SPINE An International Journal for the study of the spine Publish Ahead of Print
DOI : 10.1097/BRS.0000000000002086

Contralateral Spondylolysis and Fracture of the Lumbar Pedicle in a young athlete

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Acknowledgement: March 24, 2016
1st Revise: May 21, 2016
2nd Revise: August 1, 2016
3rd Revise: December 19, 2016
Accept: December 20, 2016
The manuscript submitted does not contain information about medical device(s)/drug(s).
No funds were received in support of this work.
No relevant financial activities outside the submitted work.

Structured abstract

Study Design

Clinical case report of unilateral pedicular stress fracture with a contralateral spondylolysis in a male high school athlete presenting with low back pain.

Objectives

To report this uncommon cause of low back pain in an adolescent athlete, and review the relevant literature.

Summary and Background Data

The incidence of spondylolysis in the caucasian population was found to be about 3-6%[1,2,3]. This number is probably higher in the athletic adolescent age group, with reports ranging from 8-15%[4,5,6]. Spodylolysis may be associated with pedicle fracture, usually on the contralateral side. This is an uncommon phenomenon that is not well described in the adolescent age group.

Methods

A 16-year-old male athlete presents with low back pain and limitation in sports as well as daily activities. Clinical evaluation was suspicious for, and radiographic evaluation revealed left-sided L5 spondylolysis as well as contralateral L5 pedicle fracture. Conservative management included Boston Overlapping brace, external electrical stimulation, modification of activities, and a comprehensive physical therapy program.

Results

Radiological evaluation revealed persistent left L5 pars defect and advanced healing of the contralateral pedicle fracture. The patient achieved complete pain relief and returned to varsity level sporting activity.

Conclusions

Complete radiographic and clinical healing of the pedicle defect was observed, with return competitive varsity level football without symptoms.

Key Words: pedicular fracture, spondylolysis, boston overlap brace, football, baseball

Level of Evidence: 5

Introduction

Low back pain due to stress fracture involving the posterior arch of the lumbar spine is a common occurrence in the young athlete[7-10]. Spondylolysis is the most common stress injury to that anatomical region of the lumbar vertebra. Unilateral spondylolysis with associated contralateral pedicular fracture is still considered to be a rare occurrence, with only few cases described in the literature[11-20]. With proper consent obtained from the patient, we report case of a male adolescent athlete that demonstrated excellent clinical response after conservative treatment for the above pathology.

Case Report

A 16 year-old male right hand dominant varsity football and baseball player presented with low back pain for 6 months. The pain initially appeared on the left side after a tackle while playing football and resolved after few days of rest at the end of the football season. Two months following this remission, during the baseball season, the patient started to experience right-sided low back pain that was aggravated by pitching as well as flexion and prolonged sitting. The pain also radiated to the right posterior thigh and calf.

Physical exam was significant for tenderness to palpation over the L5 paraspinal region on the right. Forward flexion elicited back pain radiating to the right distal thigh posteriorly. The patient had only minimal pain with extension of his lumbar spine, and no pain with single leg hyperextension. He had tight hip flexors and hamstrings as demonstrated by Thomas test of 40º, and popliteal angle of 30°. His neurological examination was normal.

Plain radiographs (Figure 1)AB demonstrated radiolucency at the left L5 pars as well as sclerosis of the right pedicle at the same level. Magnetic resonance imaging (MRI) (Figure 2AB) revealed extensive edema of the right L5 pedicle extending well into the vertebral body. These findings were confirmed with computed tomography (CT) (Figure 3AB), which showed right sided L5 pedicle fracture with a left sided L5 progressive pars defect. Spondylolisthesis was not evident in any of the above studies.

Conservative treatment was initiated with a polyethylene Boston overlap brace that was used continuously for the next six weeks, and partially for the remainder of the treatment protocol. He was also given a transcutaneous bone stimulator which he used for three hours a day. Both therapeutic interventions were used for 17 weeks. Concomitantly, he was engaged in a physical therapy program that was initialized with a neutral zone core stabilization program. At sixteen weeks he demonstrated a pain free physical examination, which included forward flexion, extension, and single leg hyperextension. CT at that time revealed advanced healing of the right pedicle fracture and a stable left pars defect (Figure 4AB). The patient was started with non-contact sports-specific training, instructed to stop using the bone stimulator, and was transitioned out of the brace. He was slowly transitioned to increasing play over the next few weeks. At twenty-one weeks he was back to full participation in sports, including setting a school record of 313 yards rushing and four touchdowns during a high-school football game. The patient was examined 9 months after he first presented to the clinic. He remained symptom free and his examination was unremarkable.

