

## Prevention, Diagnosis, and Management of Osteoporosis-Related Fracture: A Multifactorial Osteopathic Approach

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In the United States, approximately 30 million women and 10 million men aged 50 years or older have osteoporosis, low bone mineral density, or both, placing them at risk for disabling fractures. Despite the high prevalence and serious medical consequences of osteoporosis, many at-risk patients are inadequately screened and diagnosed before symptomatic fractures occur. Osteopathic physicians are in a unique position to promote a multifactorial approach to patient evaluation, disease prevention, and treatment. The author evaluates aspects of such an approach through a review of the literature. A number of screening tools based on easily assessed factors are available to identify at-risk patients. Interventions for fracture reduction should include nonpharmacologic strategies such as risk factor modification, nutrition guidance and dietary supplementation, physical exercise, and osteopathic manipulative treatment. Pharmacologic intervention should be considered for patients with low bone mineral density as well as those who have sustained vertebral or hip fracture. A holistic multifactorial assessment and intervention strategy are recommended to reduce substantially the risk of fracture and to improve long-term patient outcomes.

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Nearly 30 million women aged 50 years or older in the United States have osteoporosis or low bone mineral density (BMD).<sup>1</sup> Risk of bone fracture is substantial among women with osteoporosis. More than 40% of postmenopausal women with osteoporosis are expected to experience at least one fragility fracture.<sup>2</sup> More than 2 million osteoporotic fractures occurred in the United States in 2005.<sup>3</sup> Costs related to these injuries totaled nearly \$17 billion.<sup>3</sup>

With each osteoporotic fracture, the risk of future fracture increases.<sup>4</sup> For example, after one vertebral fracture, the risk of a subsequent, nonvertebral fracture increases two- to threefold.<sup>2</sup> Subsequent fractures often occur within 1 year,<sup>5</sup> contributing

to a cascade of events that can lead to severe disability or death.<sup>6</sup> Although 15% of patients who sustain a hip fracture are able to return to unassisted ambulation after 6 months, 24% of patients with hip fractures die within 1 year.<sup>2</sup>

Although osteoporosis is most common in postmenopausal women, bone loss and fractures are also fairly common in men. According to data from the third National Health and Nutrition Examination Survey,<sup>7</sup> up to 13 million men aged 50 years or older in the United States have low BMD, and up to 2 million of these men have osteoporosis.

A recent literature review<sup>8</sup> revealed that nearly 1 in 4 men older than 60 years will have an osteoporosis-related fracture. Like women, men experience substantial rates of morbidity and mortality after fracture. However, men are less likely than women to receive postfracture treatment for osteoporosis—possibly because of a lack of physician awareness regarding the prevalence of this condition among men.<sup>8</sup>

Despite the prevalence and deleterious consequences of bone loss and fractures, patients with osteoporosis continue to be underdiagnosed and undertreated.<sup>9-11</sup> It is important for physicians to identify individuals at high risk of osteoporosis and to implement preventive strategies. Osteopathic physicians (DOs) are in a unique position to improve diagnosis and management of this clinical condition when they implement a holistic and multifactorial approach.

The present article reveals how DOs can best reduce patient risk factors while also providing relief to patients with ongoing osteoporosis symptoms. An effective multifactorial treatment plan should include instructions for fall-risk reduction, nutrition guidance and dietary supplementation, physical exercise, osteopathic manipulative treatment (OMT), and pharmacotherapeutics. Aggressively applying a multifactorial approach should improve immediate and long-term patient outcomes.

### Diagnosis

The number of osteoporosis-related patient visits to health-care providers in the United States increased nearly fivefold between 1994 and 2003, corresponding with the introduction of alendronate as the first oral daily bisphosphonate treatment for this population.<sup>11</sup> Despite the increased focus on osteoporosis, patient diagnosis remains inadequate.

Data from National Ambulatory Medical Care Surveys<sup>10</sup> (N=7977) reveal that osteoporosis or vertebral fracture was

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diagnosed in fewer than 2% of white women older than 60 years who visited primary care physicians. However, disease-prevalence data suggest that osteoporosis or vertebral fracture would be present in 20% to 30% of such women.<sup>10</sup> Similarly, more than half of 1007 women aged 40 to 69 years surveyed in a Connecticut managed-care organization indicated that they had never discussed osteoporosis with their healthcare providers.<sup>12</sup>

