Understanding Acute Apophyseal Spinous Process Avulsion Injuries

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Abstract

Apophyseal spinous process avulsion injury was first described in 1941. Since then, there have been sparse additional reports in the literature. The authors report their second case, involving an elite adolescent tennis player. The patient underwent surgical excision of the avulsed spinous process 12 weeks after initial presentation and experienced complete resolution of back pain. The authors provide the first reported histopathological analysis of the avulsion fracture site in the literature for both of their cases. The avulsion injury of the interspinous ligament was characterized by hypercellular fibrocartilage tissue, similar to that seen in severe Osgood-Schlatter’s disease. The key physical examination finding in patients with avulsion spinous process fractures is acute tenderness directly over the fracture site that worsens with flexion rather than extension (unlike in spondylolysis). Patients should have routine radiographs, including dynamic flexion-extension views, magnetic resonance imaging, and computed tomography. The authors conclude that after 6 months of nonsurgical management for an athlete, surgical excision should be offered as an alternative. In both of their cases, nonsurgical management failed. Surgical excision offers definitive and simple treatment, as well as early return to athletic activities. Both patients were allowed to return to their competitive level of performance 6 weeks after surgery.

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The authors have no relevant financial relationships to disclose.

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Received: May 11, 2013; Accepted: September 26, 2013; Posted: March 11, 2014.

doi: 10.3928/01477447-20140225-68

Figure: Sagittal computed tomography scan showing avulsion of the L5 spinous process, seen in the currently reported case.
Aphophyseal spinous process avulsion injury was first described by Schmitt 1 in 1941. Schmitt described an adolescent with abnormal radiographic signs in the spinous process. However, it was not until 1951 that Schmitt and Wisser 2 reported additional adolescent cases and drew the parallels to Osgood-Schlatter’s disease, Sever’s disease, and Kohler’s disease. The authors concluded that what they were describing was a juvenile version of Clay Shoveler’s disease (avulsion fracture of the cervical and thoracic spine). The patients they described were boys, age 14 to 16 years, who reported heavy work prior to the onset of symptoms. The reported symptoms were pain, tenderness to palpation over the affected spinous process, and edema of the soft tissues overlying the affected spinous process. Radiographically, Schmitt and Wisser 2 described an irregularly shaped and displaced spinous process. In 1954, Ravelli 3 coined the term “Schmitt’s disease.” There was no pathological examination performed. In 1957, Weston 4 further added to the case series with 2 additional adolescents, both boys. In all, 6 cases reported by Schmitt and Wisser 2 and Weston 4, there was no surgical management and the pain resolved only when patients avoided sports and heavy lifting. Total pain resolution occurred between 3 and 20 months. After healing, the spinous process had an abnormal shape and, in some cases, remained nonunited, deformed, and displaced. Schmitt and Ruecker 5 provided long-term follow-up of patients in 1979, and reported that stress injuries in adolescents were localized to the tip of the spinous process. They reported that the natural history of the disease is benign. Healing was achieved by the formation of a pseudoarthrosis, which consolidates after several months or years.

Since these original publications, only 2 case reports in the English literature have discussed spinous process avulsion fractures. In 2000, Mannor and Lindenfeld 6 described 2 female adolescent gymnasts who presented with low back pain and were clinically diagnosed with spinous process apophysitis. The patients underwent conservative management, requiring them to stop participating in gymnastics. Once gymnastic activity was stopped, resolution of the symptoms occurred at 2 months and 2.5 months. Only 1 patient continued with gymnastics.

The current authors previously reported a spinous process avulsion fracture in an adolescent dancer. 7 The patient presented after 9 months of persistent low back pain and was treated with 8 months of conservative management with little pain relief. She underwent surgical removal of the fragment, which appeared to be a mobile nonunion. Her pain resolved and she was able to return to her full level of competitive dance by 6 weeks postoperatively (Figure 1). The authors herein describe a second, similar case in an elite tennis player and provide the first reported histopathologic analysis of the avulsion fracture site in the literature for both cases.