Discussion

Spondylolysis, or acquired fracture of the pars interarticularis, has a prevalence of 3-6% in the general population[1-3,21], but is much more common in adolescent athletes[7]. Unilateral spondylolysis occurs in 15-30% of spondylolysis cases[22-24]. L5 is the most commonly affected vertebra[25,26], followed by L4[26]. As a result of the anatomy and biomechanics of the lumbar spine, shear stress is selectively concentrated at the pars interarticularis[8,24], making it the weakest part of the vertebra. The pedicle is mechanically stronger[27-29], and follows the isthmus as the second weakest part of the neural arch[16,30,31]. Dietrich and Kurowski[32] found that the greatest loads with flexion and extension movements occur at the region of the pars. Cyron and Hutton simulated shear force on the inferior articular processes of cadaveric lumbar vertebrae. This resulted in 55 pars fractures but only 5 pedicular fractures out of a series of 77 vertebrae[31], alluding to the rarity of pedicular stress fractures (also known as pediculolysis). Cyron et al. identified extraneous activity as one of the risk factors for these injuries and emphasized the importance of adequate extensor musculature for control of the stresses on the neural arch. We feel this is particularly important in young active individuals, as most cases of pediculolysis have been described in young athletes[33].

Pediculolysis, as suggested in the literature, generally occurs at the L2–L5 levels and more commonly on the right; pars fractures are more commonly seen on the left[11,20,33]. Sairyo and Katoh[34] hypothesized that unilateral spondylolysis predisposes the contralateral side to stress fracture or sclerosis, especially in athletes engaged in sporting activities involving torsion of the trunk. They analyzed stress distributions using a finite element model of intact ligamentous L3-S1 segment, and demonstrated that indeed, the presence of unilateral spondylolysis puts the contralateral pediculus at a very high risk of stress fracture or sclerosis, especially in very active sports. They also found that the highest risk level movements are the axial rotations which place the contralateral side at increasing stress as high as 12.6 fold, and 6.8-fold on average. Our patient had a spondylolysis of the left isthmus and a fracture of the right pedicle at the L5 level. It is reasonable to assume that our patient sustained the pars defect while playing football, and progressed to fracture his contralateral pedicle during his pitching season.

Gunzburg, who first used the term pediculolysis, described reactive sclerosis and hypertrophy that develops after pedicular stress fracture[14]. In most cases described in the literature, including ours, patients presented with pedicular sclerosis in association with the contralateral spondylolysis. This physiological hypertrophy is known in the literature as sclerotic pedicle, or "vertebral anisocory"[35] on anteroposterior radiographs. The more widely accepted theory regarding the etiology of this sclerosis describes a compensatory reaction to changes in the distribution of forces and abnormal stress that results in posterior elements instability[11,14,33,35-37]. This theory is supported by evidence showing decreased pedicular sclerosis after conservative or surgical treatment[11]. Another theory suggests that this sclerosis reflects a callus formation that occurs during repeated attempts at healing of a stress fracture. This theory was suggested by Chong and Htoo[16], who reported a case of a pedicular stress fracture with no sclerosis in a 65 years old female with bilateral L5 spondylolysis and left pediculolysis. They proposed that pediculolysis does not need to go through the stage of reactive sclerosis before the fracture takes place.

CT and SPECT are still the methods of choice in the evaluation of neural arch fractures. CT provides excellent definition of the bony anatomy and aids in treatment planning, follow-up, as well as differentiation from other possible etiologies, mainly osteoid osteoma, osteoblastoma, and infection[35,36,38]. SPECT bone imaging is better in demonstrating the presence or absence of metabolic activity, and thus aids in assessing acuity of the stress injury and potential for the injury to heal[38]. MR imaging of stress fractures however, is gaining popularity. It does not utilize ionizing radiation and can demonstrate the bony morphology in increasing detail. It may provide valuable information about the acuity of the lesion with the potential of early detection by demonstrating reduced signal intensity in coronal T1 weighted images and increased signal intensity in T2 weighted images[39-41]. In addition, MRI confers a clear advantage in visualizing other lumbar spine pathology. In a comparative analysis of CT, SPECT and MRI, Campbell et al showed that MRI can be used as an effective and reliable tool in the diagnosis of complete spondylolysis fractures, although there was some discordance with diagnosis of incomplete fractures and stress reactions. Their study indicated that MRI could accurately replace SPECT imaging in conjunction with CT for diagnosis of most cases of spondylolysis. While MRI may prove useful, CT is still recommended for baseline diagnosis with increased sensitivity and ability to detect incomplete fracture, as well as for comparative follow-up studies[38,42-44]. An alternative option could be a baseline MRI followed by a CT scan to the particular level indicated by a "positive" MRI study.