Failure to identify patients at risk for osteoporosis and fracture results in missed opportunities for prevention. Vertebral fracture, for example, is often asymptomatic, going unrecognized until recurrence or height loss.<sup>5</sup> Among women randomized into placebo groups in four large clinical osteoporosis-management studies,<sup>5</sup> only 23% (n=381) of those with vertebral fracture were symptomatic. Furthermore, osteoporosis remains undiagnosed in many patients even after a symptomatic fragility fracture occurs.<sup>5</sup>

Although low-trauma fracture is a hallmark of osteoporosis, fewer than 40% of patients with such fractures at presentation are diagnosed with osteoporosis.<sup>13,14</sup> Numerous retrospective studies have documented the low frequency (5%-45%) of intervention for osteoporosis among postmenopausal women who have sustained osteoporotic fracture.<sup>9,13,15-17</sup> Wrist fractures in women who are in their mid-50s—rarely recognized as osteoporotic fractures—are important clinical indicators that herald increased risk of fracture.<sup>9</sup>

### Risk Factors

The first step in preventing fracture is to identify patients at high risk for osteoporosis. *Figure 1* features a list of demographic characteristics, medical conditions, and medications that are most commonly linked to increased osteoporosis risk.<sup>5,18-20</sup> The most widely recognized risk factors for osteoporosis are advanced age (>65 y) and history of fracture.<sup>18,21-23</sup> Previous vertebral fracture is associated with a twofold increased risk of hip fracture and a nearly twofold increased risk of other osteoporotic fractures.<sup>4</sup>

A wide variety of medical conditions (eg, multiple sclerosis, stroke, trauma-induced immobilization) and medications (eg, immunosuppressants, oral glucocorticoids) have been associated with excess bone loss and fracture risk.<sup>18,19,24</sup> These secondary influences can produce rapid effects in BMD.

## Osteoporosis Risk Factors

### ■ Medical History

- Calcium and vitamin D deficiency
- Chronic hepatic or renal disease
- Chronic obstructive pulmonary disease
- Cushing syndrome
- Early menopause (<45 y)
- Family history of osteoporosis
- Gastrointestinal diseases resulting in poor intestinal absorption
- Hyperparathyroidism
- Hyperthyroidism
- Hypogonadism
- Immobilization resulting from trauma
- Low body weight (<57.6 kg [ $<127$  lb])
- Malignancy
- Multiple sclerosis
- Personal history of fracture as adult
- Poor health
- Poor vision
- Recent history of falls
- Rheumatoid arthritis
- Stroke
- Type 1 diabetes mellitus

### ■ Demographic and Behavioral Factors

- Advanced age (>65 y)
- White
- Excessive alcohol consumption
- Sedentary lifestyle
- Smoker of tobacco

### ■ Medication Use\*

- Antiepileptic agents
- Cytotoxic agents
- Heparin (chronic use)
- Immunosuppressive agents
- Lithium
- Loop diuretics
- Oral glucocorticoids
- Tamoxifen (postmenopausal)

**Figure 1.** Factors shown to place postmenopausal women at greater risk for osteoporosis and osteoporosis-related fracture.<sup>5,18-20</sup> \*Medication list is not exhaustive. Other medications may also affect bone loss.

For example, substantial risk of fracture can begin within 6 months of a patient starting glucocorticoid therapy.<sup>25</sup>

### Patient Stratification

The National Institutes of Health<sup>26</sup> defines osteoporosis as a compromise of bone strength, which, in turn, is described as the combination of bone density and bone quality. Bone quality depends on mineralization, architecture, turnover of old and damaged bone, and fracture accumulation. Because of the recognized association of low BMD T scores with increased fracture risk and the wide availability of bone-density measurement devices, BMD testing has been the primary tool used to diagnose osteoporosis.<sup>24,27,28</sup>

The World Health Organization<sup>27</sup> defines osteoporosis based on BMD T scores, preferably of the total hip or femoral

neck. A T score within 1 standard deviation (SD) of the mean for healthy young white women is considered normal, while a T score less than -1 SD but greater than -2.5 SD is considered low BMD, and a T score less than or equal to -2.5 SD is the criterion for osteoporosis.<sup>29</sup>

Osteoporosis is classified as severe when a patient's T score is less than or equal to -2.5 SD *and* a fragility fracture has occurred. The same BMD threshold values are appropriate for identifying the risk of osteoporosis and fracture in men who are older than 50 years.<sup>30</sup>

