Spondylolisthesis and Spondylolysis in Athletes

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Participation in competitive sports carries inherent risk. Most athletic activities require an athlete to perform rapid complex movements, many of which produce compressive, torsional, and shear stresses on the lumbar spine.

Athletes who participate in contact and collision sports may have even greater loads applied to the lumbar region due to potential impact with other athletes and the playing surface. The high forces from a single traumatic event can produce serious lower back pathology, but it is believed that cumulative repetitive stresses from sports participation are responsible for most lower back complaints (Berry et al., 1994).

In gymnastics, 12 to 19% of all injuries are to the trunk and spine, whereas the incidence of spinal injuries across all sports has been reported at 20% (Cypress, 1983; McAuley et al., 1997). Low back dysfunction can be a challenging dilemma for the athlete as well as for the individual providing rehabilitative care.

Key Points

- Spondyloergic disorders of the lumbar spine are a common cause of lower back pain in the adolescent athlete.
- Athletes with these disorders often complain of lower back pain that presented insidiously and increases with lumbar spine extension.
- Treatment involves rest, avoidance of lumbar extension/trunk strengthening exercises, and an emphasis on maintaining a neutral pelvic position.

This article is intended to give athletic trainers and therapists a better understanding of spondyloergic disorders in athletes. It reviews the pertinent anatomy, provides an overview of the etiology and suggested mechanisms of injury, and presents preventive strategies. Hopefully, readers will learn to recognize the clinical presentation of spondylolysis and spondylolisthesis in order to design appropriate treatment intervention.

Anatomy

The vertebral column is a segmental structure comprising 33 vertebrae. Collectively, the articulated vertebrae provide increased mobility to the trunk and protection to the spinal cord and exiting neural structures.

The anterior vertebral body is primarily cancellous bone surrounded by a thin layer of cortical bone (Williams & Warwick, 1986). The large lumbar vertebral bodies allow weight-bearing forces to be transmitted along the vertebral column. Each vertebral body articulates with the neighboring vertebral bodies superiorly and inferiorly through intervertebral discs (Moore, 1992; Williams & Warwick, 1986).

The posterior portion of each vertebra is called the vertebral arch. It is primarily composed of cortical bone and serves as an attachment site for multiple muscles and ligaments (Williams & Warwick, 1986).
The pedicles are a dense and strong dorsal projection off the vertebral body. The two pedicles project posteriorly and join the lamina medially, the superior articulating process superiorly and the pars interarticularis inferiorly.

The lamina project dorsally and medially and join to form the spinous process. The joining of the lamina closes an osseous ring that will protect the spinal cord and spinal nerves.

The posterior vertebral arches of adjacent vertebrae articulate through bilateral facet joints which are created by respective superior and inferior articulating surfaces (Moore, 1992; Williams & Warwick, 1986). The pars interarticularis is continuous with the inferior articulating surface, and is thin and vulnerable to injury in the adolescent athlete who has not reached skeletal maturity (Stinson, 1996).

Etiology

Spondylolysis is defined as a disruption in the pars interarticularis of the posterior vertebral arch. It is often described as a fatigue or stress fracture. Spondylolysis can occur at any vertebral level, but is most common in the lower lumbar region (Dubousset, 1997). Some 90% of patients with spondylolysis have involvement at the 5th lumbar level (Saraste, 1993).

The pars interarticularis acts as a fulcrum point for hyperextension of the lumbar spine. It also has a small area of focused stress, less than 1 cm², making the pars interarticularis susceptible to this type of stress fracture (Stinson, 1996).

Spondylolysis with an anterior slippage of the involved vertebral body, in relation to the vertebrae below, is called spondylolisthesis. In approximately 80% of patients with spondylolisthesis, some anterior translation of the vertebral body, spondylolisthesis, was found with radiographic imaging (Saraste, 1993).

It is believed that disruption of the pars interarticularis increases the shear load on the intervertebral disc at the involved level, resulting in spondylolisthesis (Payne & Ogilvie, 1996). The exact mechanism for anterior displacement of the vertebral body is not fully understood, but long-term follow-up studies have shown that progression of the displacement is rare (Saraste, 1993; Stinson, 1996).

It appears that the athlete’s symptoms are related to the degree of anterior displacement of the vertebral body (Saraste, 1993). Early detection and intervention are important in assuring a favorable prognosis for return to sports.