In the case presented, the athlete was treated conservatively with a Boston overlap brace, and a core stabilization physical therapy program. In light of the inherent instability of this fracture, a transcutaneous bone stimulator was used as well. There is varying evidence on the efficacy of conservative treatment for spondylolysis and pediculolysis, although almost all treatment protocols included some level of activity restriction, immobilization, and physical therapy[38,45].

It is standard practice to treat spondylolytic fractures with activity reduction and immobilization bracing to promote symptomatic relief and bony healing through reduction of shear stresses at the fracture site as well as reduce the risk of progression to spondylolisthesis in young patients with developing spines[38,43,45,46]. The American Academy of Orthopedic Surgeons recommends using bracing that reduces lumbar lordosis and concomitant reduction of activity for at least three months before return to activity[38], as well as physical exercise focused on a reduction in lumbar lordosis, hip flexion, and hamstring contracture to provide symptomatic relief to young patients. There exist a few case studies in which young athletes who sustained a spondylolytic fracture with contralateral pedicle fracture were followed for a period of time without bracing or immobilization and still went on to heal. However these patients remained symptomatic on average longer than patients who utilized immobilization bracing[18,43,46,47], indicating immobilization plays an important part of effective treatment of spondylolysis.

External electrical stimulation is commonly used to treat stress fractures. It is thought that stimulation and augmentation of bone tissue potentials enhances new bone formation and repair[48]. Treatment with pulse electronic fields was found to be significantly efficacious as a supplement to bone grafting in spinal fusion surgery[49]. While the cost of the treatment must be considered, there is some evidence for the efficacy of bone stimulation in the treatment of spondylolysis.[44] Fellander-Tsai and Micheli reported a study on two patients with bilateral L5 spondylolysis and symptomatic nonunion who underwent conservative management for over 12-14 months without symptomatic relief and persistent nonunion of their fractures. After failure of conservative treatment they were started on bone stimulation therapy, and both patients reported resolution of symptoms within 3 months of therapy, with evidence of bony healing after 4 months of therapy and complete healing within 7-9 months of therapy. They concluded that this mode of treatment was a successful part of their patient's conservative management and additionally that it may have a role in the management of symptomatic nonunion prior to considering surgery[47].

Resolution of symptoms was noted at the 5-month follow-up and our patient achieved bony healing of the pedicle defect with continued nonunion of the pars fracture at last follow up 9 months from the initial presentation. The patient was subsequently lost to follow-up. However multiple studies including this case study show that bony union is not necessarily required for a good clinical outcome[46,48-50]. Steiner and Micheli assessed bony healing of clinical outcomes of 67 patients with spondylolysis or low grade spondylolisthesis using conservative treatment including a modified Boston brace. They showed only 12 of the patients obtained osseous healing yet 52 of the patients reported excellent or good clinical outcomes. They also demonstrated the earliest evidence of radiographic healing of spondylolytic fractures treated with immobilization occurred at 4 months[45]. However, in multiple studies in which patients had continuation of symptoms that eventually required surgical correction, almost all demonstrated nonunion[14,45,46], indicating that bony healing is still a desirable outcome to prevent possible need for surgical intervention later on. Multiple studies also suggest that early detection and treatment of acute fractures and unilateral spondylolysis fractures are associated with better osseous healing as well as overall clinical outcomes, while chronic lesions and bilateral lesions are less likely to heal although may still be associated with acceptable clinical outcomes[38,43,44,46,]. Our patient successfully achieved relief of symptom a year after initiation of the 4 month treatment protocol with return to varsity level football.

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Figure 1

AP (1a) and oblique (1b) radiographs demonstrate radiolucency at the left L5 pars as well as sclerosis of the right pedicle at the same level.