Although clinical screening for osteoporosis often focuses on T scores, osteoporosis-related fracture can be predicted by reduced BMD as well as changes in bone structure.<sup>31</sup> For this reason, patients with normal BMD may still be at increased risk of fracture. In the National Osteoporosis Risk Assessment study<sup>32,33</sup> of 2259 postmenopausal women, the majority of patients who reported fracture within 1 year were those with the lowest peripheral T scores. However, 82% of patients reporting fracture had peripheral T scores greater than -2.5, and 67% had scores higher than -2.0.<sup>32</sup> Furthermore, within each diagnostic category (osteoporosis, osteopenia, normal), the presence of multiple clinical risk factors increased patient risk for hip fracture.<sup>33</sup>

Combining assessments of BMD and risk factors for osteoporosis provides a more effective clinical strategy for establishing risk levels for patients than relying on T scores exclusively. Numerous risk factors have been linked to osteoporosis, though many of these factors have poor predictive specificity and sensitivity. Age, prior fragility fracture, premature menopause, family history of hip fracture, and use of oral corticosteroids are associated with increased fracture risk.<sup>30</sup>

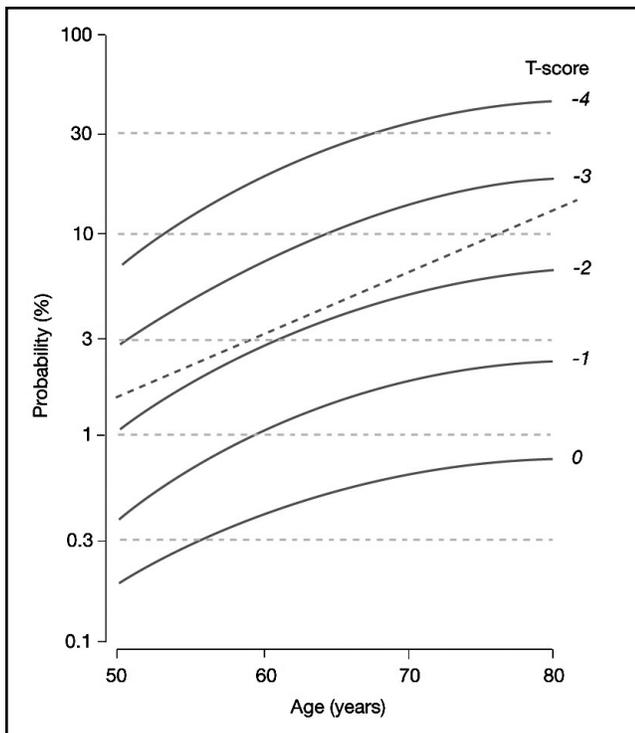
The FRACTURE Index<sup>34</sup> is a seven-question survey used to determine a patient's osteoporotic fracture risk. It is easy to administer in clinical settings (*Figure 2*). Predictive factors incorporated into the FRACTURE Index are age, personal history of fracture, maternal history of hip fracture, low body weight, smoking, and difficulty with activities of daily living.<sup>34</sup> The FRACTURE Index can be used to predict a patient's 5-year fracture risk independent of T scores. Alternative clinical screening tools include the Osteoporosis Self Assessment Tool<sup>35</sup> and the Osteoporosis Risk Assessment Instrument for Women.<sup>36</sup>

The presence of strong historical risk factors, radiographic evidence of osteopenia or vertebral deformity, previous fragility fracture, or changes in the spine (eg, kyphosis) should prompt a diagnostic bone densitometry evaluation.<sup>37</sup> Both risk-factor and BMD data can help a physician determine the need for preventive therapy. Determinations of fracture risk and the cost-effectiveness of therapy can be improved by using fracture probability data. Based on patients' ages and T scores, *Figure 3* displays the 10-year probability of hip fracture for a population of Swedish men and women.<sup>37</sup> These data suggest that the cost-effectiveness of treatment depends on the likelihood of fracture prevention.

FRACTURE Index <sup>34</sup>	
Question/Answer	Index Value*
<b>■ What is your current age in years?</b>	
<input type="checkbox"/> <65	0
<input type="checkbox"/> 65-69	1
<input type="checkbox"/> 70-74	2
<input type="checkbox"/> 75-79	3
<input type="checkbox"/> 80-84	4
<input type="checkbox"/> ≥85	5
<b>■ Have you broken any bones after age 50?</b>	
<input type="checkbox"/> Yes	1
<input type="checkbox"/> No/don't know	0
<b>■ Has your mother had a hip fracture after age 50?</b>	
<input type="checkbox"/> Yes	1
<input type="checkbox"/> No/don't know	0
<b>■ Do you weigh 125 pounds (56.7 kg) or less?</b>	
<input type="checkbox"/> Yes	1
<input type="checkbox"/> No	0
<b>■ Are you currently a smoker?</b>	
<input type="checkbox"/> Yes	1
<input type="checkbox"/> No	0
<b>■ Do you usually need to use your arms to assist yourself in standing up from a chair?</b>	
<input type="checkbox"/> Yes	2
<input type="checkbox"/> No/don't know	0
<b>■ If you have a current BMD assessment, what was your total hip T score?</b>	
<input type="checkbox"/> >-1	0
<input type="checkbox"/> -1 to -2	2
<input type="checkbox"/> -2 to -2.5	3
<input type="checkbox"/> <-2.5	4