Spondylolysis and spondylolisthesis have three major characteristic differences when compared to stress fractures that occur in other parts of the body. Unlike other stress fractures, the defect of the pars interarticularis is an acquired condition that develops in young people. There is a high incidence of spondylolysis in athletes 5 to 15 years of age (Stinson, 1996).

In a study by Micheli and Wood (1995), 47% of athletes under the age of 19 with complaints of lower back pain had spondylolysis. Only 5% of athletes over the age of 21 with lower back pain had spondylolysis. The diagnosis of spondylolysis was confirmed through imaging studies.

Second, in some cases the pars defect may be asymptomatic despite the fact that it often does not heal completely. Immobilization in a cast or brace is often effective at reducing symptoms and improving function, but radiographic union is often unattainable (Stinson, 1996). Failure of radiographic union alone should not keep an athlete from returning to sports (Hoshina, 1980; Stinson, 1996).

Finally, there is a strong genetic component related to spondylogenic disorders. Adolescents of Alaskan Eskimo descent have the highest incidence of pars defects, whereas adolescents of African American descent have the lowest (Hoshina, 1980). With this pathology, family history is an important variable when interviewing an athlete about his or her lower back pain.

Young athletes whose sports involve repetitive hyperextension of the lumbar spine appear to be at greatest risk for developing spondylolysis and spondylolisthesis. The essential components of a competitive gymnastics routine place high loads on the
pars interarticularis, resulting in a fourfold greater incidence of spondylogenic disorders in female gymnasts compared to the general female population (Jackson et al., 1976).

Other authors have reported that interior linemen (football), weight lifters, baseball pitchers, fast bowlers (cricket), and dancers all have an increased risk of developing a pars defect (Dubousset, 1997; Micheli & Wood, 1995; Saraste, 1993; Stinson, 1996).

Vertical impact forces with the lumbar spine in hyperextension have been suggested as other possible mechanisms of spondylolysis and spondylolisthesis. The forces are absorbed by the posterior elements of the vertebrae instead of the more capable anterior vertebral body. The increased forces on the pars interarticularis cause it to fatigue and fracture under stress.

It has been estimated that the vertical impact forces absorbed by a gymnast performing a routine can be as high as 11 times body weight (Hall, 1976). Flexion overload, unbalanced shear forces, and forced trunk rotation have also been suggested as possible mechanisms (Farfan et al., 1976).

Frequency of participation plays a role in the development of this pathology. Pettrone and Ricciardelli (1987) found that increased exposure to high-risk activities increased the incidence of spondylolysis and spondylolisthesis. Young gymnasts had significantly higher incidence rates when practicing more than 20 hours a week. Gymnasts who practiced less than 6 hours a week had significantly lower incidence rates.

In another study of athletes with pars interarticularis defects, the mean number of years participating in the sport was found to be more than 4 years (Jackson et al., 1976). These studies indicate that risk of spondylogenic disorders increases with increased frequency or duration of participation in high-risk sports.

**Clinical Presentation**

The young athlete with a pars interarticularis defect will typically present with complaints of an ache in the lower back that increases with activity. He or she may be unable to identify a distinct mechanism of injury, but will describe an increase in pain with activities involving lumbar extension and/or trunk rotation. The pain may progress to the point where the athlete is unable to participate in sports and may experience some limitation in activities of daily living.

The athlete’s symptoms are typically localized to the lumbar region and the athlete seldom experiences radicular signs and symptoms (Jackson et al., 1981; Weber & Woodall, 1991).

Inspection of the athlete’s lower back may reveal a hyperlordotic posture and an anterior pelvic tilt. These findings are commonly associated with spondylogenic disorders (Micheli & Wood, 1995). This posture is a common finding in female gymnasts in general and causes an increase in the loading forces to the pars interarticularis.

Closer inspection of the lumbar region may reveal spasm of the lumbar paraspinal muscles (Jackson et al., 1981). During active-movement testing, extension of the lumbar spine will elicit the athlete’s pain most frequently. Symptoms may also be elicited with lumbar rotation and lateral flexion.

Lumbar flexion is seldom painful, but the athlete may complain of pain upon returning to the standing position (Micheli & Wood, 1995). When evaluating muscle strength, it is common to find weakness of the hamstrings and abdominal muscles in individuals with spondylolysis and spondylolisthesis (Weber & Woodall, 1991). The weakness in these muscles is

![PHOTO 2 Trunk stabilization exercise, quadruped.](image-url)
PHOTO 3 Trunk stabilization exercise, kneeling.

due to overlengthening created by the hyperlordotic posture and an anterior pelvic tilt.

