Spinal Conditioning for Athletes With Lumbar Spondylolysis and Spondylolisthesis

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SUMMARY

LOW BACK PAIN IS A COMMON CONDITION IN ATHLETIC POPULATIONS. PARTICIPATION IN ATHLETICS HAS BEEN LINKED TO SPECIFIC ANATOMICAL CHANGES TO THE LUMBER SPINE (SPONDYLOLYSIS AND SPONDYLOLISTHESIS). PRACTICAL GUIDELINES FOR STRENGTH AND CONDITIONING PROFESSIONALS SHOULD RECOGNIZE THE BIOMECHANICAL STRESSES ASSOCIATED WITH ATHLETIC PARTICIPATION IN THIS POPULATION. PROGRAM MODIFICATIONS CAN BE MADE IN ATHLETES WITH SPONDYLOLITIC DISORDERS. CONDITIONING ROUTINES SHOULD EMPHASIZE SPINAL STABILIZATION AND SPORT-SPECIFIC FLEXIBILITY. THIS ARTICLE MAKES RECOMMENDATIONS FOR ATHLETES WITH SPONDYLOLITIC DISORDERS THAT SHOULD ALLOW PARTICIPATION IN LUMBAR CONDITIONING WHILE PROTECTING THE BACK FROM UNDUE STRESS.

INTRODUCTION

Low back pain (LBP) is a prevalent condition in the athletic population (10,19). Among athletes, LBP accounts for up to 40% of documented injuries (2,9,25). Although LBP is not the most frequent disorder encountered among the athletic population, it is one of the most challenging to treat, perhaps as a result of training demands. Although the etiology of LBP is multifactorial, epidemiological data have suggested that athletes are more prone to degenerative and spondylolytic related injuries when compared with the general population (2,5,8,10,13,16,26). The purpose of this article is to present a brief overview of spondylolitic disorders and to provide a comprehensive spinal-conditioning program designed to achieve the dual benefit of improved spinal conditioning while protecting the spondylolitic region from undue stress.

Spondylolitic disorders among athletes typically comprise the diagnosis of either a spondylolysis or a spondylolisthesis. The term spondylolisthesis comes from the derivative of "spondylo," which means vertebrae, and "listhesis" which means forward slippage (34). Therefore, a spondylolisthesis is essentially a forward slippage of one vertebra on another (Figure 1) (10,34). Spondylolisthesis often are attributed to degenerative changes and/or a defect at the vertebrae (3,35). A spondylolysis occurs when there is a fracture, found in a region of the vertebrae called the pars interarticularis (Figure 2) (25). A spondylolysis disorder does not imply a forward slippage of the vertebra (33). Spondylolysis defects may be unilateral or bilateral and may progress to a spondylolisthesis over time (13). Researchers have indicated that athletes with a unilateral spondylolysis may be at risk for developing a fracture of the contralateral pars interarticularis (27). For the purpose of clarity, we will refer to spondylolysis and spondylolisthesis conditions collectively as spondylolitic disorders. Where necessary, a distinction will be made.

EPIDEMIOLOGY AND PRECIPITATING FACTORS

As stated previously, athletes are more prone to degenerative and spondylolytic-related injuries when compared with the general population (2,5,8,10, 13,16,26). Spondylolitic disorders are primary causes of back pain among gymnasts, divers, weightlifters, wrestlers, and football players, with a reported prevalence of up to 40% (2,15). Within individual sports, the greatest incidence is found in gymnasts, weightlifters, rowing, and those who participate in throwing sports (14).

KEY WORDS:
low back pain; spondylosis; spondylolysis; spondylolisthesis; athletic injury

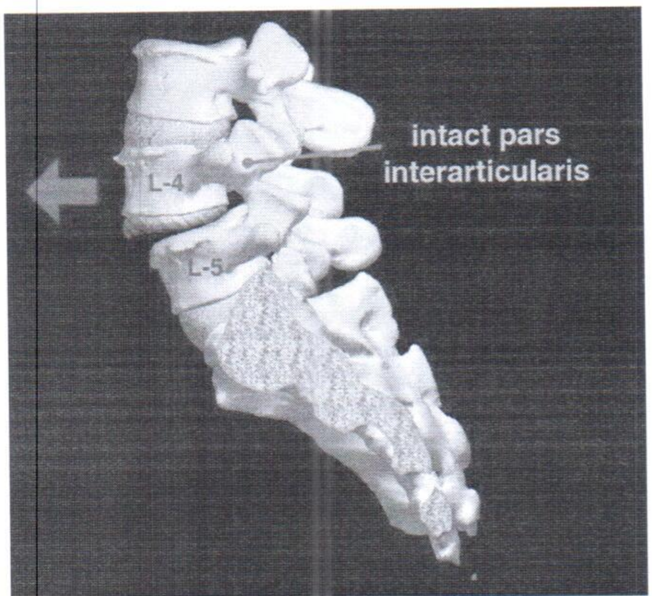

Figure 1. Spondylolisthesis. (© Primal Pictures Ltd.)

