Chapter 18

Lumbar Spine Strains and Sprains

INTRODUCTION

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Epidemiology

- Lumbar spine injuries in athletes are relatively common and most of these are thought to be strains (partial or complete tears of muscle-tendon units) and/or sprains (partial or complete tears of ligamentous/capsular/discal tissues).[1]
- Among collegiate athletes, men's wrestling, football, and women's gymnastics have the highest rates of low back injury, with an occurrence of 0.36 to 0.49 injuries per 1000 athlete exposures. Approximately 80% of these are thought to be lumbar strains or sprains.[2-4]
- Among high school athletes, 7% to 13% of all sports injuries are lower back injuries, of which muscle strains account for roughly 60%.[5]
- Low back injuries are the most common type of injury in competitive weightlifters, affecting approximately 23% of these individuals. Roughly 82% of these injuries are believed to be strains/tendonitis or sprains.[6]
- Low back pain is the most common musculoskeletal problem reported by both amateur and professional golfers, and most of these injuries are thought to be strains or sprains.[7,8]
- The majority of low back injuries occur during competition, although women's basketball, volleyball, and field hockey have higher rates of low back injury during practice.[2-4]
- Among football players, linemen seem to be more vulnerable to low back injury compared with other positions.

Pathophysiology

Intrinsic Factors

- History of previous back injury or back surgery, obesity, structural deformity (e.g., scoliosis, spondylolysis, hypermobility, leg-length inequality) all appear to elevate risk of future low back sprain/strain.
- Reduced trunk extensor muscle endurance has been found to be a risk factor for nonspecific LBP.[9]
- Lack of adequate trunk muscle endurance, in general, may lead to increased loading of the passive low-back structures (ligaments, capsules, discs), which may increase the risk of future lumbar sprain.[10]
- Contrary to popular belief, a correlation between lumbar mobility/flexibility and low back symptomatology has not been conclusively demonstrated, at least in gymnasts.[11,12]

Extrinsic Factors

- Improper technique/biomechanics leading to excessive tissue loading
- Excessive training/participation resulting in cumulative overload
- Intense training/participation (aggressiveness, "win at all costs" syndrome, etc.).[13]
- Sports-specific demands/biomechanics (e.g., extension loading in gymnasts and football lineman)
- Involvement in impact sports (e.g., football) appears to be a risk factor for lumbar strain/sprain due to loading and repetition demands of these activities.[13]
- Sports that require *repetitive end-range of motion loading (e.g., hyperextension in gymnastics),* are associated with a greater risk of *lumbar strain/sprain.* Weightlifting, as a sport, or as a performance-enhancing modality for other sports, increases the load on the spine and, thus, the potential for injury.

Traumatic Factors

- Sudden forceful tensile loading (e.g., twisting, bending)

- Muscular overexertion, with either movement or sustained positioning (strains)

Classic Pathological Findings

- Identifiable pathological findings are rare with lumbar strains/sprains.
- Reactive muscle spasm and/or muscular trigger points may be present in some individuals.[14]

Clinical Presentation

History

- The athlete may or may not recall a specific mechanism of injury (e.g., fall).
- Some athletes may report recent increases in training frequency and/or intensity.
- Pain of a lower lumbar sprain or strain generally originates in the lower back and upper buttocks, although it may refer into surrounding areas, including the thighs. The pain is usually movement-related and may be provoked only when the athlete moves in a particular way. Because of this mechanical pain, the athlete may complain of loss of function, such as an inability to turn, twist, or bend normally.
- The athlete may report painful muscle spasms.[15]

Physical Examination

Abnormal Findings

- Trunk active range of motion is typically reduced, presumably due to pain from loading injured tissues (Figure 18-1).
- Gait may be mildly antalgic during the acute phase of injury to avoid loading injured tissues.
- Palpation of the muscles in the lumbar area may reveal local tenderness, trigger points, and/or spasm.

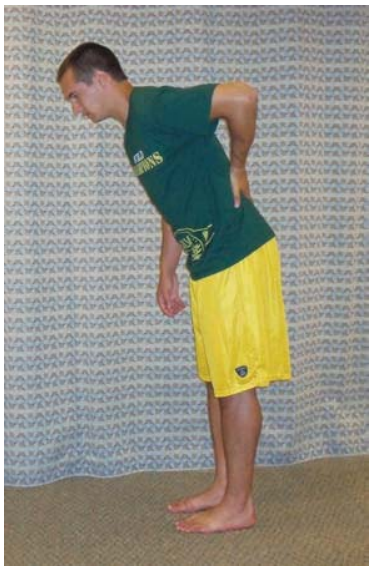

FIGURE 18-1. Trunk active range of motion is typically reduced following a lumbar strain/sprain, presumably because of pain from loading injured tissues.

- Edema, erythema, and elevated skin temperature may be apparent when the injured tissues are superficial.
- With a lumbar sprain, passive posterior-to-anterior "springing" of vertebrae adjacent to affected ligaments/capsule/disc is usually provocative.
- Contraction or palpation of affected muscles is provocative with a lumbar strain, whereas passive posterior-to-anterior "springing" of the lumbar vertebrae is usually not provocative.

Pertinent Normal Findings

- Structural deformities (e.g., sciatic list, "step-off" deformity) should be absent.
- Neurological symptoms (e.g., myotomal weakness, lower extremity reflex aberrations, dermatomal sensory changes) should be absent.
- Pain should not markedly intensify with lumbar extension. (If it does, consider spondylolysis, particularly in young athletes whose sport or position requires repetitive extension, such as gymnasts or football linemen).
- Radicular symptoms (narrow band of pain radiating into legs), particularly those below the knee, should be absent with lumbar sprains/strains.
- The straight-leg raising test may provoke mild low back pain but should not produce leg symptoms below the knee.
- Tests for sacroiliac dysfunction (e.g., posterior thigh thrust, gapping) should be negative.

