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LUMBAR PROTECTIVE MECHANISM

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The primary goal of physical therapists who evaluate and treat patients presenting with lumbar pain is to help the patients to responsibly manage their back dysfunction and prevent future recurrence (1–6). Back pain can be directly correlated to a pathological state, such as nerve impingement, joint degeneration, foraminal stenosis, disc disease or segmental instability; or, the pain can remain undiagnosed despite exhaustive testing (7–10). In either situation, the physical therapist is to identify the biomechanical and neuromuscular dysfunctions related to the exacerbation and perpetuation of the symptoms and the degenerative process. These dysfunctions may include poor posture and body mechanics, poor muscular responsiveness and strength, and limited flexibility of soft tissue and articular structures (1, 2, 6, 10–19). Once these dysfunctions are identified and measured, the treatment program is designed to assist the patient in achieving adequate flexibility, strength, responsiveness, and coordination to learn the postures and movements that will control symptoms and retard the degenerative process (1, 2, 9, 13, 20). Primary components of the treatment program are back education and training (3, 4, 6, 21–27).

Back education and training are founded on the premise that the lumbar spine is less traumatized when the patient utilizes an efficient alignment (4, 28, 29), has an effective base of support, and exhibits an inherent ability to brace or stabilize the lumbar spine during loaded or repetitive activities (3, 13, 20, 30, 31). This inherent mechanism of stabilization, whether reflex or volitional, we call the *lumbar protective mechanism* (LPM) (3, 32). This chapter presents an evaluation and treatment process in which the therapist identifies, assesses, and retrains this protective mechanism.

The initial step in a back education and training program is to identify a mechanical correlation to the patient's subjective complaint (7, 10). This requires a complete history and subjective and functional evaluation (7, 8, 10, 33, 34). The functional evaluation includes an analysis of the patient's range of motion, strength, endurance, habitual postures, presenting body mechanics, and functional capacity during tasks such as lifting (21, 22, 26, 28, 35). Specifically, the therapist identifies the patient's ability to assume a balanced alignment and to maintain this alignment during the tested activities of daily living.

ALIGNMENT

An analysis of the vertical relationship of the structures of the spine provides an initial source of information with regard to the patient's habitual postures and movement patterns (5, 10, 28). Efficient alignment allows for equal weight distribution through the spine, therefore transferring the weight of the upper body and any object carried, pushed, or pulled directly to the base of support. Observation of the patient during functional tasks such as sitting, standing, lifting, carrying objects, pushing and pulling, coming to standing, and returning to sitting reveals the patient's position and use of the cervical, thoracic, and lumbar spines. The therapist assesses as well the segmental relationship of these three spinal segments and

any changes that occur during functional activities.

An important objective assessment of the patient's vertical alignment is the vertical compression test (3, 32). This test provides the therapist and patient kinesthetic feedback as to how weight is transferred through the spine to the base of support. The patient is asked to stand in a comfortable, natural stance. The therapist then applies vertical pressure through the shoulders feeling for any give or buckling in the spine (Fig. 13.1). During the procedure, the patient is asked to relate any increase or reproduction of symptoms. In the presence of postural deviations, the therapist usually feels an instability at the level of dysfunction and the patient often reports pressure or pain from the vertical compression in the same area.

The vertical compression test, when used correctly, can help the patient recognize existing postural deviations and their functional and symptomatic effects. Deviations such as an increased lumbar lordosis, posterior angulation of the thoracic spine, anterior shear of the pelvis or regions of instability (36–38), prevent efficient weight transfer through the spine. When the natural segmental relationship of the three spinal curves is interrupted, the spine no longer efficiently transfers the weight to the pelvis, but concentrates the force of the vertical loading at the biomechanically altered segment. This concentration of force appears to facilitate a progressive breakdown of the structural and neuromuscular stability at those segments (13, 38). We suggest that the presence of such dysfunctions also inhibits the trunk muscles' natural tendency to stabilize the lumbar spine in a mid-range or neutral position during repetitive, loaded, or stressful activities.

Figure 13.1. The vertical compression test.

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Training the patient to maintain the lumbar spine in a balanced alignment during stressful activities is a primary component of the spinal rehabilitation program (3, 13, 20, 30, 31). Before education and training, the therapist must evaluate the reflex or volitional responsiveness, and strength and endurance of the intrinsic and extrinsic trunk muscles necessary to stabilize the lumbar spine in response to external force. The lumbar protective mechanism protects the spine both by holding the individual vertebrae stable in relation to each other and maintaining an efficient alignment and segmental relationship of the thoracic, lumbar, and pelvic regions (31, 32).