An explanation for gymnasts having a high incidence lies in the demands placed on his or her spine while in positions that load the pars interarticularis. It has been estimated the spine of a gymnast is loaded approximately 4 times the amount in that of the general female population (15,23). Consequently, the incidence of spondylolitic disorders has been approximated at 11% among female competitive gymnasts (15,23). Gender also plays a role, as spondylolitic disorders are 4 times more common in women than men (7). Age may also be a factor to consider as vertebral slippage is shown to occur more drastically during an adolescent growth spurt, and if the athlete was asymptomatic to begin with, the problem potential becomes all the more accentuated (29). It has been suggested, although not universally agreed upon, that in the skeletally immature athlete, spondylolitic disorders should be considered until diagnostic testing suggests otherwise (33).

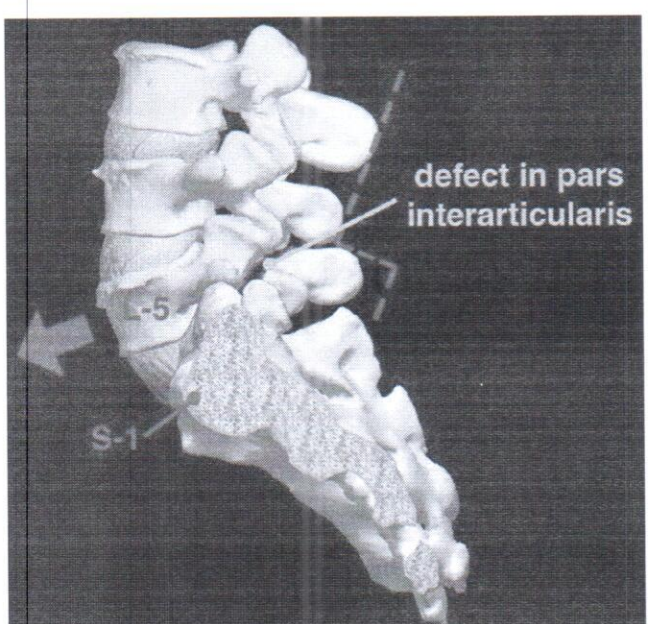

Figure 2. Spondylolysis. (© Primal Pictures Ltd.)

DIAGNOSIS

Athletes with spondylolitic disorders may present with a wide range of signs and symptoms, making clinical diagnosis elusive. Although a detailed discussion of the diagnostic signs and symptoms is beyond the scope of this article, a brief overview is necessary. The athlete's history leading to injury is often inclusive of repetitive loading into extension, flexion, twisting, or a combination of movements (4). Plain film radiographs possess the diagnostic utility to identify spondylolytic disorders using standard views; however, more sensitive imaging modalities, such as a technetium bone scan, may be required in certain cases (25). In cases of a spondylolisthesis, radiographs are able to provide information on the severity of the "slip." A slip of less than 50% is considered mild and often managed conservatively, whereas slips of greater than 50% are often referred for a surgical consult (25). Ultimately, the diagnosis of a spondylolytic disorder will be made by a physician who has interpreted the radiological and clinical presentation. Moreover, individuals diagnosed with spondylolytic disorders must be cleared by their physician prior to the initiation of any exercise programs.