Imaging

- Imaging is usually not appropriate for lumbar strain/sprain injuries, unless the injury is the result of recent significant trauma.[16]
- Plain radiography may be appropriate to rule out avulsion fractures when pain is localized to tendon-bone interface.
- Imaging should be considered in patients with severe, unremitting pain or neurological findings; pain that developed after an acute traumatic event or pain that persists longer than 6 weeks.
- Imaging should be considered earlier in young athletes because early identification of acute spondylolisthesis can influence outcomes.[17]
- Anteroposterior, lateral, 45° right and left oblique views and collimated lateral views of the lumbar spine should be obtained.
- CT, MR, or scintography may be appropriate for select patients to rule out other potential causes of back pain, such as fracture, infection, tumor, or involvement of spinal nerve roots.

Differential Diagnosis

- Visceral injury/disease (e.g., renal disease, pyelonephritis)
- Vascular disease (e.g., abdominal aortic aneurysm)
- Lumbosacral disc injuries
- Lumbosacral facet syndrome
- Lumbosacral instability
- Lumbosacral radiculopathy
- Lumbosacral spine acute fracture

- Lumbosacral spondylolisthesis
- Lumbosacral spondylolysis
- Piriformis syndrome
- Early discitis before onset of fever
- Rheumatic disease: white blood cell count, erythrocyte sedimentation rate, and human leukocyte antigen assay for HLA-B27 may be used to assess for underlying rheumatic disease.
- Sacroiliac joint injury

Treatment

Nonoperative Management

- Oral, topical, or injectable analgesics
- Oral, topical, or injectable antiinflammatories
- Muscle relaxants
- Pain/symptom modulating modalities (e.g., sensory electrical stimulation, cryotherapy)
- Spinal mobilization (nonthrust) or manipulation (thrust)
- Therapeutic massage/soft tissue mobilization
- Relative rest
- Therapeutic exercise
- Aquatic therapy
- Patient education (e.g., warm-up routines appear to have a positive effect on preventing low back injuries in golfers if they are at least 10 minutes long)[18]

Guidelines for Choosing Among Nonoperative Treatments

- Pain/symptom modulating modalities should be considered during the acute phase of injury. Once the athlete is able to tolerate active treatment, these should be discontinued or used sparingly to minimize iatrogenic effects of exercise or spinal mobilization/manipulation.
- Muscle relaxants: Medication such as Skelaxin and Flexeril has no direct effect on the muscle motor unit. Their mechanism of action is through modifying the central nervous system response to painful stimuli. They do work synergistically with pain medication allowing lower doses of pain medication to have the same pain relieving effect.
- Spinal mobilization (nonthrust) or manipulation (thrust) should be considered in the acute or sub-acute period for athletes with low-to-moderate levels of symptom irritability when the following variables are satisfied: symptom duration less than 16 days, low work-related fear-avoidance belief scores, lumbar hypomobility, hip internal rotation range of motion at least 35° on one or both sides, no symptoms distal to the knee.[19]
- Relative rest: Most athletes who experience a lumbar strain or sprain will require a period of reduced or modified activity, including removal from competition. Symptom-limited alternative activities and exercises should be encouraged to minimize deconditioning.
- Low-level therapeutic exercise should begin as soon as possible after the injury to avoid the deleterious effects of immobilization. The intensity, duration, and complexity of therapeutic exercise should be increased over time in accordance with the athlete's symptomatic and objective improvement.
- Patients who are intolerant of land exercise may tolerate aquatic therapy. Many land exercises can be replicated in a pool, with the benefits of reduced spinal weightbearing (via buoyancy), and increased spinal stabilization (via hydrostatic pressure).
- The majority of lumbar strains/sprains will be self-limiting and resolve within 6 weeks regardless of the type of treatment.[13]
- Most athletes can return to full unrestricted play after sufficient resolution of pain and restoration of range of motion and strength.

Surgical Indications

- There are no absolute indications for surgery with lumbar strain/sprains

Aspects of History, Demographics, or Exam Findings That Affect Choice of Treatment

- See general guidelines in the preceding.

Aspects of Clinical Decision Making When Surgery Is Indicated

- Lumbar strains/sprains are typically benign in nature, transient and self-limiting. Failure to respond to conservative management within 4 to 6 weeks may warrant referral for further specialized testing.

Evidence

Biering-Sorensen F: Physical measurements as risk indicators for low-back trouble over a one-year period. *Spine* 9:106–119, 1984.

In this prospective study of 449 men and 479 women aged 30 to 60, the authors examined the prognostic value of several physical measurements (anthropometric measurements, flexibility measurements of the back and hamstrings, trunk muscle strength, and endurance) for first-time occurrence of low back pain (LBP) and for recurrence or persistence of LBP. The main findings at the 12-month follow-up were that good isometric endurance of the back (extensor) muscles may prevent first-time occurrence of LBP in men and that men with hypermobile backs are more liable to contract LBP. Weak trunk muscles and reduced flexibility of the back and hamstrings were found as residual signs, in particular, among those with recurrent or persistent LBP. (Level IV evidence)

Davis PC, Wippold FJ, 2nd, Brunberg JA, et al: ACR Appropriateness Criteria on low back pain. *J Am Coll Radiol* 6(6):401–407, 2009.

This is an expert-panel consensus document by the American College of Radiology (ACR). Based on a review of the best-available evidence, the authors conclude that uncomplicated acute LBP is a benign, self-limited condition that does not warrant any imaging studies. Radiographs are recommended when any of several red flags are present, including recent significant trauma. Additional guidelines for recognition of patients with more complicated status can be used to identify those who require further evaluation for suspicion of more serious problems and contribute to appropriate imaging utilization. (Level V evidence)

Flynn T, Fritz J, Whitman J, et al: A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with spinal manipulation. *Spine* 27(24):2835–2843, 2002.

This was a prospective, cohort study of 71 patients with nonradicular LBP who were all treated with spinal manipulation. Thirty-two patients had success with the manipulation intervention, determined using change in disability scores. Five pretreatment variables were associated with treatment success: symptom duration less than 16 days, low work-related fear-avoidance belief scores, lumbar hypomobility, hip internal rotation range of motion at least 35° on one or both sides, and no symptoms distal to the knee. The presence of four of five of these variables increased the probability of success with manipulation from 45% to 95% (positive likelihood ratio = 24.38). (Level IV evidence)

Greene HS, Cholewicki J, Galloway MT, et al: A history of low back injury is a risk factor for recurrent back injuries in varsity athletes. *Am J Sports Med* 29(6):795–800, 2001.