An assessment of the patient in various postures and movements identifies the components that need to be addressed during education and training. The following evaluation procedures are primarily influenced by the principle of *proprioceptive neuromuscular facilitation* (PNF) (39, 40). Specificially, manual contact, resistance, approximation, and diagonal patterns provide a framework for consistent testing.

Primary assessment of the LPM is performed with the patient standing. The therapist applies appropriate manual resistance to the patient's shoulders or other regions of the body in anterior, posterior, rotational and diagonal directions (Figs. 13.2 and 13.3). Initially, no instructions are given, so that the patient's natural responsiveness can be assessed. If there is a delayed or diminished response, the patient is instructed to maintain a stable position against the therapist's resistance. Once a response is elicited, the strength and endurance of the LPM is assessed by increasing and maintaining resistance (3).

The functional effect of the patient's available responsiveness, strength, and endurance is clarified by further testing. The patient is asked

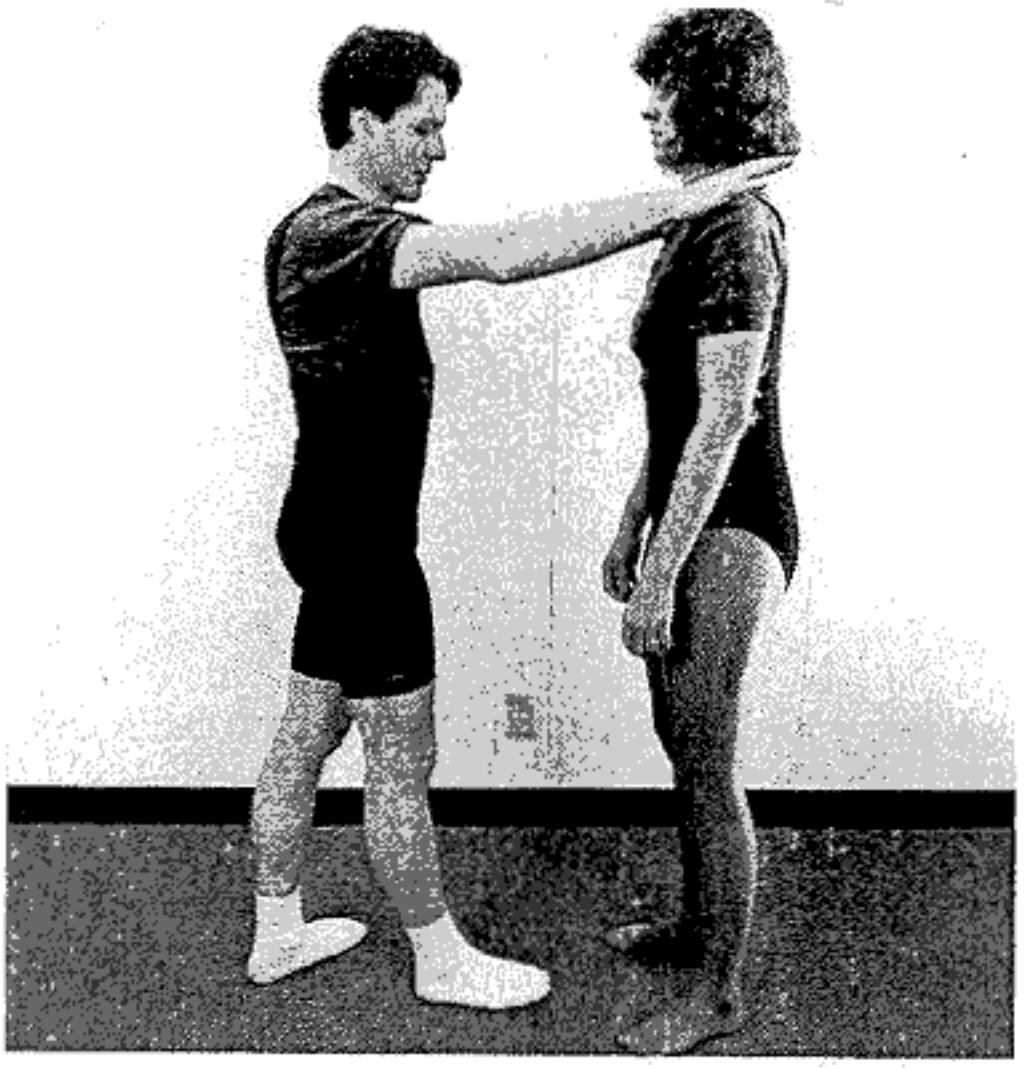

Figure 13.2. Testing the lumbar protective mechanism in standing with straight anterior-posterior resistance.

