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CASE REPORT

Elite Male Adolescent Gymnast who Achieved Union of a Persistent Bilateral Pars Defect

ABSTRACT

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An adolescent 15-yr-old male competitive gymnast presented to a university-based multidisciplinary spine institute with a persistent low-back pain for 18 mos. Although the results of x-rays were negative, his pain rendered him unable to compete in his sport any longer. A computed tomography scan was performed, which showed a bilateral pars fracture at L5, without spondylolisthesis. A nuclear medicine bone scan revealed negative findings, confirming chronic nonunion. The patient completed a 4-wk course of physical therapy 6 mos before our intervention, without any relief of pain or radiologic evidence of healing. The patient was treated with a bone stimulator for 4 hrs/day and was recommended to wear a warm-and-form-type brace. Isometric core trunk exercises were also initiated. Only after 6 wks of treatment, the subject showed clinical improvement at the follow-up visit. Computed tomography scan performed 12 wks after the initial scan showed complete union of the fracture correlating with clinical improvement. Two years later, the athlete remains completely pain-free, is training regularly, and is able to compete on a national and, possibly, international level.

Key Words: Spondylolysis, Back Pain, Treatment, Rehabilitation

Lumbar pars interarticularis defects, or spondylolysis, typically occurs in adolescents, who complain of back pain after a trauma or injury during a single athletic event, such as a football game.[1] Postoperative radiographic evidence suggests that the etiology of spondylolysis in children and adolescents is a fatigue or stress fracture. O'Neil and Micheli[2] reported that healing of spondylolysis after performing posterolateral spinal fusion would suggest that the defect is recently acquired and not chronic as with dysplastic defects. Usually, the defect becomes apparent after a period of intense athletic activity, such as gymnastics or ice skating, where repetitive axial loading to the spine occurs. Spondylolysis can present as either unilateral or bilateral defects of the isthmic portion of the pars interarticularis of a vertebra, without forward displacement of that vertebra on the adjacent vertebra (spondylolishthesis).[1] Spondylolysis, with or without spondylolisthesis, of the lumbar spine has been identified as a significant cause of low-back pain in adolescent athletes.[3] Spondylolysis is the most common overuse sporting injury of the lower back, reported to range from

13% to 47% among adolescent athletes.[4] The L5 and, occasionally, the L4 vertebrae are most often involved.[5,6]

Spondylolysis has most often been described as a hereditary condition, associated with an inherited predisposition to a hypoplastic pars interarticularis that becomes manifest because of repetitive load of the lower segment, leading to a stress reaction and a subsequent failure.[4] The classic mechanism of injury involves mechanical stress from hyperextension and rotational forces on the spine.[7] Biomechanically, the compressive and torsional forces may be amplified by an anteriorly tilted pelvis, tight hamstrings, and weak abdominal muscles.[1] Sports that demand repetitive hyperextension and rotation of the lumbar spine include soccer, wrestling, volleyball, gymnastics, football, and weightlifting.

Studies have shown that patients with spondylolysis may be successfully treated conservatively using a wide range of nonoperative interventions. A review by Stasinopoulos[4] reported that effective treatments for spondylolysis include restriction of activity, antilordotic bracing or bracing that maintains lumbar lordosis, abdominal strengthening exercises, hamstring stretching, pelvic tilts, specific stabilizing exercises of muscles surrounding the spine that are considered to provide dynamic stability of and fine control to the lumbar spine,[9] and, potentially, external electrical stimulation.[10]

However, some disagreement still exists in the literature regarding the best manner to diagnose and treat acute pars fractures. Although the pars defect can often be identified by plain radiography, radionuclide imaging (particularly, single photon emission computed tomography), computed tomography (CT), and, possibly, magnetic resonance imaging may be needed to identify and stage a pars lesion or to exclude other spinal pathology that may be present. Staging can be accomplished by recognizing well-corticated fracture margins on CT scan and by visualizing a "cold" bone scan for chronic or nonunion lesions. Of course, healing can easily be recognized by union of fracture margins at the site of a previous pars defect.[11] Treatment can consist of bracing, no bracing, exercise, rest, and even surgery. Morita et al.[12] found that, regardless of treatment chosen, the presence or absence of radiographic evidence did not correlate with symptomatic outcome. However, clinicians are often presented with the challenge of an adolescent athlete who demonstrates nonhealing (chronic nonunion or pseudoarthrosis) of a true pars defect that still complains of moderate to severe back pain with extension. This pain often prevents athletes from returning to their sport, and some decide to undergo lumbar fusion surgery. However, we present a case where an alternative treatment approach using an external bone stimulation was used in an ununited pars fracture of likely 18 mos duration.

CASE DESCRIPTION

A 14-yr-old competitive gymnast presented to a university-based multidisciplinary spine institute with a persistent low-back pain of 18 mos. Although the results of x-rays were negative, the pain rendered the athlete unable to compete in his sport any longer. The pain was severe, and occurred with all physical activities, especially with competitive gymnastics. The patient completed a 4-wk course of physical therapy 6 mos before our intervention, without relief of pain or radiologic evidence of healing. The athlete was told that, because of his spine injury, he would have to retire from his sport.

