REVIEW

Diagnosis and Management of Vertebral Fractures in Elderly Adults

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We reviewed the epidemiology, diagnosis, and treatment of vertebral fractures due to osteoporosis in the elderly. Vertebral fractures are underdiagnosed despite their high prevalence in both men and women. Clinical consequences of vertebral fractures include increased risk of future vertebral and hip fracture, acute and chronic back pain, decreased quality of life, and increased mortality. Patients with vertebral fractures have functional impairment and increased mortality similar to those with hip fractures. Asymptomatic fractures identified on radiograph also affect quality of life and mortality. A vertebral fracture is a clinical marker for a subsequent fracture and should trigger assessment and diagnosis of osteoporosis. The care of patients with vertebral fractures includes pain management, rehabilitation, and prevention of further fractures. There is evidence from randomized controlled trials that pharmacologic therapy can reduce the risk of future fractures by 40% to 50%. Vertebroplasty may be effective in the control of pain and in obtaining stability of the spine. **Am J Med. 2002;113:220–228.** ©2002 by Excerpta Medica, Inc.

The estimated lifetime risk of developing a spine, hip, or wrist fracture after age 50 years is 40% in women and 13% in men, and vertebral (spine) fractures are the most common type of osteoporotic fracture (1–3). These fractures are an underappreciated cause of morbidity and mortality in the elderly (4–6). Perhaps most important, patients with vertebral fractures have demonstrated the greatest benefit in terms of reduction in the risk of future vertebral and hip fracture from pharmacologic therapies (7–10). This article reviews the evidence concerning the epidemiology, diagnosis, and treatment of vertebral fractures due to osteoporosis in the elderly.

EPIDEMIOLOGY

Only about 30% of vertebral fractures are diagnosed in clinical practice (11), because the diagnosis depends on a patient reporting back pain of sufficient severity to trigger obtaining a radiograph (12,13). The prevalence of radiographically identified vertebral deformities rises from 5% between ages 50 to 54 years to 50% at age 80 to 84 years (14). The prevalence of vertebral deformity is similar in men and women, at least in Europe, and varies between 12% and 20% depending on the diagnostic method used (15). In Canada, the prevalence of vertebral deformity was 21.5% in men and 23.5% in women (16). Many investigators believe that the relatively high prevalence in men is due to traumatic fractures.

Few studies have assessed the prevalence and incidence of vertebral fractures in non-white ethnic groups (17). The estimated prevalence of vertebral fractures in Hispanic American or Japanese American women is approximately one half that of white women (18), and it is even lower in African Americans (19–23).

CLINICAL CONSEQUENCES OF VERTEBRAL FRACTURES

Vertebral fractures typically occur at the thoracolumbar junction (T12-L1) and in the midthoracic area (T7-T8) (13), and have both acute and chronic sequelae (Table 1). In older women, the functional impairment due to vertebral fractures is similar to that seen following hip fracture, and includes difficulty with bending, lifting, descending stairs, and cooking (24). In a prospective study of men and women, overall function declined at similar rates among patients with vertebral fractures as among those with hip fractures (25). Fear of falling and of experiencing

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Table 1. Clinical Consequences of Vertebral Fracture*

Symptoms	Signs	Function	Future Risks
Back pain (acute, chronic)	Height loss	Impaired activities in daily living (e.g., bathing, dressing)	Increased risk of future fracture
Sleep disturbance	Kyphosis	Difficulty fitting clothes due to kyphosis, protuberant abdomen	Increased mortality
Anxiety	Decreased lumbar lordosis	Difficulty bending, lifting, descending stairs, cooking	
Depression	Protuberant abdomen		
Decreased self-esteem	Reduced lung function		
Fear of future fracture and falling	Weight loss		
Reduced quality of life			
Early satiety			

* From references 12,24–30.

further fractures are the primary concerns of women with a vertebral fracture (26). Approximately 75% of those who present with a clinical vertebral fracture will have chronic pain (27,28). Pulmonary function is decreased in those with vertebral fractures and is correlated with clinical and radiological measures of severity of fractures (29,30).

