tightness [23]. Jackson's 'one-legged hyperextension test,' in which the patient's symptoms are reproduced by standing on the leg ipsilateral to the side of pain while being brought into extension by the examiner, can be used to confirm spondylolysis [29]. In addition, a comprehensive hip evaluation including ROM and impingement testing should be performed. This allows the practitioner to glean a better understanding of the patient's specific lumbopelvic mechanics [30–32].

Managing spondylolysis becomes increasingly complex when working with the athletic population, in which return to sport is a prevalent concern. Spondylolysis is most effectively treated early in its progression [33]. Treating grades I and II spondylolysis with the intent for bony healing rarely occurs. Therefore, conservative treatment is encouraged, as it tends to bring about a marked reduction in symptoms without significant risk [33]. Typical

conservative treatment measures include cessation of activity, bracing and physical therapy involving core strengthening [34].

Bracing in a thoraco-lumbo-sacral orthosis has traditionally been used judiciously for the stabilization of the lumbar spine in an effort to unload the pars and promote healing of the lesion and typically varies in length depending on the treating physician [16, 35]. Relatively recent concerns regarding bracing include the worry that patients will actually experience an increase in movement at the lumbosacral junction due to a restriction in gross body movement but not necessarily of fine joint movements [16, 34]. Simultaneously, patients may lose strength in the core and low back, thus prolonging the unloading process [34].

Physical therapy plays an important role in managing spondylolysis and has evolved in its breadth and individualization across patient populations. Flexion-based exercise programs in conjunction with stretching have been demonstrated to be effective [23]. Lumbar stabilization programs that work to strengthen the local stabilizing musculature of the spine have been shown to be equally effective, if not superior, to flexion-based therapy [36]. Integration of hip rehabilitation protocols has also been helpful in our rehabilitation of these patients. Restoration of motion and abductor strengthening help reduce stress to the spine by decreasing rotational forces and stabilizing the pelvis. Athletic patients benefit most from a combination of the two [37] and an individualized program that follows a progression from impairment-level interventions through sport-specific interventions [16]. Recommended physical therapy programs typically begin with low-impact cardiovascular training paired with core stabilization prior to sport-specific dynamic weight-bearing exercises [16].

Return to sport is safe when the patient has achieved pain-free, full spine and hip ROM and sport-specific ROM [38]. Iwamoto *et al.* found that of 35 athletic adolescents treated for spondylolysis, 87.5% showed successful pain-free return to sport and satisfactory follow-up MRI over an average of 5.4 months of rest, despite the presence of a non-bony union on MRI [39]. Following return to sport, athletes must be closely monitored for recurrent symptoms or worrisome radiological findings and must adjust their activity levels accordingly. Skeletally immature patients are particularly susceptible to repeat injuries to the pars region, especially if involved in high impact activity [40].

Although this paradigm of managing and following patients with spondylolysis works well for patients without underlying issues, those with FAI present with unique issues. Their lack of flexion and internal rotation predisposes them to re-injury of the lumbar spine, as well as to

other injuries of the lumbo–pelvic–hip region [41]. Surgical correction of hip impingement may be the only way to ensure a safe and successful return to play for those with significant impingement not amenable to conservative treatment. Arthroscopic femoroplasty has been shown to be safe and to improve performance on subjective outcome scores in patients with FAI [13, 41]. Several studies have also demonstrated increased internal rotation at 90 degrees of hip flexion after surgical correction of FAI [42, 43]. In our study, three patients underwent surgical correction of hip impingement and reported resolution of hip ROM and pain afterwards. However, it is worthwhile to note that five patients were successfully treated with physical therapy alone, without the need for surgery.

Following the initial diagnosis and management of spondylolysis in the adolescent athlete with FAI, the authors recommend close monitoring for signs of recurrent clinical symptoms or radiological indications of an incompletely healed pars defect. It is suggested that older patients undergo repeat imaging if clinically indicated to do so. For younger adolescent patients, the authors suggest ordering follow-up radiographs every 12 months until the patient has reached skeletal maturity [16]. Physical therapy should be continued in conjunction with initial return to sport to ensure maintenance of core strength and flexibility, with the patient eventually transitioning to a structured home exercise program.

This report represents the first documented series of adolescent athletes with concurrent diagnoses of spondylolysis and FAI/hip mechanical abnormality. The patients in this report demonstrated correction of motion loss at the hip, pain relief and healing of pars stress reactions. We recommend that clinicians evaluate hip ROM and impingement signs and, if necessary, order the appropriate radiological exams when assessing adolescent athletic patients presenting with LBP, as the lumbar pain may be associated with underlying mechanical hip pathologies.

CONFLICT OF INTEREST STATEMENT

None declared.

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