ANATOMY

Although our intent is not to provide an exhaustive discussion of the lumbar anatomy, a brief review is necessary to establish a clear understanding of the information presented. The lumbar spine consists of 5 vertebrae, and between each lies a disk providing cushion between the vertebrae when loaded. The joints of the lumbar spine are referred to as facet joints (Figure 3). A facet is a small smooth area on a bone that creates an articulation between neighboring vertebrae (34). Each vertebra contains 2 superior and 2 inferior articular facets providing a connection to the adjoining vertebra above and below (25). Between the superior and inferior facet lies a small, very thin area of primarily cortical bone called the pars interarticularis which is illustrated in Figures 1 and 2 (34). The pars interarticularis is the weakest area in this unit, and in young people it is particularly thin and injury susceptible (5). Because of its fragile nature, the pars interarticularis is sometimes not capable of withstanding excessive or repetitive forces; thus, it fractures (25). Defects or fractures leading to spondylolitic disorders will invariably originate at the pars interarticularis. Although this disruption can occur at any vertebral level, it most commonly occurs at the L5 segment (30,33). A fracture of the pars interarticularis (spondylolysis) may, in response to stress progress to a spondylolisthesis without causative modifications and appropriate interventions.

PATHOGENESIS

Although the etiology of LBP is multifactorial and the precise cause of spondylolitic disorders is unknown, the mechanisms precipitating these disorders among the athletic population are described in literature (6,13). It has been suggested that repetitive hyperextension movements (extension of the lumbar spine beyond the anatomical limits) place stress through the pars interarticularis and over time may lead to a spondylolysis (9). This notion may lie in the association between the frequently extended and loaded position for which gymnasts, dancers, divers, football lineman and weightlifters assume and their increased prevalence of spondylolitic conditions. It has been purported that accumulative extension at the end-range of mobility, combined with the power and force of jumps, landings, and dismounts, can cause microtrauma to the pars-interarticularis area, leading to spondylolitic disorders. Although the extended position has been established as both a precipitating and provocating factor for spondylolitic disorders (1,16, 17,28), one must exercise caution when asserting that extension should absolutely be avoided in the presence of a forward slippage. Researchers have presented conflicting findings regarding the effect of extension on some individuals with spondylolitic disorders (12,17,31). In particular, extension has shown to be efficacious in some individuals with spondylolitic disorders (31). Nevertheless, one should exercise caution with lumbar extension in the athletic population as it is a factor that places stress on the pars interarticularis and may lead to worsening of the condition.

Finally, spondylolitic disorders resulting from a defect or fracture of the pars interarticularis frequently present with spinal instability (24), thus interventions designed to increase spinal stability may be efficacious (26). Studies have reported that hypermobility (excessive) and/or instability occurs at the spine levels afflicted with a spondylolitic disorder (20,24). It is therefore the goal of treatment to directly strengthen the muscles that insert on the affected vertebrae in order to increase stability. As a result spinal stabilization to achieve "core stability" is a key component in the training of these individuals. Researchers have established that exercise training of the stabilizing muscles of the trunk reduces pain and disability in those with spondylolitic disorders (26). Despite compelling research spinal stabilization exercises are often a neglected portion of strength and conditioning regimens (26,32).

SPINAL CONDITIONING

In our experience, athletes often focus on the large muscles groups responsible for performance and tend to neglect the muscles responsible for spinal stabilization. It is essential that athletes with spondylolitic disorders work both to strengthen the stabilizing musculature and spend necessary time on

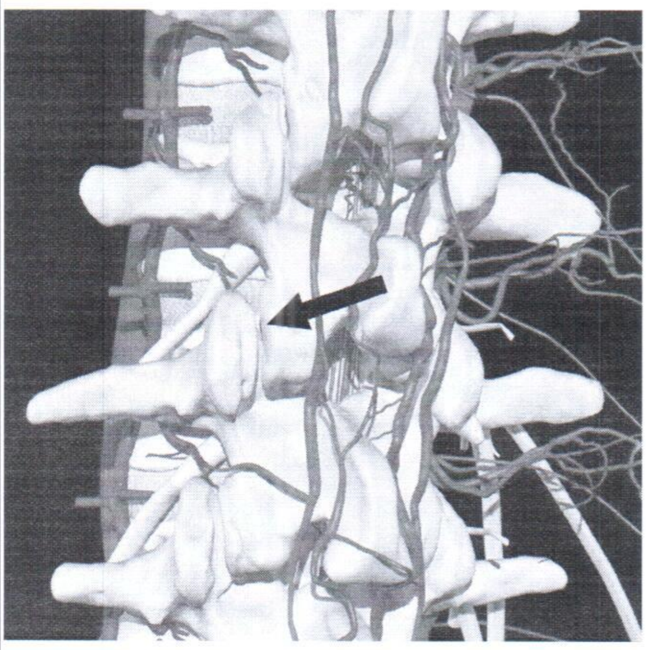

Figure 3. Facet joints of the lumbar spine. (© Primal Pictures Ltd.)

specific flexibility exercises in addition to performance training. After medical clearance to begin activity, a comprehensive spinal conditioning that considers evidence-based interventions will serve a key role in both prevention and progression of the disorder. Moreover, addressing more common impairments in flexibility and strength of the stabilizing musculature will positively affect performance that may be otherwise affected as a result of such impairments. As with any exercise program the strength and conditioning or rehabilitation professional must monitor the individuals exercise tolerance to avoid an exacerbation of symptoms.