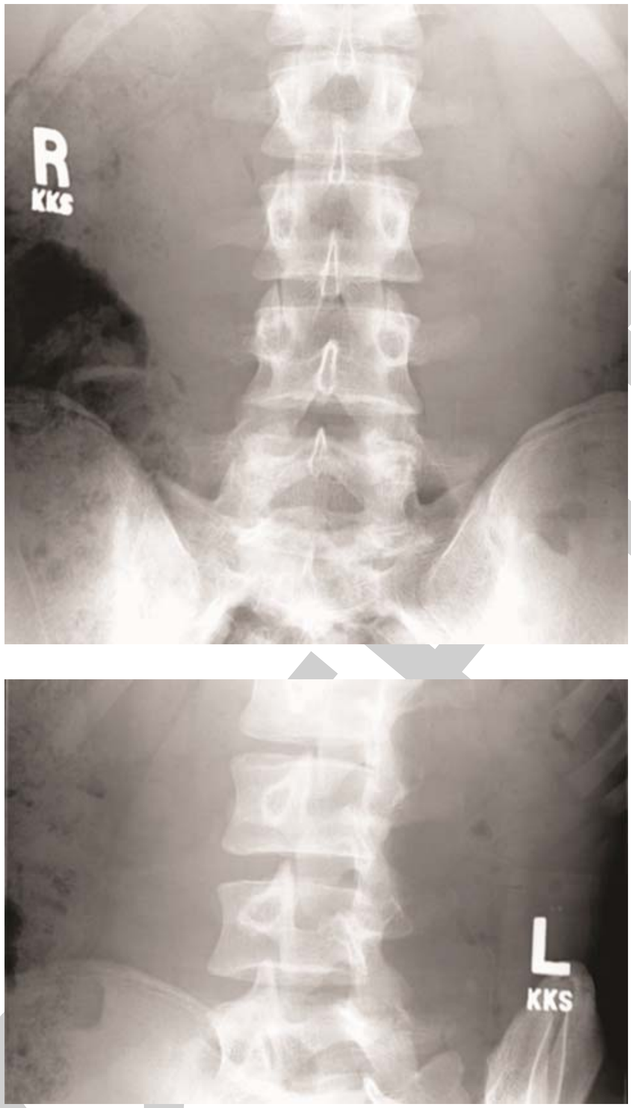


Figure 2

Sagittal (2a) and axial (2b) T2-weighted magnetic resonance imaging (MRI) revealing extensive edema of the right L5 pedicle extending well into the vertebral body.

