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Research-Based Rehabilitation of the Lower Back

Ronald G. Rogers, DC, CSCS
Ocean Shores, Washington

summary

This article presents an exercise-based approach to the management of chronic lower back pain. The exercises are selected based on specific functional deficits that have been identified in the population with low back pain. This information can be used by strength and conditioning professionals who wish to provide an efficient, research-supported approach to this common malady.

It has been estimated that 4 out of every 5 American adults will suffer an incident of back pain at some point in their lives. Some researchers estimate that the total costs of treating back pain in the United States exceeds $90 billion per year in office visits, medications, and related expenditures—roughly 1% of the country's entire annual gross domestic product (15). The lower back is by far the most commonly problematic area of the spine.

The prognosis for acute lower back problems is generally good. Acute low back problems are defined as activity intolerance because of lower back or back-related leg symptoms of less than 3 months duration. About 90% of patients with acute low back problems spontaneously recover activity tolerance within 1 month (3). Because of this favorable natural history, these episodes tend to respond well to most treatment interventions or even no treatment at all.

Chronic lower back problems, those lasting more than 3 months, respond less favorably to most treatment interventions and do not tend to spontaneously resolve over time. For chronic or recurrent back pain, traditional approaches of rest and passive therapies become increasingly ineffective and inappropriate. Active approaches inclusive of exercise are seen as the most effective interventions for the vast majority of these people (14).

Many patients with chronic back pain are advised by their primary health care providers to exercise, yet few primary care providers are equipped to provide opportunities for on-site supervised exercise. For this reason, patients often receive verbal or written instructions for exercises to be performed at home. This may lead to confusion, poor exercise technique, boredom, or noncompliance. There is indeed evidence that there may be advantages to supervised, structured exercise programs compared with home exercise programs (2, 4, 16).

Some chronic back pain sufferers seek the guidance of a personal trainer or strength and conditioning specialist. In this circumstance, it is the responsibility of the fitness professional to provide the most appropriate exercise strategies to address the condition. In a personal trainer scenario, it is also important to ensure that the client has had a thorough medical evaluation and has been cleared for general exercise.

Though a general program of strength and flexibility training for the low back region can be helpful, the fitness professional should attempt to streamline the training program using research-based methods whenever possible to help achieve the rehabilitation objectives with the greatest possible safety, efficacy, and efficiency. Exercise rehabilitation

should attempt to bridge the gap between a client or athlete's goals and his or her functional limitations. For the purpose of this discussion, functional limitations would refer to limitations of function at the person level (i.e., equivalent to activity limitation). Activities may be limited in nature, duration, or quality. Functional deficits would be a term describing limitations at the body level (i.e., impairment of body parts, organs or systems).

Overview

When considering appropriate rehabilitation strategies for a given condition, an attempt should be made to determine what, if any, physical characteristics are common to individuals afflicted by the condition. For the strength and conditioning specialist, it is especially important to look closely at those physical traits that are potentially amenable to training interventions such as strength, flexibility, endurance, speed, and coordination. Whenever possible, specific deficits should be identified.

Is there a motor control signature of low back pain subjects? A review of clinical and biomechanical literature suggests that there is. In regard to chronic lower back pain, 2 common areas of functional deficits have been identified. The first functional deficit is weakness of the lumbar extensors (1, 6, 7, 13, 20, 23).

In a study that measured peak isokinetic torque for trunk extension, flexion, and torso rotation, it was shown that an imbalance of trunk muscle strength is a risk factor for lower back pain incidence. Those with lower extensor muscle strength than flexor muscle strength were found to be at increased risk for lower back pain (13).

Kader et al. (10) compared magnetic resonance imaging (MRI) results for 78 patients with back pain. Multifidus muscle atrophy was present in 80% of the patients and was bilateral in most cases. There was a significant correlation between multifidus atrophy and the presence of radiating leg pain (10). The presence of atrophy in specific muscles would tend to implicate these muscles in regional weakness and would certainly serve as a guide to those seeking to target specifically areas of deficiency when formulating rehabilitation protocols.