In this prospective study, 18.3% (124) of 679 Yale varsity athletes surveyed in 1999 reported that they had sustained a low back injury within the past 5 years, and 6.8% (46) sustained a low back injury in the follow-up season. A history of low back injury was the significant predictor for sustaining low back injury in the following year, and athletes who reported previous low back injury were at three times greater risk. (Level IV evidence)

Lawrence JP, Greene HS, Grauer JN: Back pain in athletes. *J Am Acad Orthop Surg* 14(13):726–735, 2006.

In this review article, the authors provide evidence-based guidance on treating back pain in athletes. The authors suggest that self-limited symptoms must be distinguished from persistent or recurrent symptoms associated with identifiable pathology. Athletes involved in impact sports and those who participate in longer and more intense training appear to have higher incidence rates of back pain. Data suggest that the recreational athlete may be protected from lumbar injury with physical conditioning. Treatment of athletes with back pain usually is nonsurgical, and symptoms generally are self-limited. However, a systematic approach involving a thorough history and physical examination, pertinent imaging, and treatment algorithms designed for specific diagnoses can facilitate symptomatic improvement and return to play. (Level V evidence)

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Multiple Choice Questions

QUESTION 1. Which collegiate sports have the highest rates of low back injury?

A. Golf and competitive weightlifting (i.e., powerlifting)
B. Men's wrestling, football, women's gymnastics
C. Men's rugby and women's field hockey
D. Soccer and tennis

QUESTION 2. Which of the following factors have been shown to increase risk of lumbar spine injury?

A. History of previous back injury
B. Inadequate lumbar flexibility
C. Inadequate stretching before activity
D. Lack of motivation

QUESTION 3. Which of the following is NOT a typical/common finding in patients with lumbar strain/sprain?

A. Ankle dorsiflexor weakness
B. Decreased trunk range of motion
C. Mildly antalgic gait
D. Muscle spasms and/or muscular trigger points

QUESTION 4. Which of the following statements is correct?

A. Imaging is not usually appropriate following a lumbar strain or sprain unless the injury occurred recently.
B. Imaging is not usually appropriate following a lumbar strain or sprain unless the injury occurred during football practice or competition.
C. Imaging is not usually appropriate following a lumbar strain or sprain unless the injury occurred during gymnastics practice or competition.
D. Imaging is not usually appropriate following a lumbar strain or sprain unless the injury is the result of recent significant trauma.

QUESTION 5. Which of the following statements is NOT correct?

A. Most athletes who experience a lumbar strain or sprain will require a period of reduced or modified activity, including removal from competition.
B. Most athletes suffering from a lumbar strain or sprain will require spinal surgery.
C. Some athletes who have sustained a lumbar strain or sprain will benefit from pain modulating modalities.
D. Some athletes who have sustained a lumbar strain or sprain may be appropriate for spinal manipulation treatment.

Answer Key

QUESTION 1. Correct answer: **B** (see Epidemiology)

QUESTION 2. Correct answer: **A** (see Pathophysiology)

QUESTION 3. Correct answer: **A** (see Clinical Presentation)

QUESTION 4. Correct answer: **D** (see Clinical Presentation)

QUESTION 5. Correct answer: **B** (see Treatment)

NONOPERATIVE REHABILITATION OF LUMBAR SPINE STRAINS AND SPRAINS

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GUIDING PRINCIPLES OF NONOPERATIVE REHABILITATION

- Consider the unique requirements of the athlete's sport in addition to the identified deficits when prescribing exercises.
- Maintain or improve sport-specific fitness/conditioning via cross-training.
- Athlete must be able to adequately control lumbar spine and pelvis throughout ranges of motion required by the sport.
- Return to full, unrestricted activity should be predicated on symptom response to activity.

In lieu of trying to identify and treat the injured lumbar spine tissues, an effort should be made to determine the specific treatment approach (manipulation, stabilization exercise, or directionally specific exercise) that is likely to be most beneficial for the injured athlete. Outcomes can be improved when individuals with low back pain receive treatments that are matched to their clinical features.[1] Thus, patients with lumbar hypermobility may be appropriate for stabilization exercise, whereas those with lumbar hypomobility may benefit from manipulation.[2,3] Individuals with a directional preference for movement (e.g., flexion or extension) tend to fare better when the treatment is matched to the directional preference.[4] Guidelines are available to help clinicians match clinical findings with different treatment approaches for LBP.[2–4]

Phase I (weeks 1 to 2)

Protection

- Bracing (e.g., lumbar corset) is not recommended for lumbar sprains or strains because of a lack of proven efficacy and concerns over the deleterious effects of prolonged immobilization on connective tissue integrity. Nonetheless, there are anecdotal reports of patients with severe low back pain benefiting from transient use of bracing with activities of daily living. For this reason, any lumbar bracing should be discontinued as soon as possible.

Management of Pain and Swelling

- Sensory electrical stimulation, moist heat, or cryotherapy may be used to reduce pain and swelling.
- Unlike peripheral joints, anecdotal evidence suggests that superficial heating may be beneficial for treating acute spine pain.
- Fatiguing motor-level electrical stimulation or ultrasound combined with motor-level electrical stimulation may be effective for reducing muscle spasm or for deactivating muscle trigger points.

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- The presence of the following variables may increase the likelihood of success with lumbar manipulation or mobilization: symptom duration less than 16 days, low work-related fear-avoidance belief scores, lumbar hypomobility, hip internal rotation range of motion (ROM) at least 35° on one or both sides, and no symptoms distal to the knee.[3]

Soft Tissue Techniques

- Deep massage or ischemic compression may be used for trigger points or muscle spasms.