Women with clinical vertebral fractures have an increased number of days spent in bed, limited activity days, and hospital days compared with those without a fracture. To a lesser degree, these associations are also found among women with radiographic vertebral deformities (31). Between 2% and 10% of all patients with vertebral fractures require hospitalization (11,32,33). In 1996, there were approximately 120,000 hospital admissions in the United States for management of vertebral fractures, with total costs of almost $1.5 billion (34). Among elderly patients admitted for other medical problems, vertebral fractures added 2.1 days to their length of hospitalization stay (35).

Vertebral fractures are predictive of other vertebral and hip fractures (36,37). For example, prevalent vertebral deformities are associated with a 2.8-fold increase in the risk of hip fracture and a fivefold increase in the risk of another vertebral fracture within 3 years. The 1-year risk of a second vertebral fracture after a first documented fracture is almost 20% (38).

Both clinical and radiographic vertebral fractures are associated with increased mortality (39–45). In one study, vertebral fractures were associated with a 16% reduction in expected 5-year survival, similar to the 18% decrease in survival following hip fracture (42). A prospective study found that women with clinical vertebral fractures had an 8.6-fold increased 4-year mortality, compared with a 6.7-fold increase among those with hip fractures (41). The underlying mechanisms associated with increased mortality are not understood clearly; studies have shown that patients with radiographic vertebral fractures have increased mortality due to pulmonary disease, malignancy, and cardiovascular disease (39,42,46).

DIAGNOSIS

Typically, there is no history of trauma before a vertebral fracture (12). Clinical vertebral fractures present with back pain at the level of the fracture, which may radiate in a radicular fashion. Height loss (>2 cm to 4 cm since age 25 years) can help to identify women with vertebral fractures (47). Finally, radiographic vertebral deformities may be detected on radiographs ordered for other purposes.

Kyphosis is an important indicator of vertebral compressions in the elderly. Loss of more than 4 cm in height is associated with 15 degrees of kyphosis. Unfortunately, there is no simple clinical tool to measure kyphosis, and measures of height are subject to error due to measurement technique and variability in posture (48,49). Clinical measures of kyphosis include the distance from a patient's occiput to the wall (normally 0 cm). It may be helpful to evaluate the size of the gap between the costal margin and the iliac crest, which is normally three finger breadths (50). These measures may draw attention to features of advanced vertebral osteoporosis, such as cervical hyperextension and abdominal protuberance.

Table 2. Laboratory Investigations of Patients with Vertebral Fractures*

Initial tests should include:
Complete blood count
Serum calcium
Serum alkaline phosphatase
Serum creatinine
Urinary calcium excretion
If clinically indicated, further testing should be considered, such as:
Serum 25-hydroxyvitamin D
Serum parathyroid hormone
Serum protein electrophoresis
Sex steroids (e.g., bioavailable testosterone and gonadotropins in men)
Serum aminotransferase levels
Serum thyroid-stimulating hormone level

* From references 51–53.

The differential diagnosis of back pain and deformity needs to be considered. In all patients with vertebral fracture, the clinician should consider secondary causes of osteoporosis and metabolic bone disease such as osteomalacia, multiple myeloma, hyperthyroidism, hyperparathyroidism, and renal failure (Table 2) (51–53).

Radiographs should always be obtained for the diagnosis of a clinical vertebral fracture and so that facet erosion and other features of pathologic fracture can be seen. Three types of vertebral deformities are often described: anterior wedge, biconcave, and crush deformities (17). Occasionally, an initial radiograph may not demonstrate a fracture, but a bone scan may be positive in the first few months after a fracture (12). Radiologists may not report vertebral fractures when chest radiographs are ordered for other medical conditions (54). Magnetic resonance imaging (MRI) may be useful to determine if there are local pathologic changes in a fractured vertebra and to look for evidence of marrow edema, a sign that a fracture is recent (55).

Bone Mineral Density

Bone mineral density measured at the lumbar spine in those over 70 years of age may be falsely elevated due to discogenic sclerosis, aortic calcification, or apophyseal arthropathy (56). The National Osteoporosis Foundation recommends that all women aged 65 years or older, regardless of additional risk factors, have a bone mineral density measurement (2). Even among frail elderly residents of nursing homes, a low bone mineral density is an independent predictor of fractures (57).