CASE REPORT

A healthy 12-year-old elite tennis player presented after 4 weeks of lower back pain exacerbated by flexion and extension of the lumbar spine. He had experienced increasing difficulty training and playing tennis. Normally, he played 5 to 6 hours of tennis daily as part of a preprofessional tennis and educational program. On physical examination, the patient was neurologically intact.

As part of the initial workup, plain radiographs and magnetic resonance images (MRI) were obtained. Lumbar spine anteroposterior, lateral, oblique, and flexion-extension radiographs yielded normal findings, with no evidence of spondylolisthesis, fracture, or instability. However, the L5 spinous process was noted to appear dysplastic (Figure 2). Magnetic resonance imaging demonstrated marrow edema within the left pars interarticularis at L5. A small posterior synovial cyst at
the L5-S1 facet joint was also demonstrated. The patient was placed in a Boston overlap brace and restricted from tennis for 4 weeks for presumed spondylolysis. After 5 weeks, the patient continued to have pain with extension and developed new point tenderness of the L5 spinous process. Computed tomography (CT) was performed, revealing an avulsion fracture of the L5 spinous processes (Figure 3). The patient had no lasting relief with a trial injection at L5. Because conservative management had failed, surgery was planned to remove the fracture fragment.

At the time of surgery, 12 weeks after initial presentation, the fractured spinous process was mobile and easily palpated, as was a dense calcific-type mass within the fracture line. The fractured piece of spinous process was detached. The dense calcific-type mass extended down to the ligamentum flavum and under S1. A small, midline laminectomy of S1 was performed to remove the entire mass en bloc. This required additional removal of the ligamentum flavum in concert. The dorsal synovial cyst was exposed and also removed. The remaining L5 spinous process was preserved.

At 1 week postoperatively, the patient had complete resolution of back pain. He had no numbness, tingling, or loss of motor or sensory function. He began physical therapy. At 5 weeks postoperatively, the patient continued to be pain-free and resumed his competitive tennis regimen.

**DISCUSSION**

**Pathology**

The patient’s fractured spinous process and removed en bloc calcific-type mass were sent for pathological examination (Figure 4A). Microscopically, the avulsion injury of the interspinous ligament was characterized by hypercellular cartilaginous tissue with neovascularization, disordered organization, matrix production, and endochondral ossification with woven bone. The chondrocytic clustering implies a chronic injury pattern (hematoxylin and eosin, original magnification ×4) (B). Callus from the L3 spinous process from the previously described patient with the same injury pattern. Note the hypercellular, “pseudosarcomatous” appearance of the callus in this case (hematoxylin and eosin, original magnification ×4) (C).

**Embryology and Pathophysiology**

An understanding and review of vertebral embryology provides an explanation regarding why young athletes would be particularly prone to this type of injury. Chondrification and ossification of the vertebral column begins to occur during the first few weeks of the embryonic period. At birth, each vertebra consists of 3 bony parts connected by cartilage. The bony halves of the vertebral arch usually fuse during the first 3 to 5 years of life. The arches first unite in the lumbar region and union progresses cranially. The vertebral arch articulates with the centrum at cartilaginous neurocentral joints. These articulations permit the vertebral arches to grow as the spinal cord enlarges. These joints disappear when the vertebral arch fuses with the centrum at 3 to 6 years of age.8

![Figure 3: Sagittal computed tomography scan showing avulsion of the L5 spinous process, seen in the currently reported case.](image)

![Figure 4: Avulsed fragment of the L5 spinous process. The fragment of cortical bone is surrounded by a pale white cartilaginous proliferation (callus) (A). Microscopic view of the insertion of the interspinous ligament. This section contains hypercellular cartilaginous tissue with neovascularization, disordered organization, matrix production, and endochondral ossification with woven bone. The chondrocytic clustering implies a chronic injury pattern (hematoxylin and eosin, original magnification ×4) (B). Callus from the L3 spinous process from the previously described patient with the same injury pattern. Note the hypercellular, “pseudosarcomatous” appearance of the callus in this case (hematoxylin and eosin, original magnification ×4) (C).](image)
Five secondary ossification centers appear in the vertebrae after puberty: 1 at the tip of the spinous process, 1 at the tip of each transverse process, and 2 annular epiphyses, on the superior and inferior rims of the vertebral bodies, respectively. These secondary ossification centers fuse by age 25 years, making these areas a particularly weak point in the skeleton of children and adolescents; therefore, tendons or ligaments near a growth plate can pull hard enough to cause the bone to break. The end result of this continuous injury is an avulsion fracture.