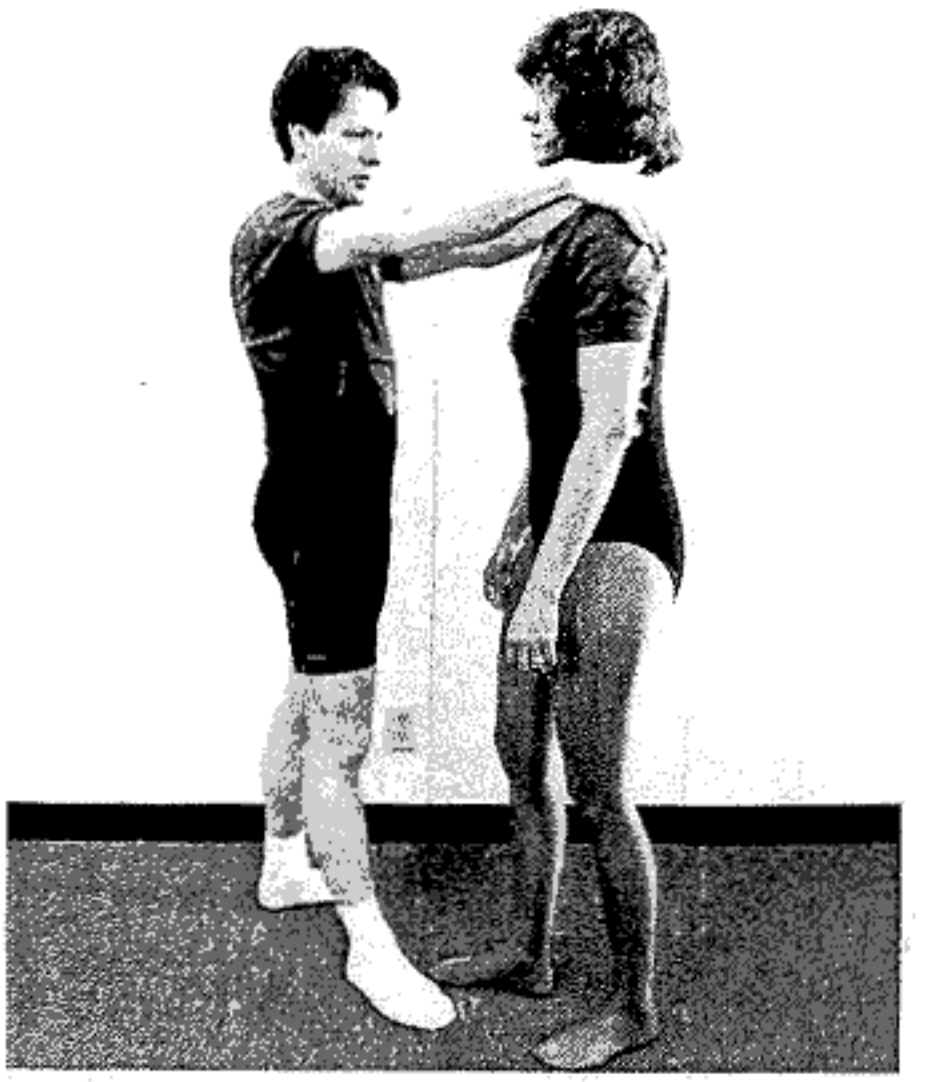

Figure 13.3. Testing the lumbar protective mechanism in standing with diagonal resistance. Note: the patient can be in either a bilateral stance or a straddled stance.

to perform several movements while sitting and standing as well as lifting and push-pull activities (Figs. 13.4, 13.5, 13.6). In each movement, the patient is observed to determine if the spine is positioned and stabilized in a balanced alignment, allowing the work to take place in the hips, legs, ankles, and upper extremities (3, 30, 41).