Quantitative ultrasound can be used to assess fracture risk, but not for the diagnosis of osteoporosis or to monitor treatment (58). Limitations to the use of ultrasound in clinical practice include the lack of a gold standard for calibration and variability in technician training.

Management of Vertebral Fractures

The care of patients with vertebral fractures includes pain management, rehabilitation, and prevention of further fractures. Acute pain due to vertebral fractures may last 12 weeks or longer. Chronic pain may be due to vertebral deformity, paraspinal muscle spasm, degenerative arthritis in the region of the fracture, or changes in spinal alignment (59).

Physical modalities for pain relief. Heat, cold, ultrasound, transcutaneous electrical stimulation, and massage therapy have been studied for the treatment of chronic back pain, but not osteoporosis (60–63). With progressive kyphosis, a patient's center of gravity shifts, which can affect gait. Walking aids may add stability, prevent falls, and relieve some of the chronic back pain caused by paravertebral muscle spasm (59). A systematic review found limited evidence that lumbar supports were more effective than no treatment among patients with low back pain (64), but the efficacy among patients with vertebral fractures is not known. If used chronically, braces may lead to weakness of paravertebral muscles and increased back pain (59).

Exercise programs for elderly patients after a vertebral fracture have demonstrated decreased use of analgesics, improved quality of life, and increased bone mineral density (65,66). A meta-analysis found that exercise programs prevented or reversed about 1% of bone loss per year in both the spine and hip in older women (65). One randomized controlled trial in elderly women with vertebral fractures found that a 10-week exercise program, consisting of balance and muscle strength with stabilization of the lumbar spine, reduced use of analgesics and pain level (66). Because patients with vertebral fractures have an increased risk of subsequent hip fractures, general measures, such as walking for exercise, fall-reduction programs, and even Tai Chi, may be beneficial (67–69).

Pharmacologic therapy for pain relief. Generally, analgesic needs can be met with therapeutic doses of acetaminophen (2.4 g/d). Breakthrough pain can be managed with codeine 30 to 60 mg every 6 hours (70,71). Frail older persons are particularly vulnerable to delirium and constipation with narcotic analgesics. Nonsteroidal antiinflammatory drugs may be useful, but care must be taken to avoid renal and gastric adverse events. One meta-analysis found that these drugs are effective for short-term symptomatic relief in patients with acute low back pain of all causes (72).

Calcitonin, by subcutaneous or intranasal administration, may be beneficial in reducing pain from acute vertebral fractures. Several relatively short-term (2 to 16 weeks) randomized trials have demonstrated that calcitonin has a rapid analgesic effect (73–76). It is recommended that a calcitonin dose of 50 to 100 IU be given subcutaneously, or 200 IU intranasally, for pain due to vertebral fractures (76,77); treatment should be repeated daily. Intercostal nerve blocks may improve pain management in patients with vertebral fractures (78).

Vertebroplasty or kyphoplasty. Much of the residual chronic pain after vertebral fracture may be due to the altered spinal configuration in patients with kyphosis. This has led to the development of treatments to reduce the anatomical defects. Percutaneous kyphoplasty involves inflation of a bone tamp within the vertebral body and re-expanding fractured vertebra before injection of bone cement (55), whereas percutaneous vertebroplasty involves injection of an acrylic polymer into a partially collapsed vertebral body (79). The best candidates for these procedures appear to be those who have focal, intense, deep pain, with evidence of a new or progressive vertebral compression fracture by conventional radiography and MRI (55,80). These procedures have been associated with pain relief in 67% to 100% of patients

(55,79,80), but there have not been any controlled studies.

Short-term complications of these procedures include increased pain and damage from heat or pressure to the spinal cord or nerve roots. Long-term complications have not been evaluated fully but may include local acceleration of bone resorption and increased risk of fracture in adjacent vertebrae. Controlled trials are needed to determine safety and efficacy of these procedures (55).