Stretching and Flexibility Techniques for the Musculotendinous Unit

- Gentle lumbar spine self-mobilization exercises should be initiated as soon as possible in a pain-free ROM to

FIGURE 18-2. Weight shifting in quadruped. From a quadruped position, slowly shift weight forward, backward, left, right, or along a diagonal to increase trunk range of motion.

limit the adverse effects of immobilization and to stimulate the synthesis and proper alignment of collagen.[5] These exercises can be performed in supine (e.g., knee to chest, posterior pelvic tilting), prone (e.g., prone press-ups), or quadruped (e.g., weight shifting/rocking in different directions) (Figure 18-2).
  - Athletes who feel better in lumbar extension may tolerate extension activities/exercises, whereas those who feel better in lumbar flexion should be encouraged to try various flexion activities/exercises. Outcomes for LBP tend to be better when treatment is matched to the patient's directional preference, and worse when the patient is given a directionally opposite treatment.[4]
- Stretching exercises should be included for the hip flexors, rotators, adductors, quadriceps, gastrocnemius/soleus, and hamstring muscles (Figure 18-3).
  - Hip/leg stretching exercises should be performed with abdominal bracing (see description that follows) while maintaining a neutral (i.e., mid-ROM) lumbar spine to avoid symptom exacerbation.

Other Therapeutic Exercises

- The presence of the following variables may increase the likelihood of success with a stabilization exercise

FIGURE 18-3. Hamstring stretch in doorway. Lie on floor with leg to be stretched resting on wall and other leg extended into the open doorway. While maintaining a neutral lumbar spine and an abdominal brace, scoot buttocks toward wall until stretch is felt in hamstrings.

treatment approach: age less than 40, straight-leg raise greater than 91°, positive prone instability test, presence of aberrant motions, lumbar hypermobility with passive testing, and absence of fear-avoidance beliefs.[2]
- Total leg strengthening should be performed, with an emphasis on the gluteus maximus and medius muscles.
  - Gluteal sets/squeezes in prone, supine or hook-lying (i.e., supine with hips and knees flexed and feet on floor)
  - Bridging in hook-lying
- Total arm strengthening should also be performed.
  - Chest press/pushups, rows, shoulder press, latissimus pull-downs, arm curls, elbow extension, wrist extension and flexion
- As with the hip/leg stretching exercises, all leg and arm strengthening exercises should be performed with abdominal bracing while maintaining a neutral (i.e., mid-ROM) lumbar spine to avoid symptom exacerbation.
  - For abdominal bracing, the athlete should tense/tighten his or her entire trunk/core to create a muscular "core-set" (corset), without holding the breath,

TIMELINE 18-1: **Nonoperative Rehabilitation of Lumbar Spine Strains and Sprains**

PHASE I (weeks 1 to 2)	PHASE II (weeks 2 to 4)
• Lumbar bracing prn; discontinue as soon as possible • Modalities prn for pain or swelling • Lumbar manipulation/mobilization if specific factors present • Massage or ischemic compression prn • Pain-free lumbar spine self-mobilization • Lower extremity stretching • Total leg strengthening emphasizing the gluteals • Total arm strengthening as tolerated • Single-leg balancing • Pelvic "clocks" and/or weight-shifting on ball • Single arm or leg unweighting in quadruped • Abdominal bracing in hook-lying ("core-set") • Bent-knee "fallouts" • Marching in hook-lying • Heel slides • Bridging in hook-lying • Walking or sport-specific cardiovascular conditioning on land or in pool	• Modalities prn for pain or swelling • Lumbar manipulation/mobilization if specific factors present • Massage or ischemic compression prn • Progress sport-specific TAS/TLS activities • Progress sport-specific cardiovascular conditioning • Continue lumbar spine stretching/self-mobilization • Exercises from supine bridged position with head and shoulder supported on dome or therapy ball • Exercises while seated on therapy ball • Progress single-leg balance activities • Exercise progression in quadruped • Prone bridging • Supine curlups with greater than or equal to 1 hip in neutral • Emphasize trunk muscle endurance • Lateral walking with cable or elastic band/cord • Oscillations with oscillating blade • Side support on forearm and bent knee • Exercises from supine bridged position with heels on dome • Diagonal chops and lifts in standing

drawing the abdomen in, or pushing the abdomen out.
  - Abdominal bracing has been shown to increase lumbar spine stability to a greater extent than abdominal drawing-in (abdominal hollowing).[6]

NOTE: All of the following exercises should be performed with abdominal bracing while maintaining a neutral lumbar spine

Sensorimotor Exercises

- Single-leg balancing on various surfaces (pillow, dome, foam pad, disc)
- Pelvic "clocks" in hook-lying
- Weight-shifting while seated on therapy ball (anterior-posterior, lateral, circles)

Open and Closed Kinetic Chain Exercises

- Single arm or leg unweighting in quadruped (i.e., from all-fours to three points of contact)

Neuromuscular Dynamic Stability Exercises

- Abdominal bracing in hook-lying ("core-set")
- Bent-knee "fallouts" (Figure 18-4)
- Marching in hook-lying
- Alternating heel slides
- Bridging in hook-lying

Functional Exercises

- Walking on land or in pool

Sport-Specific Exercises

- Sport-specific cardiovascular conditioning should be incorporated to minimize erosion of athletic performance. The athlete should be taught to control lumbopelvic movement during cardiovascular activities.
  - Consider biking for athletes who feel better in slight lumbar flexion versus extension.

FIGURE 18-4. Bent-knee "fallouts." From hook-lying, slowly lower one leg into abduction and external rotation while maintaining a neutral lumbar spine and an abdominal brace.

  - Consider walking or elliptical trainer for athletes who feel better in lumbar extension versus flexion.
  - Consider sport-specific drills/activities in a pool for athletes who do not tolerate land-based exercise.

Milestones for Progression to the Next Phase

- Acute pain, edema and muscle spasms have plateaued or started to subside.
- Activity/exercise tolerance has improved.

Phase II (weeks 2 to 4)

Protection

- Bracing should not be needed by this time.