The stork test is a reliable special test that elicits the athlete’s symptoms and is often used to confirm the hypothesis of a spondylogenic disorder (Jackson et al., 1981). The athlete stands on one foot and hyperextends the lumbar spine (Photo 1). A positive test will elicit the symptoms that first prompted the athlete to seek treatment.

**Intervention**

Many interventions have been suggested for spondylolysis and spondylolisthesis. Some methods have included bracing, cast immobilization, and surgery (Dubousset, 1997; Micheli & Wood, 1995).

This article discusses a more conservative approach to treating the athlete with a pars interarticularis defect. The goal of conservative treatment should not be to achieve bony union of the fracture but rather to alleviate symptoms and return the athlete to normal function.

It is important to restrict the activity of an injured athlete in the early stages of rehabilitation (Weber & Woodall, 1991). Stresses that load the pars interarticularis should be avoided. Exercises or positions involving lumbar extension should be avoided during the early stages of rehabilitation. Often this may require precluding the athlete from practice and competition until he or she has completed a rehabilitation program.

Early intervention should involve addressing muscle length and strength deficits identified during the initial evaluation.

In a study by O’Sullivan et al. (1997), it was discovered that specific exercises targeting the deep muscles of the spine were effective at reducing symptoms and restoring function in patients with confirmed spondylolysis and spondylolisthesis. The exercises they employed were strengthening exercises for the abdominal muscles and the lumbar multifidus.

Strengthening exercises that help stabilize the lumbar spine should be incorporated. These exercises should target the lumbar paraspinals, latissimus dorsi, lumbar multifidus, quadratus lumborum, iliopsoas, and the abdominal muscles.

Control of pelvic position and stability of the pelvis are of great importance. Strengthening exercises for the quadriceps, hamstrings, tensor facia lata, and gluteal muscles as well as the hip adductors, abductors, and rotators will help with pelvic positioning and stability.

**Exercise Progression**

The first exercise—the one that forms the foundation of the rehabilitation program—is the posterior pelvic tilt. This exercise is initially performed in supine and may require some tactile cues from the athletic trainer or therapist to ensure proper positioning. The athlete should be cued to contract the abdominal and gluteal muscles to reduce the lumbar lordosis.

It is important that the athlete be able to reliably reproduce this exercise, as this will be the pelvic neutral position used in the following exercises.

The athlete can perform lower extremity, upper extremity, and trunk strengthening exercises in supine while maintaining the neutral pelvic position throughout. As he or she progresses, the exercises can be advanced from supine to prone, quadruped (Photo 2), sitting, kneeling (Photo 3), standing, or using the therapy ball (Photo 4).

In each position, the athlete must be able to achieve pelvic neutral position and maintain it throughout the dynamic strengthening exercises. The athletic trainer or therapist should determine the progression of exercises, ensuring adequate stabilization during each activity.

The athlete must demonstrate good control of the pelvic neutral position throughout an activity before it can be advanced. Cardiovascular training equipment can be used during the intermediate stage to maintain aerobic function, but pelvic neutral position must be maintained.

After completing the progression of strengthening exercises, the athlete can begin stabilization exercises during sport-specific maneuvers (Weber & Woodall, 1991). As he or she demonstrates control of pelvic position, more
dynamic tasks can be introduced. This is continued until the athlete is ready to return to practice.

When the athlete returns to sports, there must be frequent emphasis on maintaining the pelvic neutral position as part of sports participation.

Prevention

Prevention of spondylogenic disorders is difficult, but it is possible with the knowledge of predisposing factors and the mechanism of injury. Spondylolysis and spondylolisthesis are stress fractures that occur at a relatively high rate in adolescent athletes who are involved in activities that require repeated extension of the lumbar spine.

The incidence of this disorder also increases with the number of hours per week participating in the sport. It has been suggested that posture, muscle fatigue, and heredity also increase the risk of this injury. It is important that in caring for these high-risk athletes, health care professionals be familiar with the pathology.

Preseason physcials can help to identify high-risk individuals and allow for early intervention. Intake information regarding family history and individual history of low back pain should be collected. Preseason physicals should include assessment of posture, dynamic movement, flexibility, and strength.

Athletes who are identified as having deficits in any of these categories should be placed on a preventive rehabilitation program. Health care professionals should provide education to athletes and coaches regarding the potential for injury and the appropriate prevention techniques.

References


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