STRATEGIES FOR THE PREVENTION OF FUTURE VERTEBRAL FRACTURES

Calcium and vitamin D insufficiency and deficiency are frequent in the elderly due to reduced intake of these nutrients, as well as impaired enteral absorption of calcium and reduced cutaneous synthesis of vitamin D. The prevalence of vitamin D deficiency is high in the institutionalized and community-living elderly, ranging from 5% to 18% (81–83). Some patients develop secondary hyperparathyroidism.

Vitamin D supplementation has had inconsistent effects on fracture reduction (84), but the combination of calcium and vitamin D supplementation has had beneficial effects. In a 3-year randomized trial in community-living persons with a mean age of 71 years, those treated with calcium and vitamin D had a 54% reduction in nonvertebral fractures compared with placebo (85). In another study among women in nursing homes or apartments for the elderly, treatment with calcium and vitamin D_3 led to 32% fewer nonvertebral fractures and 43% fewer hip fractures (86). Reductions in vertebral fractures, however, were not demonstrated in these studies.

Several drugs are effective in reducing vertebral fractures in patients who have experienced a vertebral fracture (Table 3) (7–10,87–89). However, there have been few trials in elderly men, and most subjects were white and younger than 80 to 85 years. Antiresorptive therapies include bisphosphonates, hormone replacement therapy, selective estrogen receptor modulators, and calcitonin. Randomized trials have shown that bisphosphonates reduce the risk of vertebral and nonvertebral fractures, including hip fractures (7–9,88,90), whereas selective estrogen receptor modulators (raloxifene) and perhaps calcitonin have only shown beneficial effects on vertebral fractures (10,87). Bisphosphonates, which include etidronate, alendronate, and risedronate, must be dosed apart from food to ensure adequate absorption. This may require supervision in patients with cognitive impairment. Nitrogen-containing bisphosphonates (e.g., alendronate and risedronate) must be administered with caution in patients with upper gastrointestinal symptoms and renal insufficiency. Etidronate has been approved for osteoporosis treatment in many countries but not in the United States. Calcitonin, administered by nasal spray, may be an option in older adults, particularly those with painful vertebral fractures, limited mobility, or gastrointestinal tolerance, or who are taking several medications. Calcitonin may also be useful in patients with swallowing difficulties due to stroke or Parkinson's disease (77). Raloxifene, which has modest effects on bone mineral density, has been shown to reduce vertebral fracture in patients with or without previous vertebral fracture (10). The risk of venous thromboembolism with raloxifene is similar to that with estrogen therapy. The effect of raloxifene on serum lipid levels is favorable, and perhaps in contrast with estrogen, there has been no increased cardiovascular risk in women with or without coronary artery disease (91).

Estrogen has beneficial effects on bone mineral density, but its effects on vertebral fractures are uncertain (92,93). A meta-analysis showed a 27% reduction in nonvertebral fractures (relative risk = 0.73; 95% confidence interval [CI]: 0.56 to 0.94) with hormone replacement therapy. This effect was greater among women younger than 60 years (92). Another meta-analysis found that hormone replacement therapy led to a 33% reduction in vertebral fractures (95% CI: 45% to 98%), especially among those with established osteoporosis (94).

Parathyroid hormone is an anabolic agent that may be effective in decreasing the risk of vertebral and nonvertebral fractures in postmenopausal women. The drug is administered daily by subcutaneous injection. In a recent trial, new or worsening back pain was reported more frequently ($P < 0.05$) among women in the placebo group, consistent with the radiographic findings (89).

In general, reduction in the risk of fractures is rapid, occurring within the first year of treatment with antiresorptive agents (8,9), which may be important in symptomatic elderly patients. Indeed, several trials have demonstrated substantial benefits in reducing the risk of two or more new vertebral fractures (8,9), which may reduce pain and disability in frail older adults.