FLEXIBILITY

Flexibility is an important component of spinal conditioning programs. A secondary finding of hamstring and paraspinal muscle tightness may be found among the spondylolitic population perhaps in an effort to provide stabilization (8). A direct association, however, between tightness of the paraspinals and hamstrings has not been established. It should also be noted that not all athletes will present with traditional hamstring and paraspinal tightness as the length of the muscle is relative to the athlete, and the requirements of the sport. Some sports, such as gymnastics and dance, will require a great deal of flexibility therefore the athletes sport and previous flexibility level must be considered, or the hamstring spasm may be overlooked, and perceived as normal.

Flexibility of the hip flexor, hamstring, rectus femoris, and tensor fascia lata musculature has been recognized as an integral component of the spinal conditioning program in those with spondylolitic disorders (7,9,22). It has been postulated in the literature that tightness of the rectus femoris may increase the lumbar lordosis due to direct effects on pelvic alignment (21). Rectus femoris tightness may alter pelvic positioning thus increasing strain on the already unstable vertebrae. With proper flexibility exercises these muscles can maintain their necessary flexibility for athletic participation and minimize undue stress on the spine from aberrant tightness. The following flexibility exercises are recommended as part of a comprehensive fitness routine in the athlete with a spondylolitic disorder. Static stretching is advocated for a duration of 30 seconds for 3 repetitions.

FLEXIBILITY EXERCISES

Hip flexor stretch. Hip flexor stretching is illustrated in Figure 4. The hip flexor stretch requires the athlete to assume a kneeling lunge position with the extremity to be stretched extended back. Rotate the pelvis backward by isometrically contracting the gluteal muscles in order to maintain a neutral spinal position. It is very important to maintain this neutral pelvic position in order to eliminate hyperextension of the spine. Once in position, further bend the front leg until a stretch is felt in the hip flexors (front of thigh) of the back leg.

Supine hamstring stretch. The supine hamstring stretch (Figure 5) requires the athlete to begin in a supine position with a towel wrapped around one foot and the ends in both hands. While keeping the leg straight, the athlete uses the towel to gently pull the leg toward the upper body until a stretch is felt in the hamstrings. If the athlete reports LBP, the non-stretched leg may be bent to reduce pressure on the spine.

Rectus femoris stretch. The rectus femoris stretch (Figure 6) requires the athlete to assume a prone position (lying flat on the stomach) with one knee bent and a pillow under their waist to maintain a neutral spine. While maintaining a neutral spine, the athlete is instructed to grab the ankle of the bent knee with one hand and pull toward the gluteal area until a stretch is felt. As flexibility increases a rolled towel can be placed under the distal thigh to create an increased stretch. Athletes reporting discomfort during this procedure may simply tighten their gluteal muscles to reduce loading of the spine and increase the efficiency of the stretch by posteriorly rotating the pelvis (21).

Iliotibial band stretch. The iliotibial band or tensor fasciae latae stretch (Figure 7) requires the athlete to stand with one hand placed along a wall/-chair for support and place the leg to be stretched closest to the wall/chair. The athlete is then instructed to externally rotate the stretching leg

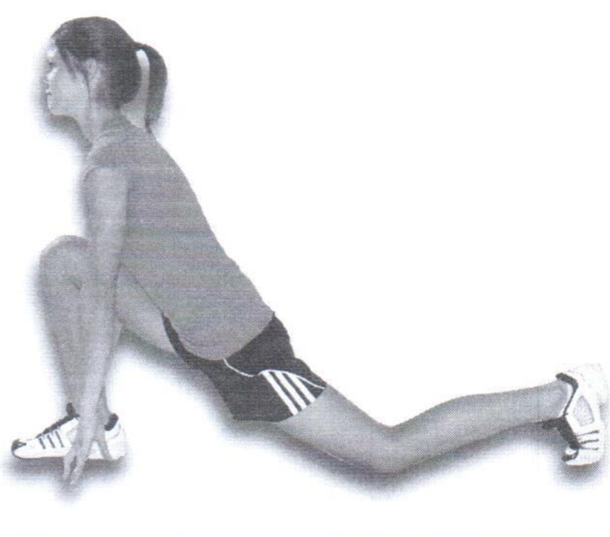

Figure 4. Hip flexor stretch.

