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Back pain in the osteoporotic individual: A physiatric approach

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Back pain from osteoporosis is commonly related to compression fractures. The patient with vertebral compression fractures additionally suffers from an ongoing risk of recurrent fractures and postural abnormalities that can result in impaired respiratory function, leading to increased risk of morbidity. Weakened back muscles, especially the back extensor group, are felt to contribute significantly to this risk. The combination of pharmacologic and nonpharmacologic interventions, through physical activity, exercise, and modalities, are potential interventions that could be used to help reduce the pain of osteoporotic compression fractures as well as potentially reducing recurrent fracture rates.

Osteoporosis is a chronic, progressive metabolic bone disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk.[1] Close to 13%-18% of women and 3%-6% of men in the USA older than 50 years meet current diagnostic criteria for osteoporosis.[2,3]

The recognition of osteoporosis as an expensive major public health problem necessitates the use of medical interventions that would reduce bone loss, decrease vertebral compression fractures, and improve patients' quality of life.[4-7] Back pain from osteoporosis is commonly related to compression fractures of the vertebra.[8] The patient with vertebral compression fractures additionally suffers from an ongoing risk of recurrent fractures and postural abnormalities that can result in impaired respiratory function.[9] Weakened back muscles, especially the back extensor group, reportedly can contribute to both kyphotic posture,[10] as well as to increased risk of recurrent vertebral compression fractures in the osteoporotic individual.[11,12]

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Rehabilitative interventions that make a difference in the outcome of osteoporosis are gradually getting more recognition.[5,13] Several studies have reported positive correlations between general physical activity, structured exercise, and back strength or bone mineral density.[14-17] Several musculoskeletal challenges of osteoporosis can be addressed through rehabilitation, ie, immobility, kyphosis, balance disorders, gait disorders, and falls.[18-21]

In the prevention of osteoporosis, some of the pharmacologic interventions such as the use of estrogen are known to be helpful, but not without some considerable side effects such as increased risk of breast and uterine cancer. Bisphosphonates have been helpful in reducing bone loss and even improving bone mass. Vitamin D as well as supplemental calcium are frequently recommended for the prevention or treatment of osteoporosis. The full breadth of pharmacologic treatment of osteoporosis is beyond the scope of this article and can be found elsewhere.

Why rehabilitation?

The basic general principle of rehabilitation after fracture is to decrease pain and facilitate mobilization as quickly as possible after the fractured area is stabilized. One of the main objectives of postfracture rehabilitation is to eliminate pain-induced reflex inhibition. Spinal compression fracture and pain can produce an imbalance between the use of back extensors (the major trunk supportive muscles) and flexors.[22] The pain-induced inhibition results in overuse of spinal flexors that will further contribute to hyperkyphosis. Therefore, it is necessary to relieve pain through proper bracing of the spine and reduction of edema in the soft tissues surrounding the fractured area. Cryotherapy has been proven beneficial in the management of posttraumatic edema[23,24] and is commonly prescribed at the acute stage of vertebral fracture and is often used in conjunction or alternating with superficial heat, which has the added benefit of relaxing the muscles. Other rehabilitation interventions and modalities include gentle massage, biofeedback, yoga, injection therapies, and acupuncture.

The result of vertebral wedging and compression fracture is increased thoracic hyperkyphosis. Compression fractures occur most often at the midthoracic and thoracolumbar spine, followed by the lower thoracic and lower lumbar spine, and rarely in the upper thoracic spine.[7,25] To decrease painful contractions of the erector spinae muscles, one needs to decrease the load over the anterior aspect of the spinal column and vertebral bodies; this can be accomplished through the use of a weighted kypho-orthosis positioned below the inferior angles of the scapulae.[26,27] For the frail elderly, the back exercise program needs to be started in the seated position. Use of a weighted kypho-orthosis can facilitate back extension exercises in this position. Additionally, the use of the weighted kypho-orthosis is beneficial as kyphotic malposture can increase risk of more vertebral wedging and fractures, increase back pain and risk of fall, and reduce participation in physical activities due to fear of falls and back fatigue.[19] The risk of falls is a very real danger as kyphosis can contribute to disequilibrium. Receptors in muscles, tendons, joints, ligaments, and skin all play a role in proprioceptive input.[21,28] Therefore, joint position sense is fundamental to posture, balance, and locomotion. Post fracture pain-induced reflex inhibition and vertebral deformity can interfere with the kinematics of the spine and proper recruitment of paraspinal muscles for support of the spine. Therefore, muscle reeducation is important to improve synchronized muscle contraction during movement of functional units of the spine.