CONCLUSION

Vertebral fractures in the elderly are associated with morbidity, reduced quality of life, and increased mortality. A vertebral fracture is a clinical marker for subsequent vertebral and hip fractures. A clinical or radiographic vertebral fracture should result in assessment for, and treatment of, osteoporosis (2). Practical recommendations for identifying people with vertebral fractures include assessment of height loss, inquiring about back pain, and examining patients for spinal deformity. These clinical findings can provide clues that vertebral fractures are present, which should be confirmed with a spine imaging study. The patient and clinician should select the most

Table 3. Randomized Controlled Trials in Subjects with Baseline Vertebral Fractures

Author (Year), Study	Study Sample	Intervention (Duration)	Results Relative Risk (95% Confidence Interval)	Reference
Black (2000), FIT, vertebral fracture arm	2027 Postmenopausal women (mean age, 71 years) with femoral neck bone mineral density ≥2 SD below young adult mean and at least one vertebral fracture at baseline	Alendronate (5-mg dose was increased to 10 mg/d* at second annual visit) (3 years)	Radiologic vertebral fracture: 0.53 (0.41–0.68) Clinical vertebral fracture: 0.46 (0.28–0.75) Multiple vertebral fractures: 0.10 (0.05–0.22) Nonvertebral fracture: 0.68 (0.49–0.92) Hip fracture: 0.49 (0.23–0.99)	(8)
Chestnut (2000), PROOF	1255 Postmenopausal women (mean age, 68 years) with lumbar spine bone mineral density ≥2 SD below mean and at least one but no more than five vertebral fractures	100 IU, 200 IU*, or 400 IU nasal calcitonin (5 years)	≥1 New vertebral fracture: (100 IU) 0.85 (0.60–1.21) (200 IU) 0.67 (0.47–0.97) (400 IU) 0.84 (0.59–1.18) Nonvertebral fractures: (100 IU) 0.64 (0.41–0.99) (200 IU) 0.88 (0.59–1.32) (400 IU) 0.81 (0.53–1.23) Hip or femoral fractures: (100 IU) 0.1 (0.01–0.9) (200 IU) 0.5 (0.2–1.6) (400 IU) 0.8 (0.3–2.0)	(87)
Ettinger (1999), MORE	2304 Postmenopausal women (mean age, 68 years) with femoral neck or lumbar spine bone mineral density ≥2.5 SD below young adult mean	60 mg/d* or 120 mg/d raloxifene (3 years)	≥1 Vertebral fracture: (60 mg) 0.7 (0.6–0.9) (120 mg) 0.5 (0.4–0.7) Nonvertebral fracture: (60 and 120 mg - pooled) 0.9 (0.8–1.1) Hip fracture: 1.1 (0.6–1.9)	(10)
Harris (1993)	423 Postmenopausal women (<75 years) with one to four vertebral fractures	400 mg/d* (etidronate for 14 days, plus 500 mg/d calcium for 74 days) (3 years)	New vertebral fractures: No etidronate = 11.7 per 100 patient-years Etidronate = 8.6 per 100 patient-years ($P > 0.05$)	(88)
Harris (1999), VERT North American study	2458 Women (mean age, 69 years) with two or more radiographic vertebral fractures or one vertebral fracture and lumbar spine bone mineral density >2 SD below young adult mean	2.5 mg/d or 5 mg/d* risedronate (2.5-mg dose discontinued after 1 year) (3 years)	New vertebral fracture: (Year 0–1) (2.5 mg) 0.54 (0.32–0.91) (5 mg) 0.35 (0.19–0.62) (Year 0–3) (5 mg) 0.59 (0.43–0.82) Nonvertebral fracture: (5 mg) 0.6 (0.39–0.94)	(9)
Neer (2001)	1637 Postmenopausal (≥5 years) women (mean age, 69 years) who met criteria: -At least one moderate or two mild vertebral fractures on radiograph -For those with fewer than two moderate fractures, lumbar spine or hip bone mineral density >1 SD below mean	20 μg and 40 μg* of parathyroid hormone (median follow-up, 19 months)	≥1 Vertebral fracture: (20 μg) 0.35 (0.22–0.55) (40 μg) 0.31 (0.19–0.50) ≥2 Vertebral fractures: (20 μg) 0.23 (0.09–0.60) (40 μg) 0.14 (0.04–0.47) Nonvertebral fractures: (20 + 40 μg combined) 0.46 (0.25–0.86)	(89)
Reginster (2000), VERT Multinational Study	1226 Postmenopausal (≥5 years) women (<85 years) (mean age, 71 years) who met criteria: -At least two radiographic confirmed vertebral fractures	2.5–5 mg/d risedronate (3 years)	New vertebral fractures: (Year 0–1) (2.5 mg) 0.50 (0.30–0.84) (5 mg) 0.39 (0.22–0.68) (Year 0–3) (5 mg) 0.51 (0.36–0.73) Nonvertebral fractures: (5 mg) 0.67 (0.44–1.04)	(7)

* Approved dose for treatment of osteoporosis.