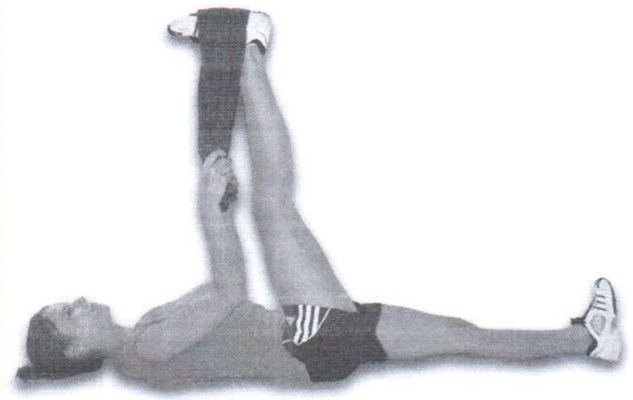

Figure 5. Hamstring stretch.

and position it behind the opposite leg and, once in position, bend the front leg into a slight lunge position and shift the back hip toward the wall. This move will require a slight side bend away from the wall.

DYNAMIC STABILIZATION

Several muscles play a roll in dynamic spinal movements and stabilization. Among these are the transversus abdominis (TrA), paraspinals, internal and external obliques, rectus abdominus, and the multifidus (32). Strengthening of these muscles will provide support to a pre-existing spondylolitic disorder by lifting the spine and maintaining neutral pelvic alignment thus transferring the force and thereby decreasing the amount of load to the area (32). Furthermore, the intrinsic muscles such as the TrA and multifidus have local stabilization function necessary to prevent excessive movement at regions of instability or hypermobility.

The TrA and lumbar multifidus have a particular function in aiding with segmental motion, and providing spinal stabilization (32). These 2 groups of muscles work together by co-contracting to provide a balancing effect to the spine (26). The TrA is the first muscle activated in any trunk movement, so it becomes an important stabilization mechanism (11). Studies show that activation of both the TrA and multifidus is delayed in those with low back pain (11,26).

The multifidus is the deepest spinal muscle, and because of its direct insertion to each vertebra, it is of the utmost importance to the spondylolitic patient (6). Of the back extensor muscles, the lumbar multifidus can provide the greatest control to the vertebral segment, and can potentially function to stiffen, or bind the lumbar spine (18,26). This muscle may atrophy over time without direct efforts to facilitate its function after an episode of low back pain. Electromyography studies of vertebral irregularities such as that of a spondylolisthesis with spinal instability indicated abnormal and decreased activity of the multifidus directly at the unstable segment (18). When functioning properly, this muscle will pull the vertebra backwards and has the ability to stabilize the spondylolisthesis directly (18). Furthermore, research has shown that after completing an exercise program which specifically strengthens the multifidus participants with spondylolytic disorders will demonstrate a significant decrease in pain and disability (18). The following stabilization exercises are recommended as part of a comprehensive fitness routine in the athlete with a spondylolitic disorder. These exercises may be performed daily during the initial stages of the disorder to improve neural activation such as rate coding and motor unit recruitment. Once in the advanced stage may be performed 2–3 times a weeks as necessary to increase muscular performance.

DYNAMIC STABILIZATION EXERCISES

Abdominal bracing. Abdominal bracing (Figure 8) requires the athlete to begin in a supine position, with legs bent. The athlete should attempt to draw the stomach up toward the sternum, and back toward the floor, holding the position for 3 seconds, and then returning to start position. This motion is referred to as an abdominal draw. This exercise comprises a very small movement that may require a great deal of concentration to appropriately target that TrA musculature. Beginning with 1 set of 10–15 repetitions and progressing toward 3 sets of 10–15 repetitions is recommended. This abdominal bracing technique will be carried over to all advancing exercises, and the athlete should not be progressed to further exercises until the form of this exercise is mastered.