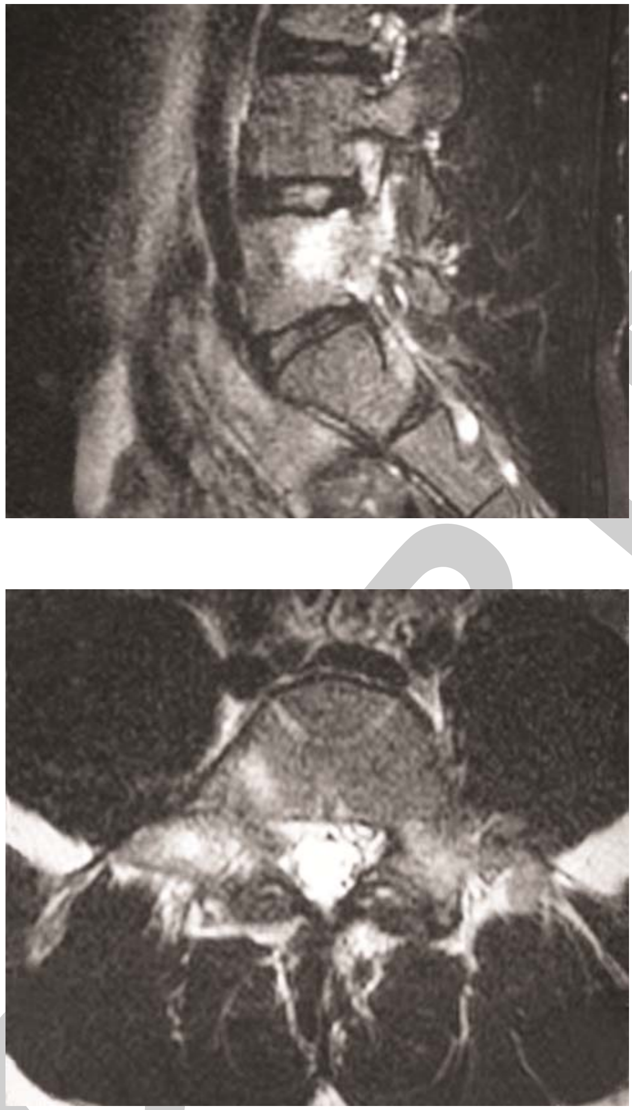
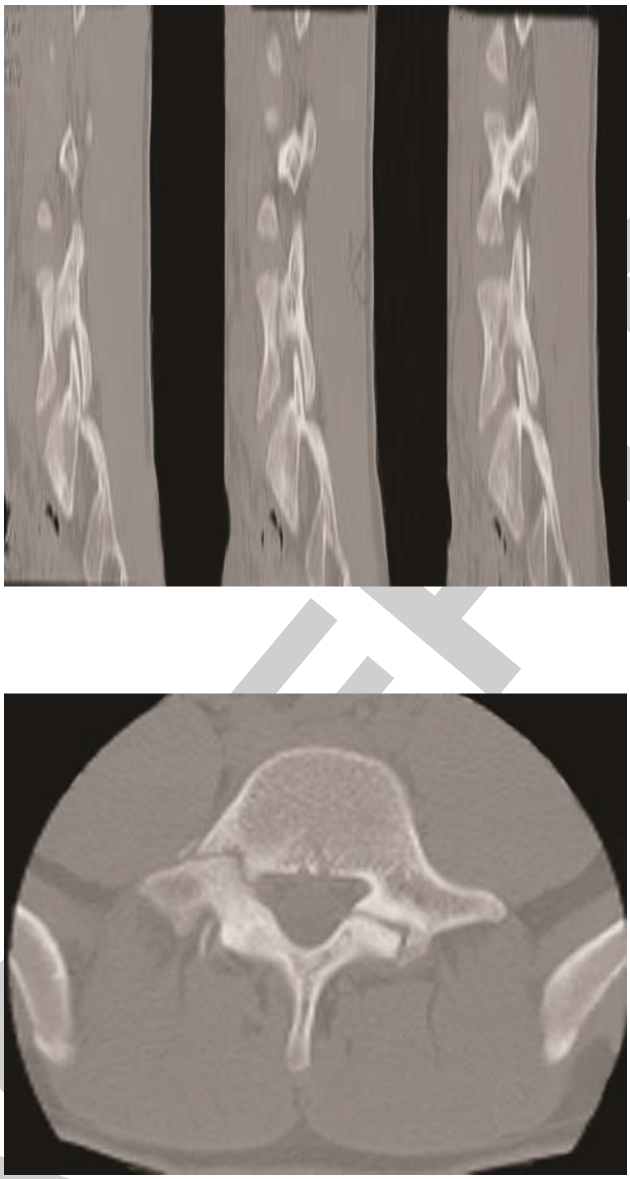
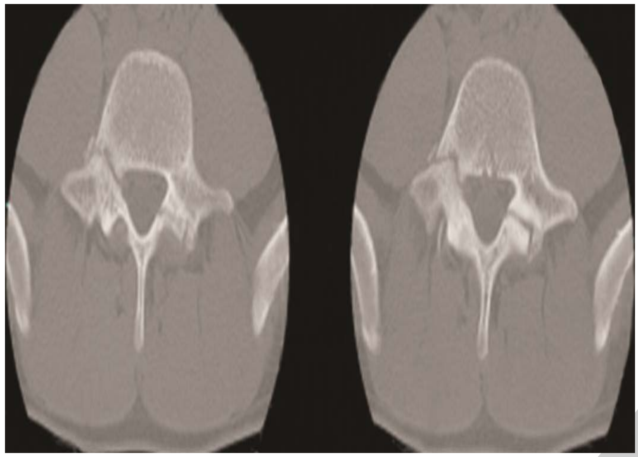


Figure 3

Three-view (3a) sagittal computed tomography (CT) withdetail center image (3b) and two-level axial (3c) and enlarged CT image (3d) revealing right sided L5 pedicle fracture with a left sided L5 progressive pars defect.





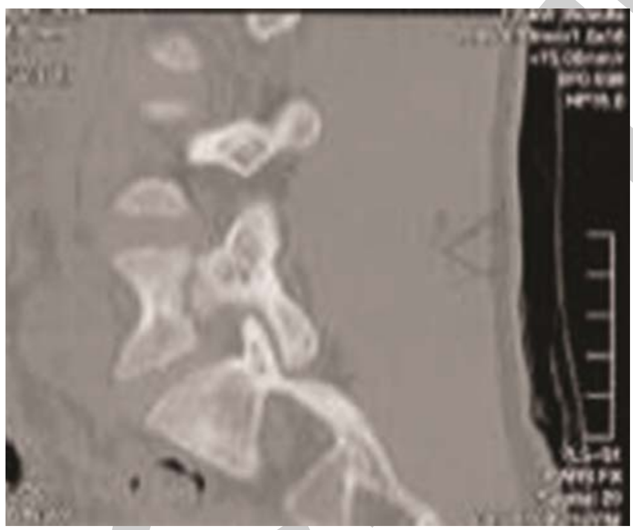


Figure 4

Lateral (4a) and axial (4b) CT at sixteen weeks revealing advanced healing of the right pedicle fracture and a stable left pars defect.