TIMELINE 18-1: Nonoperative Rehabilitation of Lumbar Spine Strains and Sprains (Continued)

PHASE III (weeks 4 to 6)	PHASE IV (weeks 6+)
• Modalities prn for postexercise/activity pain • Lumbar manipulation/mobilization prn • Progress sport-specific TAS/TLS exercises • Progress sport-specific cardiovascular conditioning • Progress lumbar spine stretching/self-mobilization • Diagonal "chops" and "lifts" while seated on therapy ball • Exercise progression from prone bridged position • Single-leg supine bridging • One-arm rows with dumbbell while ½ kneeling on bench • Exercise progression in quadruped • Side support (side bridge) on forearm and feet • Prone bridge with forearms on therapy ball • Exercises from supine bridged position with head and shoulder supported on dome or therapy ball • Sport-specific jumping, hopping, bounding • Depth drop pushups • Single-leg deadlift • Sport-specific, multi-planar activities/exercises	• Modalities prn for postexercise/activity pain • Sport-specific TAS/TLS exercises • Sport-specific cardiovascular conditioning • Progress lumbar spine stretching/self-mobilization • Single-leg deadlift progression • Diagonal "chops" and "lifts" or trunk rotation on one foot • Rotating body bridge • Hanging straight leg raise to 90° hip flexion • Bilateral hip extension over center of plinth • Exercises from supine bridge with heels on therapy ball • Exercises from pushup position with feet on therapy ball • Sport-specific jumping, hopping, bounding • Clapping pushups • Advance intensity, duration, speed and complexity of functional and sport-specific exercises/activities

Management of Pain and Swelling

- Both motor-level electrical stimulation[7] and exercise[8] have been found to be effective for reducing edema during the subacute phase of healing. Exercise is more functional, however, and should be used in lieu of electrical stimulation if tolerated. Sensory-level electrical stimulation and/or cryotherapy may be used to reduce postexercise/activity soreness.

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- Athletes who responded favorably to spinal mobilization or manipulation during Phase I may benefit from further manual therapy. These interventions may potentiate the effects of therapeutic exercise.

Soft Tissue Techniques

- Deep massage or ischemic compression may be used for trigger points or muscle spasms.

Stretching and Flexibility Techniques for the Musculotendinous Unit

- Stretching/self-mobilization exercises for the lumbar spine should be continued within the pain-free ROM.
  - From kneeling, controlled side-to-side and/or forward-backward rolling with forearms on a therapy ball or wheeled stool (Figure 18-5).
  - From hook-lying, both knees are moved side-to-side under control.
- Continue with stretching exercises for the hip flexors, rotators, adductors, hamstrings, quadriceps and gastrocnemius/soleus muscles, with abdominal bracing while maintaining a neutral lumbar spine.

Other Therapeutic Exercises

- See Phase I
- Modify and progress arm and leg strengthening exercises, making them as sport-specific as possible.

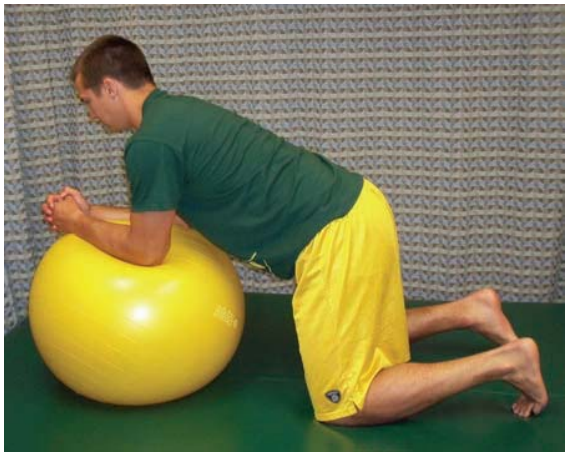

FIGURE 18-5. Controlled rolling from kneeling. From kneeling with forearms on a therapy ball or wheeled stool, roll ball side-to-side or forward-backward under control. Maintain an abdominal brace and do not allow excessive lumbar spine flexion, extension, or rotation.

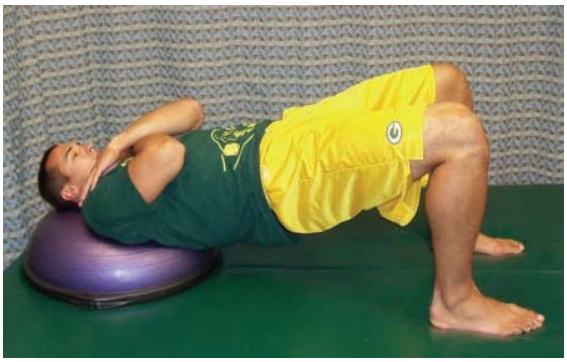

FIGURE 18-6. Starting position for exercises from supine bridged position with head and shoulders supported on dome.

- Single or double leg squats and forward or backward lunges (for developing total leg strength and isometric spinal stabilization simultaneously).
- Pushups and pullups (for developing total arm strength and isometric spinal stabilization simultaneously).
- Progress sport-specific cardiovascular conditioning (e.g., from walking to jogging).

NOTE: All of the following should be performed with abdominal bracing while maintaining a neutral lumbar spine

Sensorimotor Exercises

- Exercises from supine bridged position with head and shoulders supported on dome or therapy ball (Figure 18-6):
  - Alternate heel lifts
  - Hip abduction with elastic band/cord above knees
  - Controlled up/down bridging
- Exercises while seated on therapy ball
  - Side-to-side shifting
  - Pelvic rocking/tilts
  - "Hula-hoops" (circumduction)
  - Unilateral or bilateral shoulder flexion
  - Marching
  - Marching with contralateral shoulder flexion (Figure 18-7)
  - Single arm rowing with cable or elastic band/cord
- Progress single-leg balance activities by using more challenging surfaces, or adding dynamic elements (e.g., playing catch, walking obstacle courses)

Open and Closed Kinetic Chain Exercises

- Exercises in quadruped
  - Single arm flexion
  - Single hip extension
  - Single arm flexion with contralateral hip extension (bird-dog or pointer)
  - Rhythmic stabilization
- Prone bridging on forearms and toes (planks) (Figure 18-8)
- Curl-ups in supine with one or both hips in neutral. Levels of spinal compression and spinal shear and psoas activity were lower during curl-ups with hips in neutral versus flexion.[9]

FIGURE 18-7. Marching with contralateral shoulder flexion while seated on a therapy ball. While seated on a therapy ball, flex one hip to lift foot from floor while flexing the opposite shoulder overhead. Maintain an abdominal brace and do not allow excessive lumbar spine flexion, extension, or rotation.

