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Masterclass

Lumbar spondylolysis in the adolescent athlete

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ABSTRACT

Introduction: Spondylolysis is a common occurrence for adolescent athletes who have low back pain. The injury involves a defect in the pars interarticularis, occurring as a result of repeated hyperextension and rotation.

Clinical presentation: Clinical findings might include tightness of the hip flexors and hamstrings, weakness of the abdominals and gluteals, and an excessive lordotic posture. The validity of several clinical tests were compared alongside magnetic resonance imaging, but were not able to distinguish spondylolysis from other causes of low back pain. Medical referral should be arranged so that medical imaging and diagnostic testing can be completed to insure a proper diagnosis.

Interventions: Initial intervention includes rest from sport, which may vary from 2 weeks to 6 months. Bracing is also used to help minimize lumbar lordosis and lumbar extension. Exercises that focus on stabilization and spine neutral position should be incorporated in physical therapy intervention. Avoiding end ranges is important while performing exercises to minimize the translational and rotational stresses on the spine. Surgical interventions have also been recommended for athletes who have had persistent low back pain for more than six months with no relief from rest and bracing.

1. Introduction

Spondylolysis is a defect in the pars interarticularis of a vertebra (Logroscino, Mazza, Aulisa, Pitta, Pola, & Aulisa, 2001; Standaert, 2005; Thein-Nissenbaum & Boissonnault, 2005). The pars interarticularis is a small isthmus of bone between the superior and inferior articular facets of spinal vertebra. This defect is most commonly seen in the lumbar spine and can occur at any level but is most commonly at the L5 level (85–95%) (Syrmou, Tsitsopoulos, Marinopoulos, Tsonidis, Anagnostopoulos, & Tsitsopoulos, 2010). The fracture can be unilateral or bilateral (Logroscino et al., 2001). The mechanism of injury for most athletes is believed to be repeated lumbar hyperextension or hyperextension with rotation (McCleary & Congeni, 2007).

Chosa et al. analyzed the stress levels on the pars interarticularis during different movements. The results of their study showed that there was more stress during compression and extension or rotation, than with just compression alone (Chosa, Totoribe, & Tajima, 2004). This injury is most frequently seen in those athletes that repeatedly go into end range lumbar extension. Some of the adolescent athletes most commonly seen with spondylolysis include linemen in football, gymnasts, swimmers, divers, weightlifters, track and field athletes, soccer players, and volleyball players (Cassidy, Shaffer, & Johnson, 2005; Stanitski, 2006; Standaert & Herring, 2007).

There are a number of systems used to classify spondylolysis (Logroscino et al., 2001). The simplest classification system divides individuals into developmental or acquired spondylolysis. Developmental is a genetic predisposition to failure of the pars interarticularis and can include failure of proper development of the posterior bony arch. The ossification of the pars interarticularis occurs from anterior to posterior and can often times become congenitally incomplete, which may predispose the pars interarticularis to stress fractures (Purcell & Micheli, 2009). The bony arch, especially at the pars interarticularis may be thinner and/or elongated, therefore less able to tolerate compression or shear forces. Acquired spondylolysis will usually occur from either an acute trauma or a repetitive trauma. Acute traumatic spondylolysis

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is thought to be the result of a single trauma. An acute trauma is more likely to occur in an athlete who experiences a sudden violent trauma such as a severe collision or fall. Repetitive trauma is thought to be the type most commonly seen in the athlete who experiences repetitive hyperextension activities.

The injury begins as a stress fracture (Sakai, Sairyo, Suzue, Kosaka, & Yasui, 2010; Sairyo et al., 2005). Those that experience a unilateral stress fracture are likely to convert to a bilateral stress fracture due to the increased demand of the load on the contralateral side (Sairyo et al., 2005). The stress fracture can continue to develop into a full fracture, a non-union, and eventually a spondylolisthesis. This is especially true if proper care is not administered and the athlete continues to stress the fracture site especially with unprotected extension activities.

Spondylolysis has been reported to occur in approximately six percent of the population and twice as often in males as in females. Micheli and Wood (1995) reported that after examining 100 adolescents with low back pain, they found that 47 patients (47%) were found to have a spondylolysis. This finding is in contrast to only 6% of adults with back pain with the same spondylolysis finding. They concluded that spondylolysis was very common in adolescents but somewhat rare in adults, and that specific diagnostics should not be delayed or serious harm could occur. A contributing factor as to why spondylolysis is so much more common in adolescents is that the spine is still undergoing growth and remodeling (McCleary & Congeni, 2007). The pars interarticularis does not achieve bony maturity until approximately age 25.

Some individuals with spondylolysis have been reported to be asymptomatic (Libson, Bloom, & Dinari, 1982; McCleary & Congeni, 2007; Micheli & Wood, 1995). Libson et al. (1982) reported that individuals with unilateral spondylolysis were more likely to be asymptomatic than individuals with bilateral spondylolysis. Dinari concluded that spondylolysis did not necessarily result in low back pain but was more likely to result in low back pain in athletes, especially those who did repeated extension.