Alaranta et al. (1) found that among tests for spinal physical capacity, the static-back endurance test was the only test that was predictive for increased risk of low back pain. Of a total of 126 persons who were free from back complaints at entry, 33 developed low back pain during a follow-up of 1 year. The static-back endurance test was found to be the only physical capacity measurement that indicated an increased risk of low back pain. The static-back endurance test, sometimes called the Biering-Sorensen Test (12, 18), places the individual on a roman chair in a position of extension parallel to the floor with the hands positioned behind the back. The number of seconds that the subject can hold this position is recorded. After adjusting for age, sex, and occupation, the authors found that those subjects scoring in the lower one-third on the Biering-Sorensen Test were 3.4 times more likely to suffer a new episode of low back pain within 1 year compared with the other subjects involved in the study. Other physical parameters that were assessed were trunk flexion strength, abdominal muscle endurance, self-reported levels of physical activity, and waist girth. The authors concluded that back extensor endurance is a very good predictor of back health. They further advocated using back extensor endurance as a method for differentiating levels of back health in apparently healthy men and women (1).

A more recent study (20) investigated the association among 17 mechanical factors and the occurrence of low back pain. This study looked at 600 subjects equally divided into 4 groups: asymptomatic males, asymptomatic females, symptomatic males, and symptomatic females. Among all the factors tested, endurance of the back extensor muscles had the highest association with low back pain. Other factors that had a significant association with low back pain included length of back extensor muscles, and the strength of the hip flexor, hip adductor, and abdominal muscles. The size of the lumbar lordosis, pelvic tilt, leg length discrepancy, and length of abdominal, hamstring, and iliopsoas muscles were not associated with the occurrence of low back pain.

The second functional deficit found in relation to chronic lower back pain is compromised proprioceptive acuity. A number of studies have linked poor proprioception with low back pain (8, 9, 19, 21, 22, 24). Poor proprioception has been implicated in delayed or disrupted patterns of muscle activation. Inefficient muscle-activation patterns may, in turn, contribute to biomechanical vulnerability and further injury or increased chronicity.

One study compared responses to various footplate perturbations of 20 subjects with chronic low back pain and 20 age- and sex-matched controls. The subjects underwent 5 sets of footplate perturbations in 3 directions with 116 perturbations for each set. The main outcome measures were latency, frequency, and asymmetry of muscle activation of the erector spinae, rectus abdominus, anterior tibialis, and gastrocnemius muscles as measured bilaterally with surface electromyography. The investigators found that significantly more subjects with low back pain than control subjects exhibited absent firing of trunk muscles during 2 of the 5 footplate perturbations. They concluded that the results suggest an abnormality of the neuromuscular loop in subjects with low back pain that may represent altered proprioception (19).

Table 1 Conditioning Program		
Warm-up	Treadmill	Brisk one-half-mile walk
	Stretches	30-s static stretches of hamstrings and hip extensors
	Prone "cobra" extensions	10 reps × 2 s each
Strength training	Variable angle roman chair	15RM
	Abdominal crunches	Single set to fatigue
	Side bridges	Single set to fatigue
Proprioception training	Balance board	3 positions × 1 min each
Cool down	Stretches/extensions	Repeat of hamstring/hip stretches and "Cobra" extensions

Chronic low back pain patients have poorer balance than that of controls, especially with their eyes closed (24). An unstable sitting test was accomplished by attaching different-sized hemispheres to the bottom of a seat. Subjects performed trials with eyes open and closed while the displacements of the center of pressure were measured with a forceplate underneath the seat. When forces applied to the torsos of these individuals were suddenly released, the low back pain patients had delayed muscle response times in the dynamic stabilizers of the spine compared with the control subjects.

Hodges and Richardson (9) observed delayed recruitment of transverses abdominus and internal oblique muscles in preparation for fast limb movements in low back pain patients compared with controls. They speculated that this altered recruitment of trunk muscles in response to voluntary tasks may result in inadequate protection of spinal structures from injury.