Techniques to Increase Muscle Strength, Power, and Endurance

- Endurance should be emphasized during this phase more than strength.
  - Poor lumbar muscle endurance is a significant risk factor in development of future LBP.[10–12]
  - Trunk muscle endurance training has been shown to be effective in reducing pain and disability in patients with nonspecific low back pain.[13–15]
  - It is particularly important to regain normal bulk and endurance of erector spinae muscles and multifidus.[16]

Neuromuscular Dynamic Stability Exercises

- See sensorimotor exercises in the preceding.
- Lateral walking with cable or elastic band/cord (Figure 18-9)
- Two-handed medial-lateral oscillations of vertically oriented oscillating blade (e.g., Bodyblade) or superior-inferior oscillations of horizontally oriented oscillating blade while standing

FIGURE 18-8. Prone bridging. From a prone position with elbows spaced shoulder-width, arms perpendicular to mat, and hands touching so that the forearms form a V, the pelvis is raised by contracting the trunk flexor muscles.

FIGURE 18-9. Lateral walking with cable or elastic band/cord. Start in an athletic stance with slight hip and knee flexion. Hold handle of cable or elastic band/cord in front of torso at level of lower rib cage. After performing abdominal brace, walk sideways while keeping handle in starting position. Do not rotate torso.

- Side support (side bridge) on forearm and bent knee (Figure 18-10)
- Exercises from supine bridged position with heels on dome (Figure 18-11)
  - Bridging
  - Marching

Functional Exercises

- See sensorimotor exercises in the preceding and sport-specific exercises in the following.

Sport-Specific Exercises

- Diagonal "chops" and/or "lifts" in standing with cable or elastic band/cord, mimicking sport movements as much as possible

FIGURE 18-10. Side support (side bridge) on forearm and bent knee. Start in a side-lying position with both knees bent. Raise the pelvis by contracting the trunk lateral flexor muscles while supporting the upper body on one forearm. A straight line should be maintained from their upper body to the feet (i.e., no trunk or hip flexion or extension). The hand of the non–weight-bearing arm can assist in stabilizing the weight-bearing shoulder.

FIGURE 18-11. Starting position for exercises from supine bridged position with heels on dome.

Milestones for Progression to the Next Phase

- Minimal pain with activity
- Good tolerance for exercises listed in the preceding
- Minimal, transient postexercise/activity pain
- Minimal muscle spasm
- Minimal edema

Phase III (weeks 4 to 6)

Management of Pain and Swelling

- Sensory electrical stimulation and/or cryotherapy may be used to reduce postexercise/activity soreness.

Techniques for Progressive Increase in Range of Motion

Manual Therapy Techniques

- See Phase II recommendations

Soft Tissue Techniques

- See Phase II recommendations

Stretching and Flexibility Techniques for the Musculotendinous Unit

- See Phase II recommendations

Other Therapeutic Exercises

- See Phase II recommendations

NOTE: All of the following should be performed with abdominal bracing while maintaining the lumbar spine in a symptom-free ROM.

Sensorimotor Exercises

- Exercises while seated on therapy ball
  - Diagonal "chops" and/or "lifts" with cable or elastic band/cord

Open and Closed Kinetic Chain Exercises

- Exercise progression from prone bridged position (see Figure 18-8)
  - Single-leg unweighting (i.e., four-point to three-point)
  - Single-arm unweighting
  - Single-leg circles or diagonals

FIGURE 18-12. One-arm rows with dumbbell while half kneeling on bench (lawn mowers). Maintain an abdominal brace and do not allow excessive lumbar spine flexion, extension, or rotation while lifting and lowering weight.

Techniques to Increase Muscle Strength, Power, and Endurance

- See exercises in the preceding and the following.

Neuromuscular Dynamic Stability Exercises

- Single-leg supine bridging
- One-arm rows with dumbbell while half kneeling on bench (lawn mowers) (Figure 18-12)
- Exercise progression in quadruped
  - Arm and/or opposite leg circles (i.e., circumduction) from bird-dog position (i.e., single arm flexion with contralateral hip extension)
  - Arm and/or opposite leg diagonals from bird-dog position
  - Single knee to opposite elbow
- Side support (side bridge) on forearm and feet (Figure 18-13)

FIGURE 18-13. Side support (side bridge): From a side-lying position, the pelvis is raised by contracting the trunk lateral flexor muscles while supporting the upper body on one forearm. A straight line should be maintained from the upper body to the feet (i.e., no trunk or hip flexion or extension). The hand of the non–weight-bearing arm can assist in stabilizing the weight-bearing shoulder.

FIGURE 18-14. Prone bridge with forearms on therapy ball. From a prone position with forearms resting on a therapy ball, elbows spaced shoulder-width, and hands touching so that the forearms form a V, the pelvis is raised by contracting the trunk flexor muscles.

- Prone bridge with forearms on therapy ball (Figure 18-14)
- Exercises from supine bridged position with head and shoulder supported on therapy ball
  - Marching
  - Single-leg bridging
  - Diagonal "chops" and/or "lifts" with cable or elastic band/cord (Figure 18-15)

Plyometrics

- Sport-specific jumping, hopping, bounding activities/exercises for the lower extremities
- Depth drop pushups for the upper extremities using different size boxes

Functional Exercises

- Single-leg deadlift (Figure 18-16)

Sport-Specific Exercises

- Sport-specific, multiplanar activities/exercises should be incorporated and progressed according to the athlete's ability to maintain lumbopelvic control during the activity.
- Resistance with all sport-specific exercises should be adjusted based on the athlete's ability to perform the exercise with good form/technique while maintaining abdominal bracing.
- The intensity, speed and duration of activities should increase over time until they approximate those of the appropriate sport.
- Examples
  - Football lineman may need to initially use unweighted blocking sleds.
  - Weightlifters should initially focus on technical aspects of a particular lift using a relatively light weight.
  - Golfers should gradually increase swing speed according to symptom response.
  - Gymnasts should practice routines at slower than usual speed.
- Consult with athlete and coaches for other sport-specific exercises/activities.