EDUCATION AND TRAINING OF ALIGNMENT AND STABILIZATION

To educate a patient is to influence the patient's thought process by altering knowledge base and kinesthetic awareness so as to expand the options for decision making. Education of the spinal patient also involves the identification of existing patterns and instruction directed at helping the patient to replace these patterns with more efficient ones. This process can be considered successful only if the information imparted is learned by the patient. The patient should be able to exhibit a balanced alignment, stabilization, and efficient body mechanics in any given activity of daily living. This learning process requires repetition and positive feedback (40, 42).

The techniques used to educate and train a patient can vary widely. However, if the goal is to influence the patient's kinesthetic awareness, the principles of PNF provide a clinically proven framework for enhancing neuromuscular facilitation and reeducation (39, 40). Manual contact, appropriate resistance, visual cues, verbal feedback, traction, and approximation all facilitate a specific response from the patient. This specific response is important in training posture and movement, as well as in

Figure 13.4. Testing the lumbar protective mechanism in active sitting. The patient is observed to determine if the spine is positioned and maintained in a balanced alignment.

Figure 13.5. Testing the lumbar protective mechanism in active standing or bending. The patient is observed to determine if the spine is positioned and maintained in a balanced alignment.

Figure 13.6. Testing the lumbar protective mechanism during resisted activities. The patient is observed and monitored through kinesthetic feedback to determine if the spine is positioned and maintained in a balanced alignment as well as to determine the patient's muscular responsiveness and recruitment.

teaching exercise. Each time a new exercise is given, the patient is manually guided through the exercise using the PNF principles. This ensures the appropriate recruitment of muscles and prevents substitution and compensation. This response is then learned through repetitive exercises and activities that require the patient to maintain the newly learned posture or movement (3, 39, 40).

The circumstances that influence the presence and effectiveness of the lumbar protective mechanism are a naturally balanced alignment, utilization of appropriate principles of body mechanics, and well-conditioned musculature (3).

Alignment and Body Mechanics

Factors that inhibit the assumption of a naturally balanced alignment include existing posture patterns and structural limitations such as decreased soft tissue and articular mobility (11, 32, 43, 44). The therapist, utilizing visual, verbal, and manual techniques of PNF facilitates the patient to correct any nonstructural postural deviations identified in the evaluation and assume a more balanced alignment. This process of retraining through awareness highlights for the therapist the structural deviations that must be addressed with soft tissue (5, 32, 45, 46) and joint mobilization (7, 33, 34, 47, 48) and PNF stretching techniques (39, 40, 46). These restrictions can include soft tissue restrictions in the scalenes, iliopsoas, pectorals, and hamstrings, and limited spine and rib mobility that prevent the assumption of a completely balanced alignment.

Once a more balanced alignment is achieved, the vertical compression test is repeated, noting any improvements in weight transference and pain. If there is any noted improvement, the therapist then retests the LPM to reassess the patient's responsiveness, strength, or endurance. Clinically, most patients demonstrate an improved LPM when there is an improvement in alignment (3, 32). For this reason, we suggest that the initial step of the actual education and training process be directed at any identified postural deviations. This is coupled with the training of the following four basic body mechanic principles (3):

1. Base of support;
2. Utilization of proper axis of motion;
3. Weight shift or momentum;
4. Weight acceptance or balance.

These basic principles, when applied to body mechanics and exercise, enhance the maintenance of an efficient alignment and facilitate

the action of the lumbar protective mechanism. These principles also provide a foundation from which the patient can begin to solve problems and take on an active role of self-responsibility (9, 13, 23, 24, 49).

Exercise

The development of well-conditioned musculature involves a program that consists of relaxation, flexibility (3, 11, 13, 43, 44, 50–53), stabilization (3, 13, 30), and strengthening exercise (3, 11, 13, 14, 20, 30, 44, 54, 55). This program is designed specifically to improve dysfunctions identified in the initial objective and functional evaluation and enhance the structural changes facilitated with manual techniques. Initially, the patient's strength and flexibility are rated and measured (1, 17, 20, 43). These data assist the therapist in establishing parameters for developing the exercise program and allow for accurate assessment of any gains or improvements. Equally important, any deviations in strength and flexibility that can be mechanically correlated to the patient's pain further emphasize the patient's role in rehabilitation.

The relaxation and flexibility exercises address those limitations that restrict the patient from assuming a more balanced alignment, using the proper axes of motion, and recruiting maximal strength response from key muscle groups (Fig. 13.7) (11, 12, 20, 31, 56–59). These exercises are initially performed three or four times a day to gain a rapid improvement and then tapered to four or five times a week.