Physical examination revealed a normally proportioned athletic, muscular male. No muscular pain was found on palpation. Range of motion revealed no pain with lumbar flexion but severe lumbar pain with extension and rotation to the left more than the right. There was also a positive single-leg hyperextension stress test bilaterally. This test is performed by having the patient stand, grasp one knee, and hyperextend the low back. Back pain on the weight-bearing side suggests an ipsilateral pars interarticularis fracture. No evidence of motor, sensory, or reflex loss was identified.

Radiographic imaging revealed a bilateral pars fracture at L5 on CT scan. Nuclear medicine bone scan result was negative, suggesting chronic nonunion or old injury.[11] A lumbar magnetic resonance imaging scan was obtained and revealed no disc pathology.

The patient was treated with an external pulsed electromagnetic field (PEMF) bone stimulator for 4 hrs/day and a warm-and-form-type lumbosacral orthotic brace worn 24 hrs per day. The stimulator was loaned to him by the manufacturer, and the settings were typical for patients who wear the device after lumbar fusion surgeries to promote fusion.

Isometric core and lumbar stabilization exercises were initiated. Only after 6 wks of treatment, the patient showed radiographic evidence of initial bony union across the fracture, and at 12 wks, he showed complete union. Follow-up CT evaluation was determined to objectively identify bony union before clearing the patient for aggressive therapy and eventual return to sport (Figs. 1 and 2).

Two years later, this athlete is now completely pain-free, is training regularly, and is able to compete on an international level in the sport.

DISCUSSION

In this case, an athlete with persistent lumbar spondylolysis and pseudoarthrosis, proven by CT

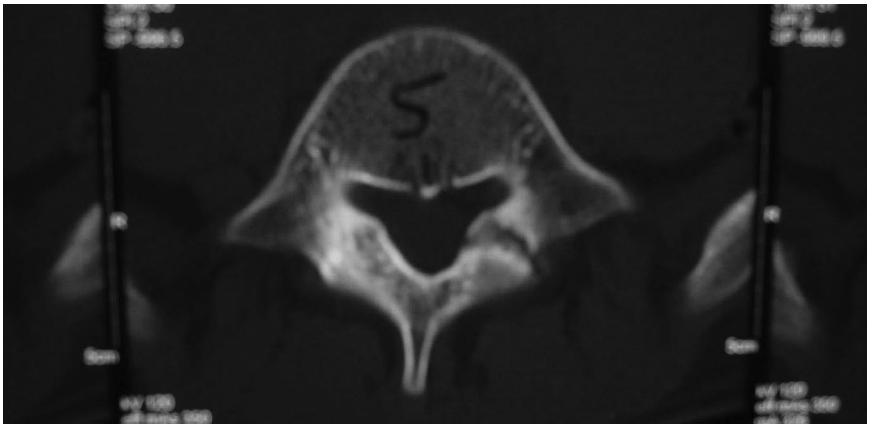

FIGURE 1 *Axial CT of the L5 vertebrae and pars indicating bilateral pars defect. Please note that the defect can be appreciated much more easily on the left; however, there is indeed a defect bilaterally.*

scan, was able to heal the defect, in contrast to previously published case reports that suggested spontaneous healing would not be possible once pseudoarthrosis occurred. There are few reported cases and no published basic research studies of delayed union of lumbar pars fracture. O'Connor and Micheli[13] reported a 19-yr-old collegiate soccer player who recovered from a unilateral pars fracture after discovery of nonunion 4 mos postonset. This pars defect was considered chronic because it was 18 mos after the injury that the defect was demonstrated on CT scan. In addition, the bone scan was negative, which suggests that the anatomical region is physiologically inert and not presently undergoing remodeling.

The patient completed a 4-wk course of physical therapy 6 mos before our intervention, without relief of pain or radiologic evidence of healing. We used an external bone stimulator and LSO bracing and included physical therapy once the pain subsided. Bone stimulation is not approved for use in chronic nonunion pars defects. However, stimulation is used routinely in patients who suffer from a pseudoarthrosis after lumbar fusion surgeries. Typically, the PEMF stimulator device is worn externally over the spine 4 hrs per day. Devices that use PEMF typically use external coils that are placed outside the tissue above the fracture site. The coils produce a magnetic field that induces an electrical filed in the tissue. The patient typically does not sense the electrical stimulation from this noninvasive device. Marks[14] found that in patients who failed to fuse after their surgery, twice as many fused when given PEMF stimulation than those who were not given the stimulation. Moody[15] found similar results and demonstrated no safety problems or side effects. Given that chronic pars defects are unlikely to fuse spontaneously, PEMF stimulation was found to case bone stimulation,