FIT = Fracture Intervention Trial; MORE = Multiple Outcomes of Raloxifene Evaluation; PROOF = Prevent Recurrence of Osteoporotic Fractures; VERT = Vertebral Efficacy with Risedronate Therapy.

appropriate therapy based on the best available evidence, personal preferences, and cost. There are a number of consensus and evidence-based practice guidelines (Appendix) that can be used to guide decision making (2,51–53).

Reduction in the risk of fractures can occur as early as after 6 months of treatment (7). The number needed to treat in clinical trials that have enrolled elderly women with vertebral fractures has ranged between 10 and 22 (7–10).

However, clinicians may face barriers to treating osteoporosis in the elderly, including other medical problems, polypharmacy, and the cost of medication. In addition, cognitive impairment or early dementia may influence the choice of medications. Some patients and caregivers may perceive that it may be too late to focus on prevention of fractures. However, the benefits of preventing pain and disability, and perhaps functional decline, should be considered.

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APPENDIX. ORGANIZATIONS WITH HELPFUL INFORMATION ON OSTEOPOROSIS

American Academy of Orthopedic Surgeons
6300 North River Road
Rosemont, Illinois 60018-4262
Telephone: (847) 823-7186; (800) 346-AAOS
Internet: http://orthoinfo.aaos.org/

American College of Obstetricians and Gynecologists Resource Center
409 12th Street S.W.
P.O. Box 96920
Washington, D.C. 20090-6920
Telephone: (202) 863-2518
E-mail: resources@acog.org
Internet: http://www.acog.com

American Association of Clinical Endocrinologists
1000 Riverside Avenue, Suite 205
Jacksonville, Florida 32204
Telephone: (904) 353-7878
Internet: http://www.aace.com

Endocrine Society
4350 East West Highway Suite 500
Bethesda, Maryland 20814-4410
Telephone: (301) 941-0200
Internet: http://www.endo-society.org/pubaffai/factshee/osteo.htm

International Osteoporosis Foundation
Cholibergerg 17
4114 Hofstetten
Switzerland
Telephone: +41 61 731 1482
E-mail: info@osteofound.org
Internet: http://www.osteofound.org/what/index.html

National Institute on Aging
Public Information Office
Building 31, Room 5C27
31 Center Drive MSC 2292
Bethesda, Maryland 20892-2292
Telephone: (301) 496-1752
Internet: http://www.nih.gov/nia/health/agepages/osteo.html

National Institutes of Health Osteoporosis and Related Bone Diseases (National Resource Center)
1232 22nd Street N.W.
Washington, D.C. 20037-1292
Telephone: (202) 223-0344; (800) 624-BONE
E-mail: orbdnrc@nof.org
Internet: http://www.osteo.org/health/htm

National Osteoporosis Foundation
1232 22nd Street N.W.
Washington, D.C. 20037-1292
Telephone: (202) 223-2226
Internet: http://www.nof.org

North American Menopause Society
P.O. Box 94527
Cleveland, Ohio 44101-4527
Telephone: (440) 442-7550
Internet: http://menopause.org/consedu/index.html

Osteoporosis Society of Canada
Resource Centre
33 Laird Drive
Toronto, Ontario M4G 3S9
Canada
Telephone: (800) 463-6842
Internet: http://www.osteoporosis.ca

Society Obstetricians and Gynaecologists of Canada
780 Echo Drive
Ottawa, Ontario K1S 5N8
Canada
Telephone: (613) 730-4192
Internet (public education): http://sogc.medical.org/SOGCnet/sogc_docs/common/pub_ed/index_e.shtml