One study looked at a subset of chronic low back pain patients with the clinical diagnosis of lumbar segmental instability (21). In this study, 15 symptomatic subjects were compared with 15 asymptomatic subjects in the ability to reposition the lumbar spine into a neutral position. Repositioning accuracy was assessed using the 3 Space Fastrak (Polhemus Inc., Colchester, VT). The participants were assisted into a neutral spinal sitting posture and then asked to reproduce this position independently over 5 trials separated by periods of relaxed full lumbar flexion. Lumbosacral repositioning error was significantly greater in the symptomatic group. These authors concluded:

> The results of this study indicate that individuals with a clinical diagnosis of lumbar segmental instability demonstrate an inability to reposition the lumbar spine accurately into a neutral spinal posture while seated. This finding provides evidence of a deficiency in lumbar proprioceptive awareness among this population.

Work by Kavcic et al. (11) using torso electromyography on subjects performing various "stabilizing exercises" suggested that no single muscle dominated in the enhancement of spine stability and that their individual roles continually change across tasks. These authors argue that when training for spine stability, enhancing motor patterns that incorporate many muscles rather than targeting just a few is justified (11).

Having identified 2 specific deficits common to those suffering with chronic lower back pain, a logical approach to exercise rehabilitation is to design a program that specifically addresses these deficits. In this case, such a program would include exercises designed to increase the endurance of the lumbar extensors while incorporating elements to improve balance, coordination, and reaction time. Exercises that necessitate motor recruitment in varied patterns should also be included. This article presents low back rehabilitation protocols designed around these principles.

Exercise Strategies

Table 1 summarizes the typical lower back rehabilitation protocols used by the author. These include a brisk warm-up walk; static stretches for the hamstring, gluteal and lower back extensors; abdominal crunches; and side bridges. Although these exercises have been carefully chosen and should be reasonable for most individuals with chronic lower back pain, individual needs of the patient or client must always be considered. Variations may be necessary.

To address a primary objective of targeting the deep lumbar extensors, a variable angle roman chair device can be used. Changing the angle of the device or shifting the hand position to increase or decrease the distance from the center of mass results in changes in the resistive load (17) (Figures 1a and 1b). The hands may be positioned behind the back,