Supine alternate shoulder flexion with resistance. Supine alternate shoulder flexion with resistance (Figure

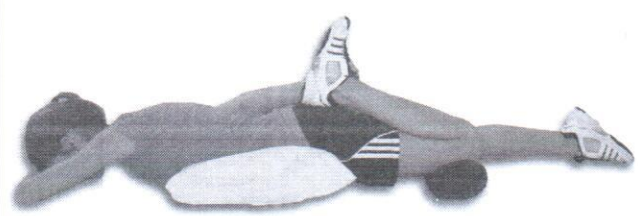

Figure 6. Rectus femoris stretch.

Figure 7. Tensor fasciae latae/iliotibial band stretch.

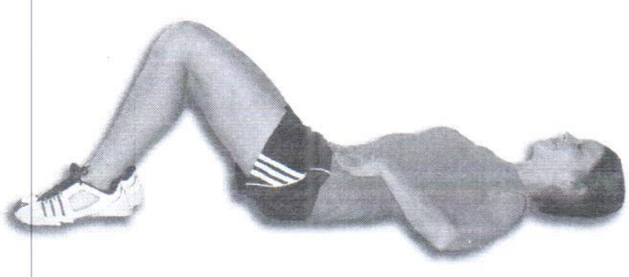

Figure 8. Abdominal bracing.

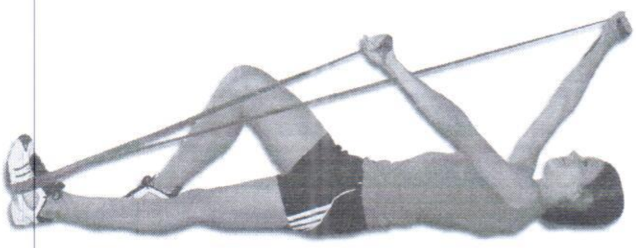

Figure 9. Supine alternate shoulder flexion with elastic band resistance.

9) requires the athlete to begin in a supine position with one leg bent and a resistance band wrapped around the sole of the opposite foot. The athlete alternates lifting one arm above the head at a time while maintaining the abdominal draw position. His or her back should be flat and the TrA should be contracted throughout the entire set. The athlete should begin with 1 set of 10–15 repetitions using a low tension resistance band and progress to 3 sets using a higher tension band. Additional repetitions should not be added until the athlete is capable of maintaining the flat back position the entire time.

Long sit back extension with resistance. Long sit back extension with resistance (Figure 10) requires the athlete to begin in a long sitting position, with a resistance band wrapped around the soles of both feet, and the ends held in each hand. While maintaining a straight neutral back, and an abdominal draw, the athlete should slowly extend his or her trunk at the hips and return to the start position. The individual should be monitored closely to avoid extension of their spine beyond the neutral position. The athlete's elbows should be along the torso and maintained throughout the exercise. The athlete should begin with 10–15 repetitions and progress to 3 sets of 15–20.

Quadruped stabilization with resisted hip extension. Quadruped stabilization with resisted hip extension (Figure 11) requires the athlete to begin in a quadruped position with a resistance band wrapped around the sole of one foot, and grasping the ends in each hand. The athlete is instructed to bend and straighten the leg while contracting the lumbar and abdominal muscles. The end position is held for 2–3 seconds before bending the leg again. The athlete should maintain a straight back position and level hips for the entire duration of the exercise. He or she should begin with 10 repetitions on

Figure 10. Long sit back extension with resistance.

each leg using a low tension resistance band and progress to 3 sets of 15 repetitions on each leg is advised.

Standing lunge extension with resistance. Standing lunge extension with resistance (Figure 12) requires the athlete to begin in a deep standing lunge position with a resistance band under the front foot and the ends held in each hand at the level of the chest. The athlete is first asked to simultaneously draw in and contract the abdominals to stabilize the spine in a neutral position. The trunk is then slowly extended backward to the neutral position and then returned to the original start position. The extension motion is relative as it occurs from a flexed to neutral position. At no point during the exercise should the athlete's back hyperextend in the patient with a confirmed spondylolysis. He or she should begin with one set of 10– 15 repetitions and progress to 3 sets of 15–20 repetitions.