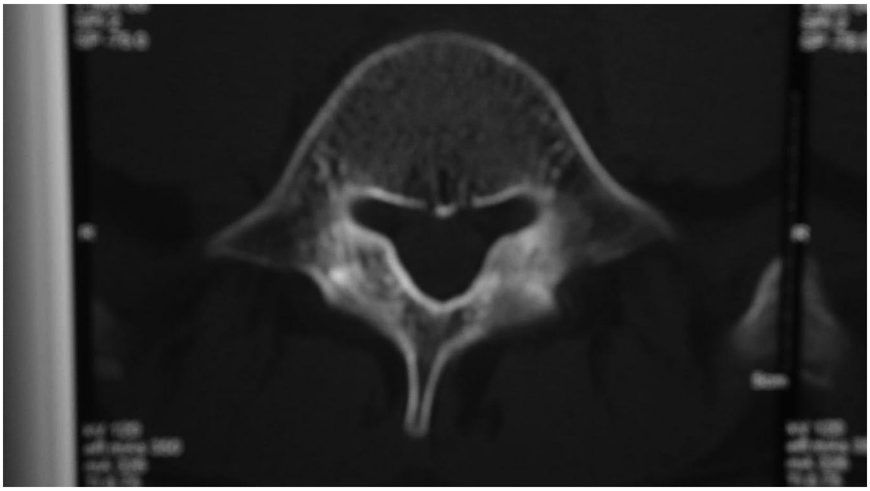

FIGURE 2 *Axial CT of same patient at the same L5 vertebral level indicating resolution of the bilateral pars defect after treatment. Again, the pars defect has resolved bilaterally; however, it is much more easily appreciated on the left.*

and because the stimulator seemed to produce no significant risks, we felt that it was appropriate to try this measure to maximize the chance for bony union.

The therapeutic intervention included basic core strengthening and lumbar stabilization exercises. The radiographic healing coincided with clinical improvement and full return to sport. Although we suspect a direct relationship between the treatment and radiographic healing of the pars defect, such direct cause and effect relationship remains uncertain because this is the only case.

A substantial body of evidence exists that bone stimulators can successfully heal nonunion of fractures in the limbs[4] and are used to speed lumbar fusion rates. One study recommended a trial of external stimulation before considering surgery in patients with anterolateral "black line" stress fracture of the tibia.[4] Goodwin et al.[10] found that, in the spine, external bone stimulation improved lumbar fusion rates in those who had undergone instrumentation. Fellander-Tsai and Micheli[16] reported two cases of delayed unilateral pars defect in athletes, where the opposite side had healed. These authors suggested that by one year, it was unlikely that a persistent pars fracture that had not fused would fuse spontaneously. At 14 mos, these athletes had bone stimulators placed and their braces removed, and at 18 mos, both sides were healed. In these cases, the pain had resolved at 4 mos, only to return at 10 mos, prompting workup and treatment. One other case report by Pettine[17] found a positive outcome in the use of external bone stimulation in the setting of persistent spondylolysis.

Although it is not demonstrated that radiographic healing results in clinical recovery, when faced with persistent pain and disability, many clinicians will treat the radiographic abnormality and hope the symptoms resolve. However, multiple authors found that it was not always necessary for a defect to fuse for the athlete to have pain resolution. In those patients where there is persistent pain and disability and the defect has not healed, athletes are often faced with the difficult reality that they are not able to participate in their sport despite being otherwise capable of competing. Therefore, in many cases, surgical treatment is offered to many patients with persistent pseudoarthrosis. Debnath[18] reported that 81% of their subjects with unilateral lumbar pars stress injuries or frank defects had a high rate of success with nonoperative treatment. However, they concluded that if the patient has a persistent nonunion at 6 mos after the time of injury, it is unlikely that he or she will fuse spontaneously. Therefore, at this point, surgery is warranted. Our case suggests that surgery may not be necessary to fuse a chronic pseudoarthrosis because a trial of repeat bracing and bone stimulation, successful in this case, might be considered as an alternative. Although one case cannot predict the outcome of future cases, this case does suggest that a larger study should be considered to investigate the efficacy of this treatment in chronic, nonhealed pars fractures.

In this case, the patient completed a 4-wk course of physical therapy, without relief of pain. He was never offered surgery but was instead counseled to give up the sport and deal with chronic pain. In such a case, the bone stimulation trial was warranted as an alternative to retirement in an Olympic-quality, athlete who was only 14 yrs old. The intervention was successful, resulting in delayed union and then pain relief, which suggests a necessity for further research. The research should focus on the success of nonsurgical treatments to heal chronic pars fractures and whether radiographic healing correlates with clinical improvement.

Although on initial examination the differential diagnosis would include other spine pathologies, the history and objective radiologic evidence clearly identify a pars defect. In view of that, the clinical recovery seen in this case was remarkable, as the athlete was still pain-free 2 yrs after the treatment and was competing at an international level.

This case report suggests that there is a possibility of healing of a chronic pars interarticularis fracture and that substantial clinical improvement can occur, even 18 mos after the onset of the injury.

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