While efficient function of the lumbar protective mechanism depends on alignment and proper body mechanics, the most critical factor influencing this mechanism is the available responsiveness and strength of the lower trunk muscles (3, 11, 12, 31, 54, 57). The patient's ability to brace or selectively recruit the intrinsic and extrinsic muscles necessary to stabilize the lumbar spine is initially assessed in the supine hook lying position. The therapist gently applies pressure to the anterior and lateral walls of the trunk and asks the patient to tense muscles or press out against the pressure. If a diminished or inefficient response is observed and palpated, the patient is immediately trained in bracing exercises (3, 32, 49). To perform these exercises, the patient locates the specific area of diminished response, presses his fingers deep into the soft tissue, and attempts to push the fingers out using the trunk muscles. This process is enhanced with the added facilitation of resisted hip flexion as illustrated in Figure 13.8. The patient is also instructed to maintain the response to develop endurance within these muscle groups.

Once the patient demonstrates the ability to produce and maintain an efficient bracing contraction, the program then incorporates progressive stabilization exercises (3, 13, 30). This progression is designed to improve the strength and endurance of the abdominal and lower trunk muscles during both open kinetic and closed kinetic activities (Figs. 13.9 and 13.10).

Figure 13.7. The hamstrings muscle group can be stretched in supine position with resistance applied to the hip extensors during an active contraction of the quadriceps at the patient's end range of motion.

Figure 13.8. Finger-tip pressure and resisted hip flexion enhance the responsiveness and strength of the trunk muscles' ability to brace.

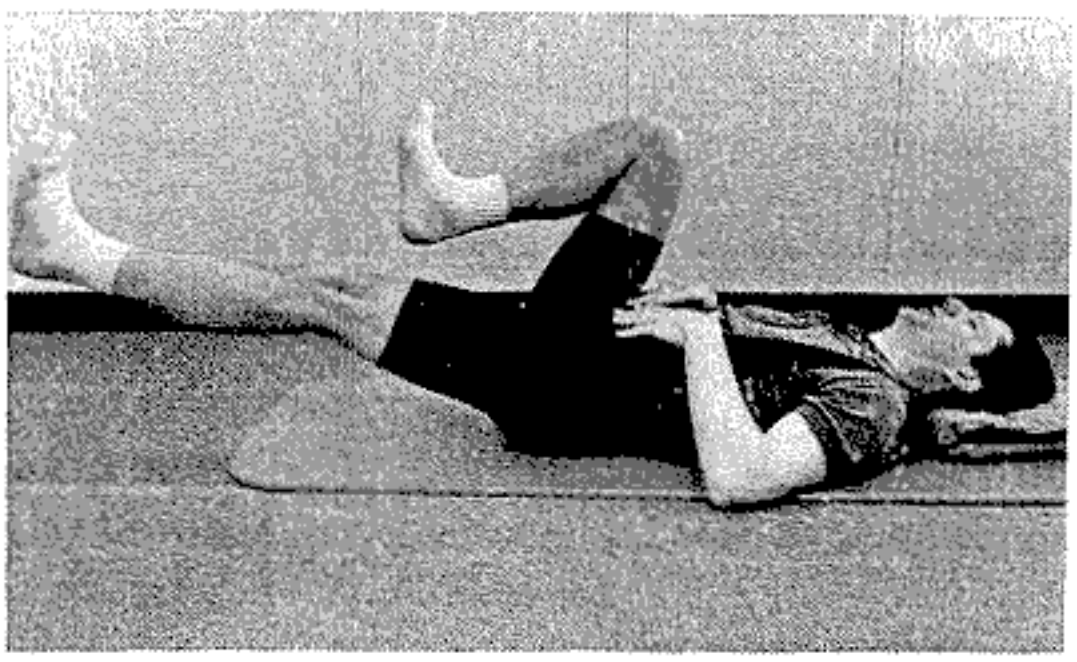

Figure 13.9. Superimposed extremity movement during bracing further enhances the strength and endurance of the muscles that stabilize the lumbar spine. The fingers can remain in the area of greatest weakness to facilitate the maintenance of the bracing contraction.