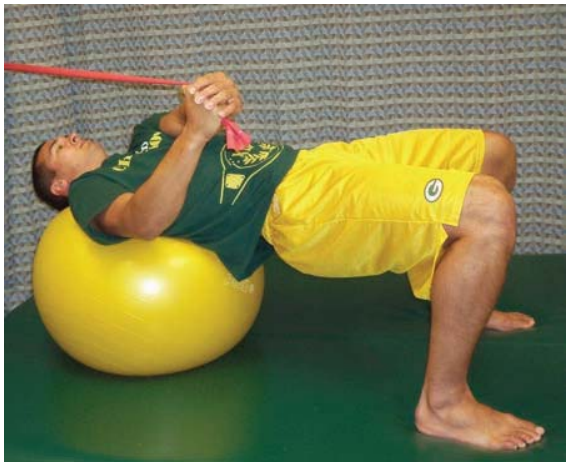

FIGURE 18-15. Diagonal "chops" or "lifts" from supine bridged position with head and shoulders supported on therapy ball. Maintain an abdominal brace and do not allow excessive lumbar spine flexion, extension, or rotation while "chopping" or "lifting."

FIGURE 18-16. Single-leg deadlift: Start in single-leg stance position with arms at sides, then move trunk forward and contralateral leg into extension by flexing stance leg's hip. Stance knee should remain slightly flexed throughout exercise. Continue leaning trunk forward (via flexing at hip) as far as possible while maintaining spinal alignment and control.

Milestones for Progression to the Next Phase

- No pain with activity
- Intermittent short-duration pain with movement
- Minimal, transient postexercise pain
- No observable swelling
- Active and passive joint ROM within normal limits
- Trunk muscle deficits less than 25% with manual muscle testing, isokinetic testing, and/or functional testing

Phase IV (weeks 6+)

Management of Pain and Swelling

- See Phase II recommendations

Techniques for Progressive Increase in Range of Motion

- Joint or soft tissue mobilization and/or stretching/flexibility exercises should continue if deficits persist.

Other Therapeutic Exercises

- See Phase III recommendations

NOTE: All of the following should be performed with abdominal bracing while maintaining the lumbar spine in a symptom-free ROM

Sensorimotor Exercises

- Single-leg deadlift progression
  - With both shoulders abducted 90°
  - With one shoulder flexed 90° reaching to floor (alternate flexed shoulder with each repetition)
  - On labile surface (e.g., foam pad)

Open and Closed Kinetic Chain Exercises

- See exercises in the preceding and the following.

Techniques to Increase Muscle Strength, Power, and Endurance

- See exercises in the preceding and the following.

Neuromuscular Dynamic Stability Exercises

- Diagonal "chops and/or "lifts" or trunk rotation with cable or elastic band/cord balancing on one foot
- Rotating body bridge: Move from side plank/bridge position on one arm (see Figure 18-13) to prone bridge (see Figure 18-8) then to side bridge on opposite arm while maintaining neutral lumbar spine and abdominal brace throughout. Hold each bridged position for 10 seconds. The foot of the upper leg should be placed on the floor for the side bridge to enable rolling into a prone bridge without changing foot alignment.
- Hanging straight leg raise to 90° hip flexion
- Bilateral hip extension over center of plinth (Figure 18-17)

FIGURE 18-17. Bilateral hip extension over center of plinth. While holding onto plinth, lift legs from floor to horizontal under control. Motion should occur about the hips, not the spine to avoid lumbar sprain/strain exacerbation.

FIGURE 18-18. Starting position for exercises from pushup position with lower legs and/or feet on therapy ball.

- Exercises from supine bridged position with heels on therapy ball
  - Bridging
  - Marching
  - Roll ball side-to-side
- Exercises from pushup position with lower legs and/or feet on therapy ball (Figure 18-18)
  - Roll ball side-to-side
  - Alternate hip extension
  - Pushups
  - Bilateral hip and knee flexion (prone tucks) (Figure 18-19)

Plyometrics

- Sport-specific jumping, hopping, bounding
- Clapping pushups

Functional Exercises

- See Phase III recommendations.
- The complexity and speed of activities should increase over time until they approximate those of the appropriate sport.

Sport-Specific Exercises

- See Phase III recommendations.
- The intensity and duration of activities should increase over time until they approximate those of the appropriate sport.

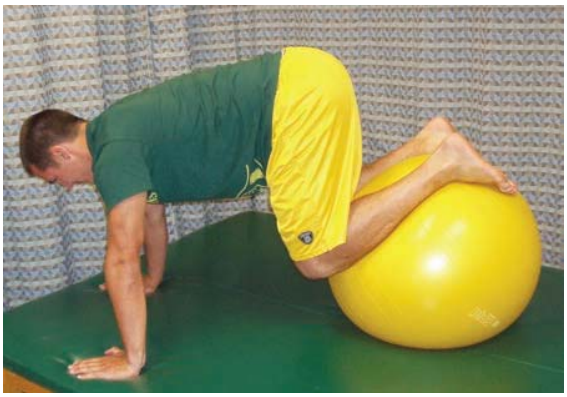

FIGURE 18-19. Prone tucks. Start in pushup position with legs or feet on therapy ball. Roll ball forward then back to starting position while controlling for excessive lumbar spine motion.

Milestones for Progression to Advanced Sport-Specific Training and Conditioning

- Full, pain-free ROM
- Normal trunk muscle strength (as determined by manual testing or dynamometry)
- Good technique with all Phase IV exercises

Criteria for Abandoning Nonoperative Treatment and Proceeding to Surgery or More Intensive Intervention

- Lumbar strains/sprains are typically benign in nature, transient and self-limiting. Failure to respond to conservative management within 4 to 6 weeks may warrant referral for further specialized testing.
- There are no absolute indications for surgery with lumbar strain/sprains.

Tips and Guidelines for Transitioning to Performance Enhancement

- During the last phase of rehabilitation the athlete should be advanced to his or her maximum functional potential.
- A whole-body warm-up should precede activity/exercise.
- Exercises should be performed at roughly the same time of day as practices or events.
- All three energy systems should be trained, with the most sport-specific system(s) emphasized.
- Activities/exercises that closely approximate the specific movements and skill requirements of the sport should be included.
- The level of resistance used during functional strengthening drills should approximate or slightly exceed the intensity of the sport.
- Agility, plyometric, speed, and strengthening activities/exercises should be included at a progressively higher level of performance, intensity, and complexity.
- If appropriate, elements of changing speed, direction, and center of gravity should be introduced.
- It may be appropriate to have the athlete exercise with control into nonneutral ranges of motion once they have demonstrated excellent lumbar spine control in neutral. The need to exercise into nonneutral ranges should be predicated on the sport's movement requirements and balanced against any untoward symptom aggravation.