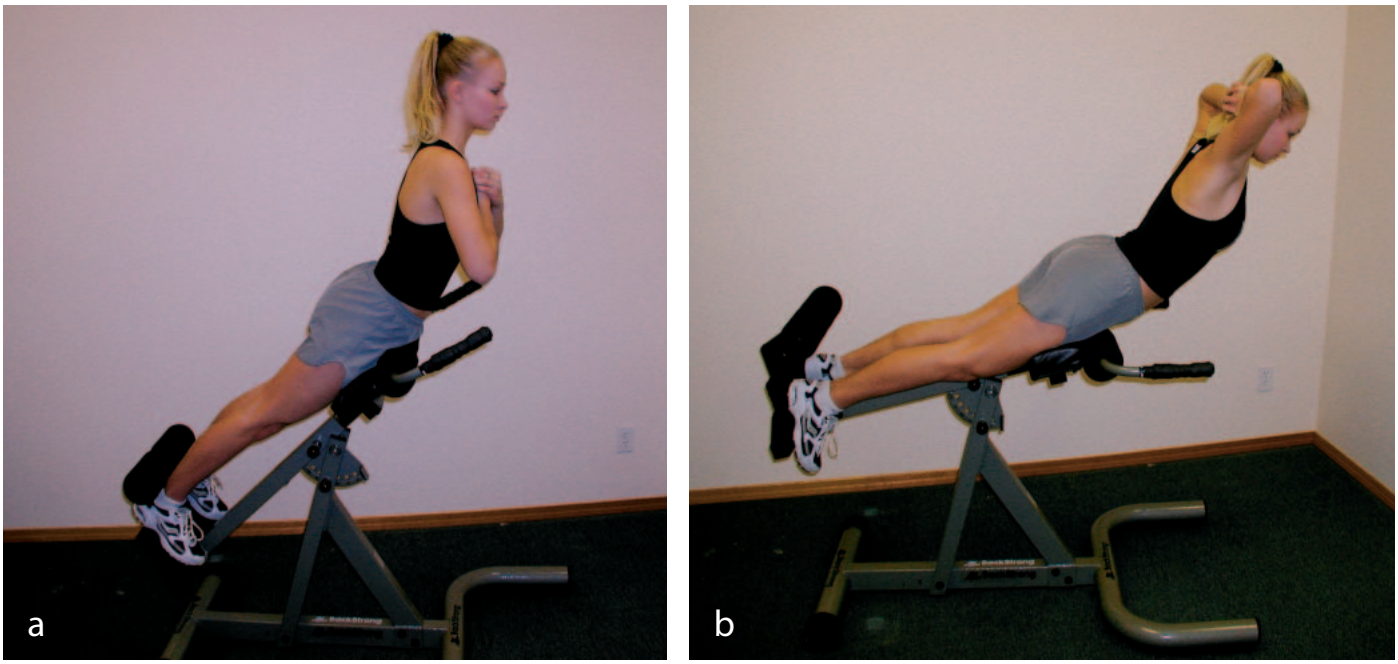

Figure 1. Variable angle roman chair exercise: (a) 45° setting with hands at sternum; (b) 15° setting with hands behind head.

against the sternum, crossed in front of the chest, or behind the head to progressively increase the load. The load is varied in an attempt to maintain a 15 repetition maximum (RM). If subjects are able to exceed a 15RM in a position of maximum load, they are encouraged to continue to perform as many complete repetitions as they are able. In performing the roman chair exercises, the technique should emphasize full ranges of motion. The movement should not simply hinge at the hips but should move from a hanging posture through maximum tolerable extension. The goal is to fully recruit the intersegmental muscles like the multifidi.

With the goal of increasing proprioceptive acuity and improving muscle activation patterns, a full-length "wobble board" can be used. The wobble board is a 24- × 48-in. padded platform. A secured dowel runs lengthwise along the midline undersurface of the platform creating an unsteady base (Figure 2). Subjects are coached to hold progressively challenging postures while attempting to maintain balance (Figures 3a–3f). They are encouraged to maintain a stabile core by locking the ribcage into a fixed position relative to the pelvis. As little motion as possible should take place between the ribcage and the pelvis. At the same time, the subject should try to maintain normal breathing rhythms and avoid holding his or her breath. This will presumably better prepare the individual to engage in similar stabilization strategies when performing real-world tasks such as carrying groceries, making a bed, or pushing a lawn mower. Core stabilizing strategies are useful during these and similar activities that cannot reasonably be performed while holding one's breath.

The use of wobble boards is well-established in the rehabilitation of lower-extremity conditions such as ankle sprains (5). Although conclusive evidence of similar benefits in back rehabilitation is lacking, the principles of balance and proprioceptive training are now being applied to the spine. Stability balls are gaining popularity for core training as they introduce a proprioceptive challenge to the strength exercise. I believe that the wobble board may be better suited to this purpose. The construction of the board creates a smaller radius about the unstable surface resulting in "wobbles" of greater velocity and lesser amplitude. This should produce greater facilita-

Figure 2. Wobble board detail.