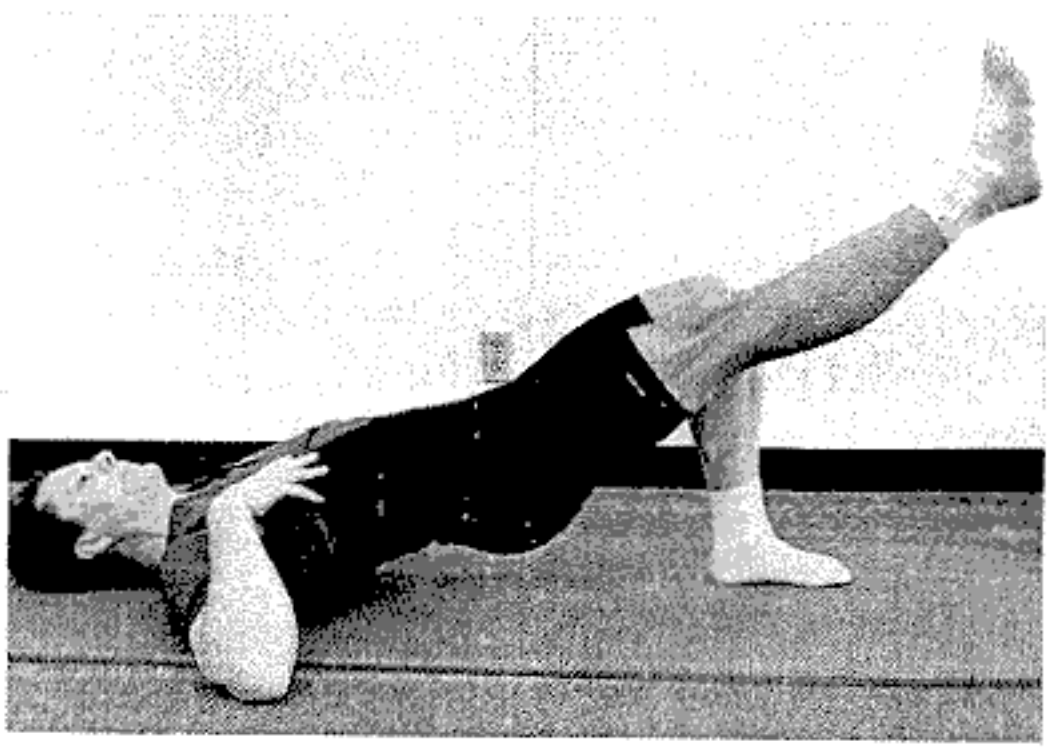

Figure 13.10. Bridging with leg extension while bracing places a greater demand on the trunk stabilizers.

This exercise program progresses to include the addition of weights to the extremities as well as graded external force to the trunk during weight shift and movement over fixed distal extremities. This resistance is facilitated with the use of pulleys or a sports cord. This resistance, applied to functional activities, ensures the carryover of the improved strength and stabilization to activities of daily living. It is this phase of training that becomes specific to the patient's work, home, or recreational activities.

The responsiveness of the LPM is retrained to its maximum potential as the patient's stabilization strength and endurance improves. This quick adjustment (39) or balancing component is challenged with such activities as medicine ball tosses, two-person resisted push-pull exercises, selective Swedish ball exercises, and the use of equipment which varies the base of support such as the profitter or circular balance board.

In conjunction with the stabilization exercises, the patient is placed on a general strengthening program to address any weakness identified in the key muscle groups of the trunk and extremities (3, 6, 11, 13, 14, 20, 30, 43, 44, 54). These exercises are prescribed to achieve two primary goals. First, the patient exercises the trunk and extremities while maintaining a balanced, pain-free position of the trunk, promoting the use of the LPM during loaded and repetitive activities. Examples include repeated squats incorporating forward bending at the hips and resisted lifting patterns with the upper extremities. Second, the patient facilitates general strength and coordination of the trunk muscles through controlled concentric and eccentric movement of the spine, as with progressive controlled rotation of the lower trunk (50, 3, 60).

Throughout the rehabilitation program, exercises are continuously modified to meet the patient's progressive needs. At all times, the exercise program should be directed at improvement in specific functional tasks. In addition, the length and intensity of the exercise program should correlate with the patient's lifestyle and work, home, and recreational demands (Fig. 13.11).

Figure 13.11. During lower trunk rotation, the patient is manually assisted performing movement with proper sequencing and coordination.