Specific Criteria for Return to Sports Participation: Tests and Measurements

- Adequate pain-free trunk ROM for given sport
- Normal trunk muscle strength (as determined by manual testing or dynamometry)
- No obvious deficits in lower or upper extremity strength or flexibility

Evidence

Brennan GP, Fritz JM, Hunter SJ, et al: Identifying subgroups of patients with acute/subacute "nonspecific" low back pain: Results of a randomized clinical trial. *Spine* 31(6):623–631, 2006.

In this prospective, randomized study the authors studied the impact of classifying 123 patients with LBP of less than 90 days' duration into one of three subgroups based on the type of treatment believed most likely to benefit the patient (manipulation, stabilization exercise, or specific exercise). Patients who received matched treatments experienced greater reductions in disability after 4 weeks and after 1 year than those who received unmatched treatments. This suggests that nonspecific LBP should not be viewed as a homogenous condition and that outcomes with nonspecific LBP can be improved when subgrouping is used to guide treatment decision making.

Hicks GE, Fritz JM, Delitto A, et al: Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil* 86(9):1753–1762, 2005.

This prospective, randomized study of 54 patients with nonradicular LBP examined the variables associated with treatment success following an 8-week standardized stabilization exercise program. Based on treatment response, the most important variables associated with success were age less than 40, straight-leg raise greater than 91°, positive prone instability test, presence of aberrant motions, lumbar hypermobility with passive testing, and absence of fear-avoidance beliefs. (Level IV evidence)

Hides JA, Richardson CA, Jull GA: Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. *Spine* 21:2763–2769, 1996.

In this clinical trial, 39 patients with acute, first-episode LBP were randomly allocated to either a control group or specific exercise group with 1-year and 3-year telephone questionnaire follow-ups. The specific exercise group performed exercises intended to specifically challenge the lumbar multifidus (LM) and transversus abdominis muscles. At the 10-week follow-up examination LM cross-section area was greater in the specific exercise group. The control group had decreased LM size at 10 weeks despite resuming normal levels of activity. This suggests that LM atrophy may persist after cessation of LBP without exercise intervention. (Level I evidence)

Kavcic N, Grenier SP, McGill S: Determining the stabilizing role of individual torso muscles during rehabilitation exercises. *Spine* 29:1254–1265, 2004.

In this study, 10 healthy males performed a series of eight different exercises while electromyography, three-dimensional lumbar motion, and external forces were measured. Based on subsequent calculations of spine stability, the authors determined that larger, more "global" muscles are better able to alter spine stability than "local," intersegmental muscles. They also concluded that focusing on a single muscle, or only a few muscles, appears to be misdirected if the goal is to ensure a stable spine. (Level IV evidence)

Koumantakis GA, Watson PJ, Oldham JA: Trunk muscle stabilization training plus general exercise versus general exercise only: Randomized controlled trial of patients with recurrent low back pain. *Phys Ther* 85:209–225, 2005.

This prospective, randomized study of 55 patients with nonspecific subacute or chronic LBP compared outcomes following 8 weeks of general trunk muscle exercise or 5 weeks of lumbar multifidus and transversus abdominis muscle training plus 3 weeks of general muscle trunk muscle exercise. Disability decreased to a greater extent at 8 weeks in the general trunk muscle exercise only group, although no difference was measured between groups at the 3-month follow-up, suggesting that stabilization exercises focused initially on isolated training of the lumbar multifidus and transversus abdominis do not provide additional benefit. (Level I evidence)

Vera-Garcia FJ, Elvira JL, Brown SH, et al: Effects of abdominal stabilization maneuvers on the control of spine motion and stability against sudden trunk perturbations. *J Electromyogr Kinesiol* 17:556–567, 2007.

In this prospective, single-limb trial, the authors studied the effectiveness of abdominal bracing and abdominal hollowing to control spine motion and stability against rapid perturbations in 11 healthy males in a semiseated position. Based on electromyography and lumbar spine kinematics, the authors reported that the abdominal hollowing maneuver was ineffective for stabilizing the lumbar spine after sudden perturbation. In contrast, the abdominal bracing maneuver fostered torso co-contraction, actively stabilized the trunk and decreased lumbar spine displacement after sudden perturbation. (Level IV evidence)

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Multiple Choice Questions

QUESTION 1. Following a lumbar sprain or strain, gentle lumbar spine stretching/self-mobilization exercises should be initiated as soon as possible in a minimally painful ROM to

A. limit the adverse effects of immobilization.
B. stimulate collagen synthesis.
C. promote proper collagen alignment.
D. All of the above

QUESTION 2. Which of the following statements concerning abdominal bracing is true?

A. Abdominal bracing has been shown to increase lumbar spine stability to a greater extent than abdominal hollowing.
B. Abdominal bracing should be performed immediately after all leg and arm exercises.
C. Abdominal bracing should be performed by drawing-in or hollowing the abdomen.
D. None of the above is true.

QUESTION 3. Which of the following statements concerning abdominal bracing is true?

A. Poor lumbar muscle endurance appears to be a significant risk factor in development of future LBP.
B. Endurance should be emphasized less during the early phases of lumbar sprain/sprain rehabilitation than strength.
C. Trunk muscle endurance training has been shown to be effective in reducing pain and disability in patients with nonspecific low back pain.
D. It is particularly important to regain endurance of the erector spinae and multifidus muscles.

QUESTION 4. Which of the following is a valid reason for abandoning nonoperative treatment of a lumbar sprain or strain and proceeding to surgery?

A. Subnormal trunk muscle endurance
B. Failure of the lumbar multifidus muscle to recover its normal cross-sectional area
C. Lack of full/normal lumbar spine ROM
D. None of the above

Answer Key

QUESTION 1. Correct answer: **D** (see Phase I)

QUESTION 2. Correct answer: **A** (see Phase I)

QUESTION 3. Correct answer: **B** (see Phase II)

QUESTION 4. Correct answer: **D** (see Phase IV)