Stability ball leg lifts. Stability ball leg lifts (Figure 13) require the athlete to begin in a bridge position with the stability ball centered on the upper back and head, and feet planted on the ground. With an abdominal draw, and a straight-neutral back position maintained, the athlete should extend the knee to the level of trunk while remaining centered on the ball. He or she should then hold the lifted leg position for 3 seconds and repeat with the opposite leg. The focus should be upward in order to maintain a neutral cervical spine. He or she should begin with one set of 10–15 repetitions on each leg and progress to 3 sets.

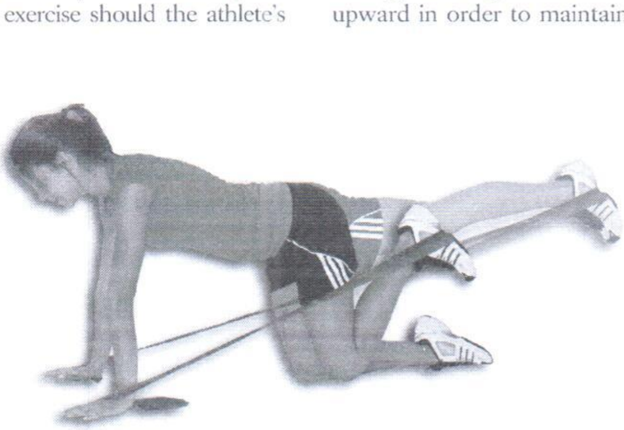

Figure 11. Quadruped stabilization with resisted hip extension.

Stability ball pikes. Stability ball pikes (Figure 14) require the athlete to begin in a supine position, with their arms extended over the head and a stability ball held tightly between the lower legs. The stability ball is then lifted to meet the arms (creating a V position), transferred to the arms, and the body is returned to start position. The movement is then repeated transferring the ball back to the feet and returned to the original starting position. The exercise can be made easier by bending the legs and holding the ball at knee level. The abdominal draw should be maintained throughout the exercise, and a straight back maintained. He or she should begin with one set of 10 repetitions and progress to 3 sets of 15–20 repetitions.

Stability ball back bridge. The stability ball back bridge exercise (Figure 15) requires the athlete to begin in a supine position, with their arms flat on the floor and feet and lower legs positioned on top of the stability ball. While maintaining an abdominal draw, the athlete lifts the stomach to the level of the legs (creating a straight body position), holds for 3 seconds, and returns to the start position. It is important to make sure the start and end position of each lift is performed while maintaining the abdominal draw and a neutral spine. Beginning with one set of 10–15 repetitions, and progressing to 3 sets of 15–20 is advised. The difficulty level may be increased by crossing the arms over the chest or performing a single leg version.

SPORT-SPECIFIC CONSIDERATIONS

Athletic demands on the spine vary depending upon the sport, position, and level of competition. Each sport may have unique biomechanics that can affect the efficacy of a spinal conditioning program and future prevention efforts. Certain sports such as

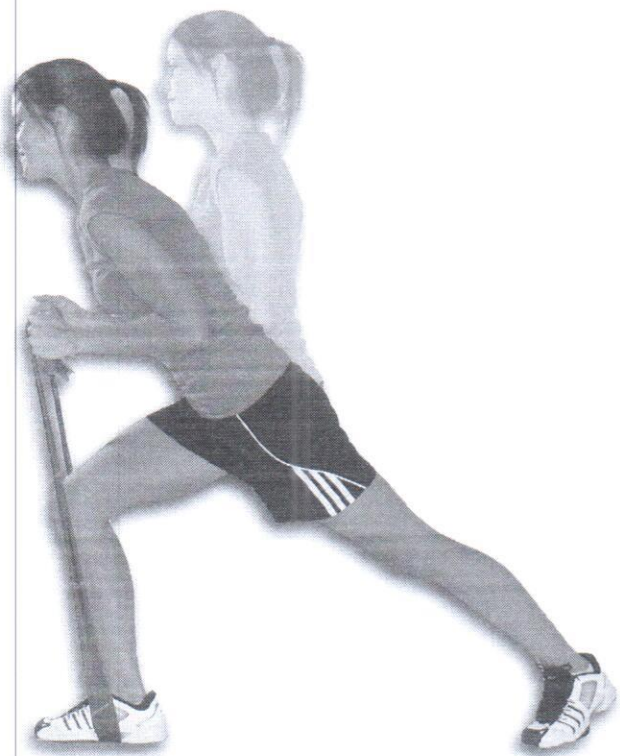

Figure 12. Standing lunge extension with resistance.

gymnastics, dance, cheerleading and weight-lifting will require activity modifications due to their particularly high demands on the spine.