The mechanism by which exercise decreases pain is not totally understood. There is a complicated and delicate interplay that occurs between bone and muscle that is well suited for rehabilitation strategies. The main role of bone is to provide scaffolding for muscular attachments that allows for upright posture, locomotion, and protection. Both the skeletal and the muscular system are interdependent on each other and when there is a compromise in the character of 1 of these 2 component systems, the other will also be compromised. Reduction in the biomechanical competence of the axial skeleton can result from a combination of sarcopenia as well as osteoporosis. Age- and immobility-related involutional loss of functional muscle motor units affects type II fibers more prominently than type I.[29] This results in decreased muscle mass, power, and endurance as well as a decrease in the protective role of muscles in musculoskeletal health. These factors contribute to the postural deformities that occur with aging. Reduction of muscle strength becomes more challenging for women since they generally have lower muscle strength than men to begin with.[30] It is a well-accepted fact that muscle and bone loss occur with aging. The loss of axial muscle and the correlation with musculoskeletal changes, however, have not been adequately addressed in the literature. Therefore, further studies are needed to define the contribution of muscles to maintenance of musculoskeletal integrity.

Rehabilitation training includes evaluation for the performance of safe locomotion and activities of daily living, including transfers, lifting, ambulation, and balance. Evaluation for the risk of falls is an essential part of the rehabilitation specialist expertise and is of high priority during the rehabilitation phase since fragility and falls are a malignant combination that can have disastrous consequences.

Several studies[31-33] have demonstrated the positive effect of loading, weight-bearing, and resistance exercises on bone mass in healthy individuals; however, there is controversy in the literature regarding interpretation of data on the effects of exercise on bone. It has been shown that not all types of exercise are effective in the reduction of vertebral compression fracture. In a study of the effect of spinal flexion exercises vs spinal extension exercises, compression of vertebral bodies attributable to flexion of the spine resulted in 89% more vertebral fractures in those who performed flexion exercises.[34]

Wallace and Cumming[35] systematically reviewed and conducted meta-analysis of randomized controlled trial (RCTs) to determine the effect of exercise on bone mass in pre- and postmenopausal women. They searched MEDLINE from 1966 to 1997, finding 35 RCTs; 15 of the 35 involved the lumbar spine with an average of 1.6% bone loss prevented in 9 RCTs with impact exercise and 1.0% bone loss prevented in 6 RCTs with nonimpact exercise.

Shea et al[36] searched the Cochrane Library in MEDLINE and EMBASE from 1966 to 2003, to examine the effectiveness of exercise therapy in the prevention of bone loss and fractures in postmenopausal women. The result of the search was that aerobics, weight-bearing, and resistance exercises are all effective in increasing the bone mineral density (BMD) of the spine in postmenopausal women. In a previous study, we have demonstrated that "Rehabilitation of Osteoporosis Program—Exercise" (ROPE) and back-strengthening exercise could decrease risk of vertebral fractures and falls.[37]

Martyn-St James and Carroll evaluated 118 studies, looking at the effects of progressive, high-intensity resistance training on BMD in postmenopausal women.[38] They found a significant increase of BMD. Gregg et al[39] performed a prospective cohort study to determine whether higher levels of physical activity are related to lower inci-