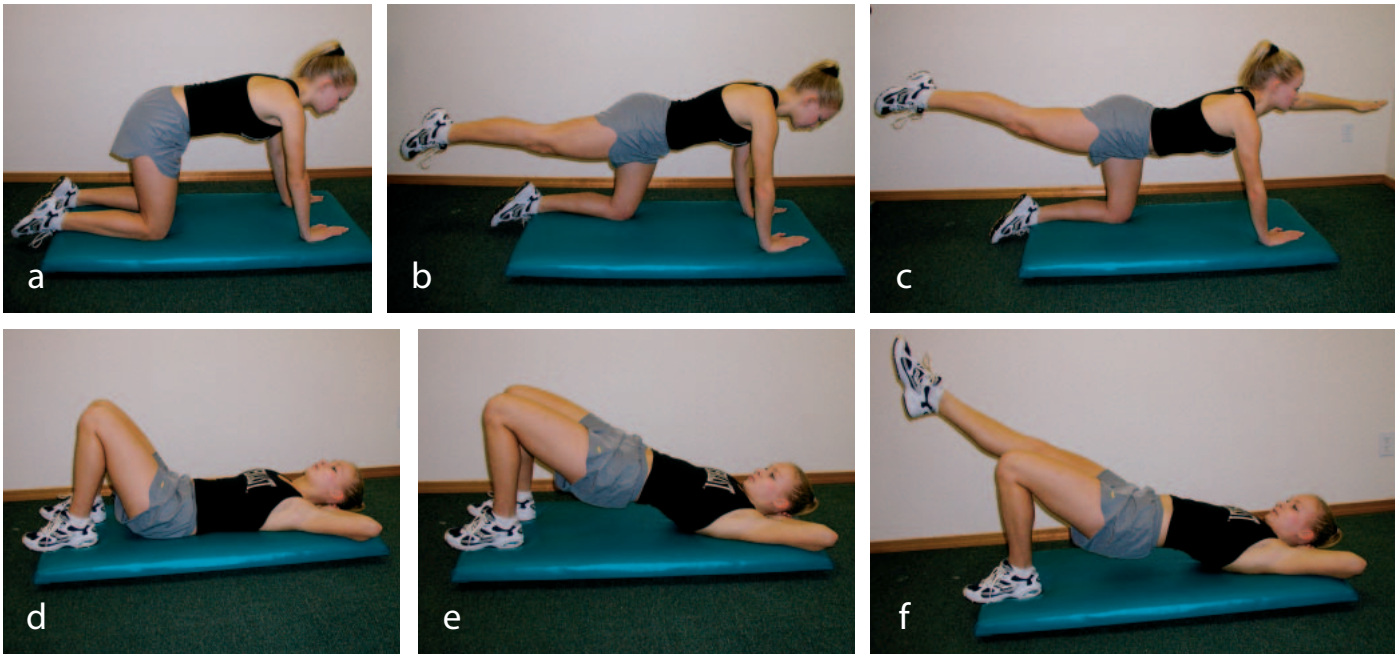

Figure 3. Examples of wobble board progressions: (a) 4-point stance; (b) 3-point stance with leg extended; (c) 2-point stance with opposite arm and leg extended; (d) supine with slight pelvic tilt; (e) supine bridge; (f) supine bridge with 1 leg extended.

tion of mechanoreceptors and force more rapid muscular responses to the sudden loading. The wobble board also places the subject nearer the ground, which may enhance safety. Serial modification of the postures will allow the rehabilitation subject to concentrate on maintaining form and using efficient balance strategies in simple postures first. The postures can then be modified by removing 1 or more points of support or by closing the eyes. The subject is guided through 3 different postures per session at 1 minute each. Increasingly challenging postures demand greater balance skills and force more rapid and complex motor recruitment responses as advocated by Kavcic et al. (11).

Special Considerations

Certain individuals would not be considered appropriate candidates for the rehabilitation procedures described in this article. Absolute contraindications are relatively rare and would include any medical condition for which inversion on the roman chair would be inappropriate. This would include poorly controlled hypertension or glaucoma. Orthopedic spinal instability, such as a recent fracture or severe spondylolisthesis (greater than grade 1), would also be contraindications. Radiating leg pain (sciatica) should not be considered an absolute contraindication unless accompanied by atrophy, sensory loss, or motor weakness in the affected extremity. Bowel or bladder incontinence would certainly be a contraindication as would moderate to severe osteoporosis. Appropriate candidates should have no other medical conditions that would preclude vigorous physical exercise.

In designing a rehabilitation program, it is not only important to select exercises that will target areas of functional deficiencies but also to select exercises that are realistic to the abilities of the individual. This is especially important for those suffering from chronic lower-back pain, a condition that tends to produce considerable fear-avoidance behaviors in those afflicted. The author has been successfully using the protocols described in this article in a clinical setting for more than 2 years.

Conclusion

Chronic lower back pain is a challenging condition to treat. Exercise is considered appropriate for the vast majority of those afflicted by this condition. Those who have been properly screened medically may benefit by a referral to a personal trainer or strength and conditioning specialist. The fitness professional as a reliable authority should direct these individuals to the most appropriate and well-validated exercise strategies for this condition.

Weakness in the back extensors and altered proprioception are 2 functional deficits that have been associated with chronic lower back pain. Identifying these common functional deficits provides a basis for prescribing specific exercises in attempting to rehabilitate clients with this condition. A regimen emphasizing targeted strength exercises for the lumbar extensors along with exercises focused on balance and coordination has been shown to be effective in the rehabilitation of those suffering from chronic lower back pain. ♦

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Rogers

Ron Rogers is a chiropractic orthopedist in private practice in Ocean Shores, Washington.