SUMMARY

The fundamental premise of back education and training is the maintenance of a balanced, pain-free alignment of the lumbar spine during repetitive, loaded, or resisted activities while allowing the movement and work to take place in the hips, legs, ankles, and upper extremities. This is accomplished through dynamic stabilization of the intrinsic and extrinsic trunk muscles (LPM) and utilization of other key muscle groups. The goal is to retrain dynamic movement that allows a fluid transfer of weight and force throughout the movement, not allowing the weight or force to become fixed in the lumbar spine. This requires the education and training of posture and movement as well as the facilitation of a responsive and strong lumbar protective mechanism and overall flexibility, strength, endurance, and coordination through exercise.

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References

1. Mayer T, Gatchel R, Kishino N, et al. Objective assessment of spine function following industrial injury. Spine 1985; 10:482–493.
2. Mayer T, Gatchel R, Mayer H, et al. A prospective two-year study of functional restoration in industrial low back injury. JAMA 1987; 258:1763–1767.
3. Saliba VL, Johnson, GS. Back education and training. course outline. San Anselmo, CA: The Institute of Physical Art. 1988.
4. Hultman G, Nordin M, Ortengren R. The influence of a preventive educational programme on trunk flexion in janitors. Applied Erg 1984; 15:127–133.
5. Johnson G, Saliba V. Soft tissue mobilization. In White AH, Anderson R. Conservative care of low back pain. Baltimore: Williams & Wilkins, 1991.
6. Waddell G. A new clinical model for the treatment of low-back pain. Spine 1987; 12:632–644.
7. Grieve GP. Common vertebral joint problems. London: Churchill Livingstone, 1981.
8. Kirkaldy-Willis, WH. Managing low back pain. 2nd ed. New York: Churchill Livingstone, 1988.
9. White AH, Rothman RH, Ray CD. Lumbar spine surgery: Techniques and complications. St. Louis: CV Mosby, 1987.
10. Jull GA. Examination of the lumbar spine. In: Grieve G, ed. Modern manual therapy of the vertebral column. London: Churchill Livingstone, 1986; 547–558.
11. Janda V. Muscle weakness and inhibition (pseudoparesis) in back pain syndromes. In: Grieve G, ed. Modern manual therapy of the vertebral column. London: Churchill Livingstone, 1986.
12. Lewit K. The contribution of clinical observation to neurological mechanisms in manipulative therapy. In Korr I, ed. The neurobiologic mechanisms in manipulative therapy. London: Plenum Press, 1978; 3–25.
13. Saal JA. Rehabilitation of sports-related lumbar spine injuries. Phys Med Rehab: State of the Art Reviews 1987; (4):613–638.
14. Biering-Sorensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine 1984; 9:106–119.
15. Cady L, Bischoff D, O'Connel E, et al. Strength and fitness and subsequent back injuries in firefighters. J Occup Med 1979; 21:269–272.
16. Liemohn W, Snodgrass L, Sharpe G. Unresolved controversies in back management—a review. J Orthop Sports Phys Ther 1988; 1:239–244.
17. Mayer T et al. Objective assessment of spine function following industrial injury. Spine 1985; 10:482–493.
18. Smidt G, Herring T, Amundsen L, et al. Assessment of abdominal and back extensor function—a quantitative approach and results for chronic low-back pain patients. Spine 1983; 8:211–219.
19. Thorstensson A, Nilsson J. Trunk muscle strength during constant and velocity movements. Scand J Rehab Med 1982; 14:61–68.
20. Smidt G. Trunk muscle strength and endurance in the context of low back pain. In Grieve G, ed. Modern manual therapy of the vertebral column. London: Churchill Livingstone. 1986.
21. Bergquist-Ullman M, Larsson U. Acute low back pain in industry. Acta Orthop Scand (Suppl) 1977; 170:1–117.
22. Kvien TK, Nilsen H, Vik P. Education and self-care of patients with low back pain. Scand J Rheumatol 1981; 19:318–320.
23. Linton S, Kamwendo K. Low back schools—a critical review. Phys Ther 1987; 67:1375–1383.
24. Matmiller AW. The California back school. Physiotherapy 1980; 66(4):118.
25. Moffett J, Chase S, Portek I, Ennis J. A controlled, prospective study to evaluate the effectiveness of a back school in the relief of chronic low back pain. Spine 1986; 11:120–123.
26. Simmons J, Dennis M, Rath D. The back school: a total back management program. Orthopedics 1984; 7:1453–1456.
27. Zachrisson-Forsell M. The Swedish back school. Physiotherapy 1980; 66(4):112.