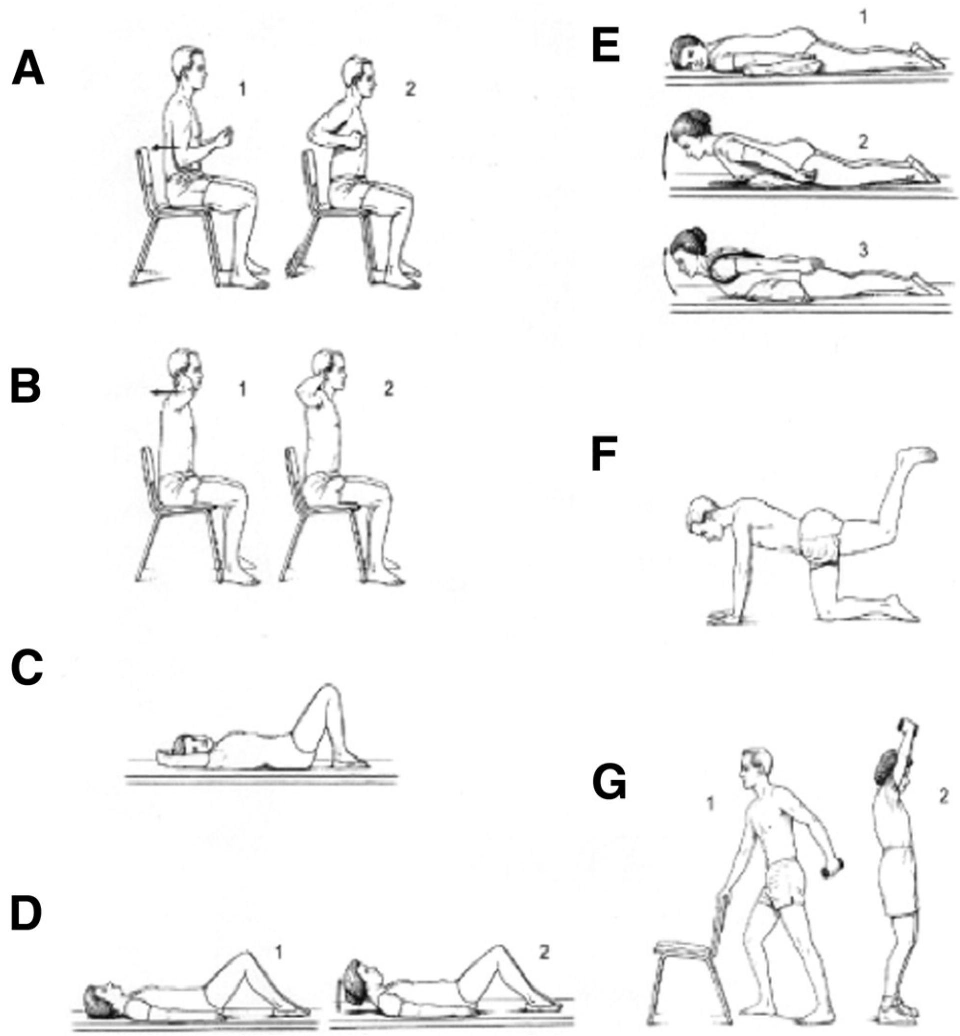

Figure 1 Nonstrenuous Exercises for Patient With Severe Osteoporosis. (A) Back extension exercise in sitting position. This position avoids or minimizes pain for patients with severe osteoporosis. (B) Deep-breathing exercise combined with pectoral stretching and back extension exercise. Patient sits on a chair, places hands at the level of the head, and inhales deeply while gently extending the elbows backward. While exhaling, patient returns arms to the starting position. This exercise is repeated 10 to 15 times. (C) Exercise to decrease lumbar lordosis with isometric contraction of lumbar flexors. (D) Technique of isometric exercise to strengthen abdominal muscles. (E) Extension exercises in prone position with pillow under abdomen (to avoid hyperextension). To increase the effect of back extension strengthening, weight is added (E3). (F) Exercise for improving strength in lumbar extensors and gluteus maximus muscles. (G) Specificity of exercises: muscle-strengthening and weight-loading exercises that may decrease bone loss. (These exercises were developed for the osteopenic spine by M.S. through a grant from the Retirement Research Foundation. These techniques are designed to decrease strain on the spine despite weight lifting.) G1, Shoulder extensors contribute to reduction of kyphotic posturing. They can be strengthened with a proper combination of weight lifting and weight-bearing exercises while balance is maintained. One knee is bent to avoid lumbar strain. To avoid straining the spine and to maintain balance, leaning or holding onto a steady object for support is recommended. Note: The amount of weight lifted is about 1 to 2 lbs, not to exceed 5 lbs. The amount of weight needs to be prescribed according to the patient's bone mineral density (status of osteoporosis) and the condition of the upper extremities. G2, Bilateral or unilateral spine and hip weight-loading exercise. When weight is lifted above the head, knees should be bent slightly to avoid straining the lumbar spine. Note: The amount of weight lifted is about 1 to 2 lbs in each hand, not to exceed 5 lbs in each hand. The amount of weight needs to be prescribed according to the patient's bone mineral density (status of osteoporosis) and the condition of the upper extremities. (A, B, F, and G adapted from Sinaki M. Metabolic bone disease. In: Sinaki M, editor. Basic clinical rehabilitation medicine. 2nd ed. St. Louis: Mosby; c1993. p. 209-36. C, D, E1, and E2 adapted from Sinaki M. Musculoskeletal rehabilitation. In: Riggs BL, Melton LJ 3rd, editors. Osteoporosis: etiology, diagnosis, and management. 2nd ed. Philadelphia: Lippincott-Raven Publishers; c1995. p. 435-73. E3 adapted from PTS: Posture Training Support [pamphlet]. Jackson [MI]: CAMP International; c1993. By permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

dence of hip, wrist, and vertebral fractures. The authors found that at greater activity levels there is a significant reduction of the relative risk of hip fracture after adjustment for age, dietary factors, falls at baseline, and functional and health status. They also found fewer incidences of vertebral fractures during the follow-up.