Avulsion fractures are typically caused when so much force or repeated physical trauma is exerted on a tendon or ligament that it pulls away, tearing off a segment of bone along the way. These fractures are relatively rare, given that the body itself will signal individuals, via pain, to stop exerting force before they hurt themselves more. Athletes who push through such signals are at risk of avulsion fractures. Children are at risk of avulsion fractures because their growing bones will break before their young tendons and ligaments tear. In adults, the ligaments and tendons tend to be injured.

Differential Diagnosis

Lower back pain is a common complaint of adolescent athletes. The differential diagnosis includes muscle strains and sprains, spondylolysis, spondylolisthesis, disk herniations, ring apophyseal avulsions, and nonmechanical causes such as disk space infections, neoplasms, rheumatological/inflammatory conditions, and developmental disorders.

Spondylolysis is one of the most common causes of lower back pain in adolescents and should be considered in the differential diagnosis of almost every adolescent athlete who has significant lower back pain. In adolescents, disk disease is uncommonly seen; however, disk herniation in concurrence with a ring apophyseal fracture is unique to adolescent athletes.

Lumbar apophyseal avulsion injury is exceedingly rare in the literature. The current report, the authors’ previously reported case, and the 2 cases reported by Mannor and Lindenfeld are the only 4 in the English literature. Previously reported spine process apophyseal injury cases have occurred in the thoracic spine. The actual epidemiology in the population is unknown.

Clinical Evaluation

The key physical examination finding in patients reporting back avulsion fracture is acute tenderness directly over the spinous process that worsens with flexion rather than extension (unlike in spondylolysis). Patients should have routine radiographs, including dynamic flexion-extension views. Magnetic resonance and CT remain the best initial imaging modalities, with confirmation by bone scan.

Management

In both of the cases reported by the current authors, nonsurgical management failed. In their currently described case, the patient’s initial imaging, including MR, showed no fracture. On reviewing the MRI, the current authors concluded that the slices were too thick and that proper protocol had not been followed. Nonsurgical management was only attempted for 6 and 8 months. According to Weston, with cessation of activities, 1 patient had pain resolution at 5 months. The other patient required cessation of activity and splinting before complete resolution at 3 months. Mannor and Lindenfeld reported resolution of pain with nonsurgical management in their patients within 2 and 3 months. This led the current authors to conclude that, in the vast majority of spine process apophyseal injury cases, the injury is self-limiting and heals nonsurgically, much like Osgood-Schlatter’s disease. However, also similar to Osgood-Schlatter’s disease, there are cases that are refractory to nonsurgical management that benefit from surgical excision. This may be true in elite athletes, who often need extremes of flexion for their sport or activities. These patients also often do not have the luxury of stopping their activities. In all cases, a trial period of nonsurgical management is recommended. However, the current authors believe that after 6 months of nonsurgical management for an athlete, surgical excision should be offered as an alternative. As demonstrated, surgical excision provides definitive and simple treatment and allows early return to play.

Return-to-Play Criteria

Return-to-play criteria include full pain-free range of motion, appropriate aerobic conditioning, normal strength, and a demonstrated ability to perform sports-related skills without pain. Athletes should also demonstrate adequate spinal awareness and dynamic postural control. In this case, the patient was allowed to return to his full level of competitive tennis 6 weeks postoperatively. In the authors’ previous case report, the patient was also allowed to return to dance 6 weeks postoperatively.

Conclusion

The authors have described a second case of lumbar spinous process apophyseal injury and provided the first reported histopathologic analysis of the avulsion fracture site in the literature. The authors concluded that after 6 months of nonsurgical management for an athlete, surgical excision should be offered as an alternative. Surgical excision has been demonstrated to provide definitive and simple treatment and allows early return to play.

References


