Treatment of vertebral fractures due to osteoporosis

Role of Posture Training Support (PTS) and Spinal Proprioceptive Extension Exercise Dynamic (SPEED) program

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Keywords
Osteoporosis, back extension exercise, rehabilitation, Spinal Proprioceptive Extension Exercise Dynamic (SPEED) program, Posture Training Support (PTS)

Summary
The objective of exercise in the treatment of osteoporosis is to improve axial stability through strengthening of back extensor muscles. Therefore, a back extension exercise program specific to one’s musculoskeletal competence and pain can be performed in a sitting position and later advanced to the prone position. When fragility is resolved, back extension is performed against resistance applied to the upper back. A significant reduction in back pain, kyphosis, and risk of falls and an improvement in the level of physical activity have been achieved through the SPEED (Spinal Proprioceptive Extension Exercise Dynamic) program. In addition, the application of a “Posture Training Support” (PTS) using a backpack may decrease kyphosis and pain related not only to compression fractures but also reduce iliocostal friction.

Therapeutic exercise should address osteoporosis-related deformities of axial posture, which can increase risk of fall and fracture. Thus, the role of a therapeutic exercise program is to increase muscle strength safely, decrease immobility-related complications, and prevent fall and fracture. As with pharmacotherapy, therapeutic exercises are individualized.

Schlüsselwörter
Osteoporose, Training der Rückenmuskulatur, Rehabilitation, SPEED-Programm, Posture Training Support (PTS)

Zusammenfassung
Das Ziel der medizinischen Trainingstherapie bei Osteoporose besteht darin, die Rückenmuskulatur zur Verbesserung der aufrechten Körperhaltung zu kräftigen. Deshalb sollte ein spezifisches Trainingsprogramm entsprechend den individuellen Fähigkeiten des Patienten individuell dosiert werden.

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Therapie vertebraler osteoporosebedingter Frakturen

Die Bedeutung des Posture Training Supports (PTS) und des Spinal Proprioceptive Extension Exercise Dynamic (SPEED)-Programms

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Bone, to be maintained, needs to be mechanically strained – within its biochemical limits (1). Pharmacotherapy alone is not sufficient for the comprehensive management of osteoporosis. In 1982, investigators took the first critical look at the benefits and shortcomings of back exercise programs affecting the spine with osteoporosis (1). Since then, through myriad publications, it has been well documented that exercises and their execution techniques have a significant role in the treatment of osteoporosis (2). In addition, reports have shown that participation in a therapeutic spinal flexion exercise (3) and recreational physical activities that induce strain during flexion beyond biochemical competence of

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the vertebral bodies can result in fracture (4).

As with pharmacotherapy, osteogenic exercises and rehabilitation measures need to be individualized. In general, for osteogenicity, loading exercises are preferable to endurance exercises. Strengthening of the axial muscle group can improve the mobility of older individuals and decrease both kyphosis and the risk of vertebral fractures. Studies have shown that even when exercise and rehabilitative measures do not increase bone mass, they still can be beneficial for reducing the occurrence of vertebral fractures (5), improving disequilibrium, and decreasing the risk of falls (6) and subsequent appendicular fractures. In addition to helping with musculoskeletal health, exercise has other benefits that affect quality of life. Some of the well-known benefits of exercise are improved cardiovascular health, decreased body weight, and improvement in diabetes mellitus, hyperlipidemia, depression, and stress management.

Axial deformities

Kyphosis commonly occurs with reduced back muscle strength or vertebral bone loss or fracture, or both. Hyperkyphosis results in back pain, decreased physical activity, increased risk of further vertebral fractures, and postural instability (7).

Posture in osteoporotic patients is classified into five types: normal, round back, hollow round back, lower acute kyphosis, and whole kyphosis (8). Round back is a posture with increased thoracic kyphosis and normal lumbar lordosis; hollow round back has increased thoracic kyphosis and increased lumbar lordosis; lower acute kyphosis has thoracic lordosis and lumbar kyphosis; and whole kyphosis has kyphosis of the entire spine.