Sinaki et al[18] performed a randomized controlled trial with 65 postmenopausal, nonsmoking, healthy white women. Twenty-seven subjects performed progressive, resistive back-strengthening exercises for 2 years and 23 subjects served as controls. The authors measured bone mineral density, incidence of fracture in spine radiographs, back extensor strength, and level of physical activity for all subjects at baseline, 2 years, and 10 years. They found an incidence of 14 vertebral compression fractures in 322 vertebral bodies in the control group (C) and 6 fractures in 378 vertebral bodies examined in the back extensor group ($P = 0.0290$). The relative risk for compression fracture was 2.7 times greater in the C group than in the back extensor group. The authors concluded that strong back muscles have significant effect on the reduction of vertebral fractures in estrogen-deficient women and that the benefits from participation in a 2-year back exercise course continued even 8 years after cessation. Huntoon et al[40] reported a reduction in recurrent fractures in a group of osteoporotic patients who had undergone vertebroplasty in conjunction with a back extensor strengthening program.

The data in the literature support the theory that back extension exercise contributes to the strengthening of vertebral structures to prevent fracture.[41-44]

The rehabilitation program

Once referred to a physiatrist, a patient with osteoporosis-related back pain completes a thorough evaluation beginning with a complete medical history, comprehensive physical examination, as well as back radiographs to assess for the presence of vertebral compression fractures. If vertebral compression fractures are present, the initial radiographs provide a baseline for comparison to subsequent radiographs at follow-up visits; this helps to monitor for risk of further fractures for modification as needed to the comprehensive treatment program. In addition to the complete neuromuscular examination, the physiatric evaluation may focus on postural abnormalities, muscular weakness, and deconditioning, especially of the supportive muscles of the spine. The examination is tailored to the individual patient to account for the fragility and biomechanical competence of the spine before initiation of proper back exercise program in this group. Other laboratory tests such as BMD and blood tests are also arranged on the basis of initial clinical findings and diagnostic work-up.

Before prescribing a rehabilitation program, one needs to consider the patient's physical, functional, psychological, and social status and limitations. There must be an understanding of the general principles of therapeutic exercise defined in the "Osteoporosis Rehabilitation Guidelines,"[45] which have been developed on the basis of earlier evidence-based studies and literature. One exercise strategy that is actively used at our (MS) institution is the ROPE program. ROPE includes management of back pain using weighted kypho-orthosis, isometric back extension exercise in sitting or prone position, and postural retraining. Figure 1 illustrates the ROPE back extensor exercises.

Analgesics are sometimes needed during rehabilitation, but caution must be used when providing non-steroidal anti-inflammatory agents or opioids due to the high number of comorbidities that are often found in this population. Topical preparations may prove to be safer and more efficacious but, as each patient is assessed individually, their unique set of circumstances is considered when determining the appropriate analgesic regimen during the program. Early rehab intervention for pain management could assist in pain relief, thereby decreasing the need for oral analgesics as well as helping to prevent development of chronic pain syndromes. Behavioral modification techniques can also be used with consideration that the benefit of pain relief should not outweigh the risk of side effects such as disorientation or oversedation, which may result in falls. If pain persists after vertebral fractures despite conservative management, kyphoplasty or vertebroplasty may be beneficial. These interventions, when followed by the ROPE program, may improve the successful outcome by decreasing the risk of additional vertebral fractures.[40]

Conclusions

Early intervention for pain management could prevent the development of chronic pain syndromes and is the basic concept in rehabilitation of post vertebral fractures. Musculoskeletal rehabilitation and nonpharmacologic interventions consist of exercise, physical management of pain, orthotics, and gait training. Exercise stimulates an increase in bone diameter, which improves the strength of the tissue, thereby decreasing the risk of painful fractures. While many of the studies found in today's literature suggest high-intensity, resistance exercises are needed to produce the greatest effects, newer studies have found that low intensity and isometric exercises have beneficial effects on bone mass, reduced fracture rates, and improved pain relief. Rehabilitation programs that include these principles should be considered for osteoporotic individuals with or without vertebral compression fractures.

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