Other risk factors for spondylolisthesis include spina bifida occulta, scoliosis, Scheuermann's disease, excessive lordosis, and cerebral palsy (Sakai et al., 2010). Spina bifida may be more frequently involved due to lack of development of the elements of the posterior arch.

Neumann (2013) reports that, due to the sacral angle and the inferior facet of L5 facing anterior while the superior facet of S1 facing posterior creates a large anterior shear on the L5 pars interarticularis. Individuals who stand with an excessive anterior pelvic tilt will greatly increase the anterior shear at the L5 level, thus greatly increasing the risk for spondylolysis at L5. The anterior shear, along with boney immaturity of adolescence are two of the greatest contributing factors making spondylolysis more common in the adolescent population.

2. Clinical presentation

Adolescent athletes with a spondylolysis will most likely complain of low back pain that primarily worsens with extension activities (McCleary & Congeni, 2007). The level of pain may vary greatly and be described as a dull ache or severe sharp pain especially with extension. The patient may also complain of increased pain with direct pressure to the spinous processes at the level of the fracture or at the one above. There will often have muscle guarding that may be unilateral or bilateral. There patient will often demonstrate significantly limited lumbar range of motion, especially in extension and/or rotation. They may experience referred pain into the buttock or thigh but are not likely to have any radicular signs (McCleary & Congeni, 2007). The pain typically worsens with activity, especially extension activities, and improves with rest. Depending on the individual, they may demonstrate tightness of the hip flexors which could limit their overall extension and thus put extra forces on the lower lumbar spine. They may also demonstrate tightness of the hamstrings (Bono, 2004; Purcell & Micheli, 2009) Other individuals may be excessively hypermobile in the lumbar spine putting greater shear forces at the L5 level. These individuals often are found to have muscle weakness of abdominals and gluteals, and therefore have difficulty keeping out of an excessive lordotic posture (Thein-Nissenbaum & Boissonnault, 2005). This has been found to be especially true with adolescent female gymnasts, cheerleaders and dancers. (Neumann, 2013).

One clinical test reported in the literature thought to help detect spondylolysis is the single leg hyperextension test (Bono, 2004). The patient is asked to stand on one leg while simultaneously extending the lumbar spine. The test is said to produce pain on the side that the patient is standing when ipsilateral spondylolysis is present. Masci et al. examined the validity of the single leg hyperextension test using bone scintigraphy and computed tomography as the gold standard for detecting active spondylolysis (Masci, Pike, Malara, Phillips, Bennell, & Brukner, 2006). The single leg hyperextension test was determined to be not useful in detecting active spondylolysis as it was found to be neither sensitive nor specific in detecting active spondylolysis (Masci et al., 2006; Sundell, Jonsson, Adin, & Larsen, 2013; Gregg, Dean, & Schneiders, 2009).

Sundell et al. tested the validity of several other clinical tests that are thought to detect spondylolysis using MRI as the gold standard. The prone back extension with fixed pelvis test, the coin test, the percussion test with reflex hammer, the sacrum nutation test, the HOOK test, and the MCI control test were all included in the study. These tests were all performed preceding an MRI scan. The results showed that these clinical tests were not able to distinguish spondylolysis from other causes of low back pain (Sundell et al., 2013).

Adolescent athletes with persistent low back pain that worsens with extension activities should be suspected to have spondylolysis and should be referred for further diagnostic testing to rule out spondylolysis and/or spondylolisthesis (Micheli & Wood, 1995). Diagnostic testing will most often begin with X-ray. The best angle for viewing the pars interarticularis is a lateral oblique view (McCleary & Congeni, 2007; Libson et al., 1982). This view may not adequately show in early, newly developing spondylolysis. Further medical imaging may include single proton emission computerized tomography (SPECT), computed tomography (CT), and magnetic resonance imaging (MRI). SPECT has the ability to show stress reactions of the bone before they would be evident on X-ray. SPECT can also tell if the area is likely to be symptomatic (hot scan) versus asymptomatic (cold scan) (McCleary & Congeni, 2007). Negative results from SPECT imaging indicates it is high unlikely that the athlete has a pars fracture (Standaert & Herring, 2007). CT is able to visualize bony morphology and identify occult fractures. It can also differentiate between bony healing and fibrous non-union. MRI has been reported to be of value in early detection of spondylolytic lesions. Current studies have concluded that MRI imaging can be used as first-line imaging in detection of juvenile spondylolysis (Campbell, Grainger, Hide, Papastefanou, & Greenough, 2005). MRI was not found to be as valuable in stress reactions and incomplete lesions (McCleary & Congeni, 2007; Campbell et al., 2005). At times all four forms of medical imaging may be necessary in order to make an accurate diagnosis.

3. Interventions

There is not universal agreement as to which interventions are most effective. One frequently utilized intervention is rest from the