**Figure 2.** FRACTURE Index assessment tool for predicting the risk of fracture in postmenopausal women. (Adapted from Osteoporosis International, Vol 12, 2001, 519-528, an assessment tool for predicting fracture risk in postmenopausal women, Black DM, Steinbuch M, Palermo L, Dargent-Molina P, Lindsay R, Hoseney MS, Johnell O. Table 4 ©2001 International Osteoporosis Foundation and National Osteoporosis Foundation, with kind permission of Springer Science and Business Media.<sup>34</sup>) \*Women without a current bone mineral density (BMD) assessment and a total FRACTURE Index score of ≥4 should receive further evaluation, including BMD testing. Women with a current BMD assessment and a total FRACTURE Index score of ≥6 should receive further evaluation and intervention.

Hip fracture is particularly disabling and is associated with a substantial risk of mortality.<sup>37-39</sup> Because most hip fractures result from falls,<sup>38</sup> a patient's risk of fall should be assessed as an integral part of osteoporosis management and fracture prevention. Factors associated with increased risk of fall (eg, neuromuscular disorder, older age, poor visual acuity) have been linked to fracture risk—independent of BMD.<sup>37</sup>



**Figure 3.** Probability of a hip fracture occurring within 10 years for a population of Swedish men and women, based on femoral neck T scores. The solid lines represent the logarithmic probability of fracture for each T score. The dashed line shows the probability at which interventions become cost-effective. (Reprinted from *The Lancet*, Vol 359, Kanis JA, Diagnosis of osteoporosis and assessment of fracture risk, 1929-1936, ©2002, with permission from Elsevier.<sup>37</sup>)

Clinical assessment of a patient's fall risk should include questions about the circumstances of prior falls (if any), medical history (including medications taken), and thorough evaluations of balance, gait, mobility, muscle strength, and visual acuity. An algorithm for fall assessment and management was developed by the American Geriatrics Society<sup>39</sup> (Figure 4).

### Clinical Assessment

Patients with osteoporosis can be asymptomatic. Alternatively, they can have previously unrecognized loss of vertebral height or undiagnosed fractures.<sup>40</sup> Vertebral fracture is often asymptomatic and may be particularly difficult to diagnose using radiographic images. This elusive quality may be one reason for underreporting.<sup>40</sup> In one study,<sup>40</sup> radiologists were found to have a success rate that was close to 50% in correctly identifying fractures in chest radiographs for postmenopausal women.

To avoid misdiagnosing early osteoporosis and associated fractures, physicians must adopt a vigilant assessment strategy that incorporates laboratory and clinical risk-assessment data.

### Asymptomatic and Undiagnosed Fractures

The US Surgeon General<sup>6</sup> recommends that all individuals be evaluated to determine risk factors for fracture. Assessment begins with a thorough patient history—with particular attention given to patient age, weight, history of fracture, and any diseases or medications known to diminish bone strength.<sup>41</sup> Patient height should be measured annually to monitor for decreases suggestive of undiagnosed vertebral fracture. Postmenopausal women with osteoporosis and height loss of 2 cm (0.8 in) are three times more likely to have an occult vertebral fracture than are women without height loss.<sup>42</sup>

Patients who demonstrate height loss, back pain, or both should be evaluated with lateral radiographs of the thoracic spine to determine the presence of vertebral fracture.<sup>41,43-45</sup> To help identify high-risk patients, any chest radiographs on file should be carefully reanalyzed for the presence of previously undetected vertebral fractures.<sup>46</sup>

