Spondylolysis is one of the more common causes of pathological low back pain in adolescents, and among athletes it occurs most frequently in the presence of repetitive hyperextension of the lumbar spine. Advances in imaging technology have enhanced the evaluation of athletes with suspected spondylolysis. Treatment options vary widely, though clinical studies do not uniformly support a single management approach. Certified athletic trainers need to be aware of this condition in order to facilitate proper diagnosis.

Anatomy/Pathophysiology

The lumbar spine is a marvelously engineered unit. When structurally sound, it provides support for the weight of the upper body, as well as a high degree of mobility about the torso itself. Motion occurs through bilateral synovial joints between the superior and inferior facets of adjacent vertebrae. The pars interarticularis is the segment of the vertebral arch that lies between the superior and inferior articular processes. The pars comes under high stress when the back is extended (460 – 600 Newtons of anterior shear force) and is prone to stress fracture development. Spondylolysis refers to this stress fracture, which can be unilateral or bilateral. Fractures at the pars can cause the body of the fractured vertebrae to separate from the neural arch and slip into rotational or anterior displacement. This displacement is referred to as spondylolisthesis.

The healing potential of spondylitic lesions varies, but fibrocartilaginous union is common. This fibrous tissue gives the lesion stability, and most of the time it remains asymptomatic. Occasionally, problems can arise if it becomes hypertrophic and impinges on the adjacent spinal nerve root. The fracture site itself can remain painful if micro-instability persists.

The presence of a fracture on one side of the vertebra predisposes it to the development of one on the opposite side. If bilateral lesions develop, the intervertebral disc, articular facets, and ligaments are forced to bear the entire shear load imposed by the upper body, increasing the likelihood of a forward slip. When this occurs, there is an antero-superior segment consisting of the body, pedicles, transverse processes, and superior facets, and a postero-inferior segment consisting of the inferior facets, laminae, and spinous process. Disc degeneration often ensues.

Incidence

The overall incidence of spondylolysis in the general Caucasian population is about 6% with a 2:1 predominance of male:female. In some Eskimo populations, the incidence is as high as 60%. A 35-50% incidence exists among family members of affected individuals. The onset of weight bearing, with a concurrent increase in lumbar lordosis is also considered to contribute to development of this problem, as spondylolysis is seen on x-ray in up to 5% of all seven-year-olds, but rarely in individuals five years old or less.

Isthmic spondylolysis is thought to occur in individuals with an inherited tendency to dysplastic bone remodeling and who also participate in “at-risk” activities. Sports that involve hyperextension of the lumbar spine include football (interior linemen), gymnastics, volleyball, diving, wrestling, weight lifting, etc (see Table I). Progression of spondylolisthesis probably relates more to heightened muscle tension associated with rapid growth than participation in sport.
**Diagnosis**

Spondylolysis is usually asymptomatic in the general population, and is often diagnosed incidentally when radiographs of the back are obtained for some other reason. Adolescent athletes in the second decade are more likely to present with symptoms, often in the midst of a growth spurt. Symptoms are usually of insidious onset and are nonspecific, with low to moderate intensity exertional lumbar pain that may or may not be perceived as unilateral.

Examination often reveals spasm of the paralumbar musculature and pain induced by motion through the facets (in this case due to motion through the fracture). This can be tested with the patient prone and resting on the elbows, which increases lumbar spine lordosis. From this position, manual pressure to increase lordosis at the facets can be applied. This maneuver removes much of the contribution of the lumbar extensors to pain generation with extension, since the muscles are relaxed in this position. During range-of-motion testing of the spine, patients with spondylolysis will classically display pain with a combination of lateral bending toward the lesion and rotation away from the lesion. One-legged hyperextension on the ipsilateral side elicits pain as well. Most patients with spondylolysis do not exhibit evidence of nerve root irritation.

The application of diagnostic imaging technology for spondylolysis has advanced considerably over the past 10-15 years. Traditionally, oblique lumbar x-ray views have been obtained to identify the fracture through the pars, which reveals a classic “collar on the Scotty dog” appearance when present, along with lateral views to rule out a forward slip or listhesis.

SPECT scan, a form of radionucleide bone scan that can analyze multiplanar cuts through the area in question, is much more sensitive than plain films. SPECT determines whether there is metabolic activity within an injured area. It can be used to rule out spondylolysis in the presence of negative plain films and can be used to assess the potential for healing of fractures that have already been noted on x-ray.

CT scan is more specific than SPECT scanning, because the area of injury can easily be identified if thin cuts are obtained. CT is often used to follow up positive findings on SPECT scan and can be used to try to predict healing potential on the basis of presence or absence of bony callus through the fracture gap, as well as sclerosis at the fracture margins. CT is superior to any other form of imaging when following up an established diagnosis of spondylolysis for assessment of bony union.

MRI scanning has increasingly been used as a diagnostic tool for spondylolysis for several reasons. There is no radiation exposure, it provides good information about possible associated pathology, and it often reveals bone marrow edema at the pars. The latter advantage allows lesions to be detected earlier than with CT, and this edema may correlate to better healing potential. The high sensitivity of MRI may increase the rate of false positives to an unacceptable level, which has been found in some studies comparing various diagnostic imaging methods. When ordering an MRI of the back with attention to the pars, it is important to clearly designate this purpose so that imaging is properly focused on this area of interest.

**Treatment**

A patient with a documented pars lesion on x-ray and a lack of positive findings on bone scan, or evidence of bony callus on CT (including sclerosis at the fracture margins), tend to have a low rate of bony healing and can be managed conservatively. Rehabilitation goals should include improvement of lower extremity flexibility (in order to minimize over-utilization of the lumbar spine from muscle-related motion restriction at the hips). Patients with hamstring tightness may be experiencing compensatory muscle tightness in an attempt to decrease lumbar lordosis. When attempting to increase hamstring flexibility in a patient with spondylolysis, symptoms might be exacerbated. Strengthening of the abdominals and other extensor antagonists should be initiated, as well as incorporation of multiplanar dynamic stabilization exercises that are sport specific.

**Table 1 – Incidence of Spondylolysis in Various Athletic Populations**

<table>
<thead>
<tr>
<th>Sport Incidence</th>
<th>Percent incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gymnastics, female</td>
<td>11%</td>
</tr>
<tr>
<td>Heavyweight lifting</td>
<td>15 - 36%</td>
</tr>
<tr>
<td>Wrestling</td>
<td>15 - 33%</td>
</tr>
<tr>
<td>Football</td>
<td>15%</td>
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</tbody>
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