Athletic movements that require loading of the spine while in the hyperextended position can be detrimental to the spine, particularly in patients diagnosed with a spondylolysis. In gymnastics, for example, this movement occurs frequently during performance of such skills as that of back walkovers, back handsprings, giants on uneven bars, or improper dismount landings. All of the skills, whether performed correctly or not, can place the athlete into a forceful hyperextension. The gymnast should therefore be educated in proper, non extended dismount landing in order to illuminate any unnecessary vertebral strain. On certain skills, such as giants on uneven bars, a hyperextended position may indicate improper technique. Essentially undue stress on the spine from athletic positioning or movements can be minimized by retraining the athlete to perform the skill with modifications. The spinal conditioning exercises presented are designed to have broad applicability and will serve useful for all levels of athletic participation. Furthermore, with appropriate stabilization and flexibility the athlete may benefit from improved performance, particularly if impairments were present.

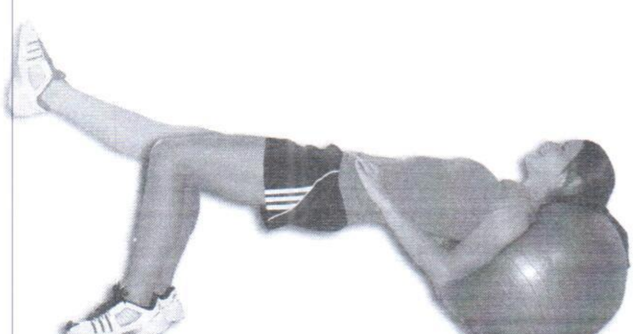

Figure 13. Stability ball leg lifts.

CONCLUSION

Recognizing the need for activity modifications and implementation of efficacious strength and conditioning routines is essential for the athlete with a spondylolitic disorder. Studies show that the longer symptoms are present before intervention takes place, the lesser chance there is for optimum recovery (1). Early intervention that respects the underlying anatomical irregularities and presenting impairments is therefore of primary importance in maintaining participation in athletics.

GENERAL GUIDELINES FOR SPINAL CONDITIONING

- Athletes with a spondylolitic disorder must receive appropriate medical clearance before participation.
- Athletes should begin spinal conditioning slowly, focusing on flexibility exercises, and basic static stabilization exercises. Incorporate more advanced stabilization exercises in a graduated manner avoiding pain and/or compromised performance.
- Any exercise that increases pain should be avoided. If this situation occurs, the exercises should be reverted back to the less advanced stage of the regimen.
- The performance of quality exercises is far more important than quantity. Many exercises will require a great deal of focus while learning in order to master correct form and this should not be mistaken for slow progress.
- Athletes should be encouraged to hold their spines in a comfortable position during the exercises.

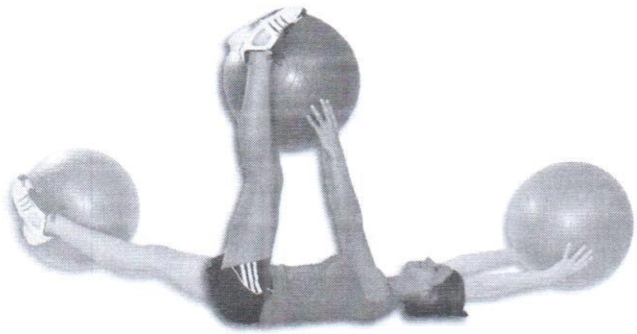

Figure 14. Stability ball pikes.

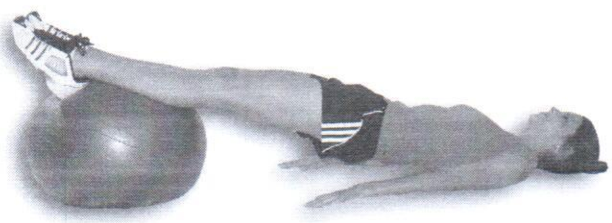

Figure 15. Stability ball back bridge.

Aberrant postures that increase pain or asymmetrically load the spine may place additional stress to the area, and is an indication that the athlete has been progressed to rapidly.

- The flexibility and stabilization exercises recommended in this article should be continued throughout the year and not reduced to the athlete's periodized model. Maintenance is the key to preventing worsening, progression of the slippage, or any future spondylolitic occurrences at neighboring vertebral levels.■

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