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Recommended Interventions

The effectiveness of conventional back extension exercise and physical therapy in
ostoporosis was first reported in 1982 (1). Later, in 1986, the progressive, resistive back extension exercise was performed using a backpack containing weight equivalent to 30% of the individual’s maximum back extensor strength (Fig. 1). The results of this study showed significant improvement in back extensor strength in healthy and osteopenic women without significant increase in bone mass. The exercise regimen in this study also proved to be effective in improving kyphotic posture in healthy postmenopausal women (15). After eight years of cessation of the exercise, the back extensor strength was still significantly greater in the previously exercised group than in the control group; this 2-year exercise was shown to decrease the relative risk of vertebral fractures by 63% (Fig. 2) (16).

In cases of osteopenia, back extension from a prone position with application of weight as tolerated with a backpack is recommended. Low-intensity back strengthening exercise is recommended. Low-intensity back strengthening exercise without a backpack was prescribed in women with osteoporosis and proved to be effective in increasing back extensor strength and improving quality of life (17).

The quantitative evaluation of the efficacy of conventional back extension exercise in increasing back extensor strength in women with back pain was first reported in 1989 (18). Rehabilitation of osteoporosis is a comprehensive program that includes strengthening of back extensors and upper and lower extremities without overstretching the ligamentous and capsular structures of the engaging joints.

**Back extension exercise**

The spine in osteoporosis requires exercises that can increase axial stability without causing vertebral wedging or fracture. Therefore, exercise programs that can induce axial deformities without resulting in vertebral fractures are highly desirable. Frost’s theory of minimal effective stress stimulus indicates the need for loading the spine to induce bone formation (19). Therefore, weight lifting that does not result in compression fracture is recommended.

The osteoporotic spine does not tolerate compressive forces beyond its biochemical competence. To accomplish loading of the spine, the exercise program – as with pharmacotherapy – needs to be prescribed on an individual basis. Past experience proves that trabecular structures do not need to be stimulated vertically when the person already has a predisposition to kyphosis and uneven distribution of forces on vertebral bodies. This objective can be achieved with non-loading back extension exercises (5). It is hypothesized that these exercises may not initially increase bone mass significantly, but trough both strengthening the back extensor muscles and loading the horizontal trabeculae of the spine, further vertebral fracture can be prevented (20, 21).

Back extension exercises are prescribed according to the status of the individual’s musculoskeletal health. Back extension exercise for the fragile spine can be initiated in the sitting position and later advanced to back extension in the prone position (1, 3). Specific exercises are recommended for the spine with osteopenia, osteoporosis, and severe osteoporosis. Back extension in a sitting position is safe for new vertebral compression fracture; however, the implementation needs some innovative interventions (Fig. 2).

**Falls**

Osteoporosis and reduction of muscle strength cause an imbalance in musculoskeletal stability. Increased bone porosity decreases the biomechanical competence of bone. Trauma to the skeletal structure can vary from gravity alone to the high impact of a moving, energized body part to the floor. The point of no return from frac-
Final considerations

In the selection of the most effective exercise program, bone mineral density (BMD) of the spine and hip needs to be considered. In general, osteopenia indicates that an exercise program can be more strenuous than with osteoporosis, given the musculoskeletal issues. The presence of vertebral fractures together with low BMD indicates severe osteoporosis that requires a more selective choice of exercise. This implicates for the spine a careful start with extension exercises in a sitting position and a gradually progression. Mechanical loading and muscle contraction promote bone formation. Non weight bearing exercises, such as swimming, can improve muscle strength, cardiovascular fitness, and coordination, but they are not bone-loading exercises. Spinal orthoses and "Posture Training Support" (PTS) can improve kyphosis, back strength, and, subsequently, quality of life. Implementation of the Spinal Proprioceptive Extension Exercise Dynamic (SPEED) program can improve disequilibrium, kyphosis, back strength, and level of physical activity and decrease risk of falls, but it needs to be continued on an as-needed basis (Fig. 3, Fig. 4).

Conflict of interest

The authors declare that there is no conflict of interest.

References