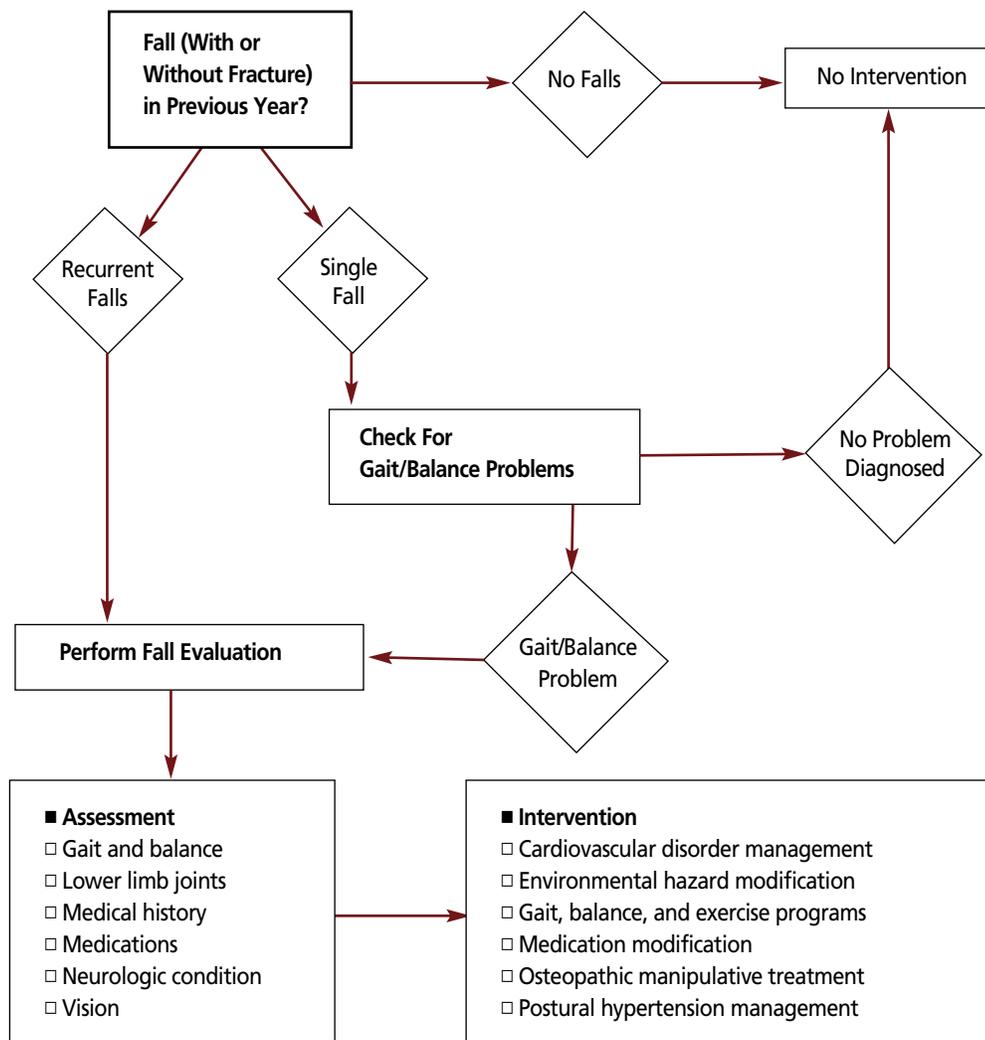
The current guidelines of the National Osteoporosis Foundation (NOF)<sup>18</sup> recommend BMD assessment in all women aged 65 years or older and in postmenopausal women younger than 65 years who have known fracture risks. A screening tool that encompasses known risk factors can aid physicians in identifying individuals who should undergo BMD evaluation.<sup>34</sup>

### Acute Fractures

Only about one-third of vertebral fragility fractures occur with acute symptoms.<sup>47,48</sup> A nonvertebral fragility fracture is more likely to become symptomatic than a vertebral fragility fracture. All identified acute fragility fractures demand immediate medical attention, rapid institution of effective treatment, and careful assessment for future risk prevention measures.<sup>48</sup>

The American Association of Orthopedic Surgeons<sup>41</sup> recommends the establishment of clinical procedures and partnerships within the medical community that facilitate the proper evaluation and management of osteoporosis in patients with acute fragility fractures. These approaches could include the use of office recognition protocols (eg, stickers on patient charts) or patient questionnaires to help identify patients who have had acute fractures. Another approach could involve incorporation of a computerized clinical decision-support system to improve physician performance.<sup>41</sup> Such a system would be similar to those shown effective in the management of certain other conditions, such as cardiovascular disease and diabetes mellitus.<sup>49</sup>

All patients with acute fractures need to be questioned about any possible previous fractures. Although such fractures may occur without initial symptoms or obvious long-term disability, a history of fracture indicates a substantial risk for recurrence. In these patients, BMD testing can be used to confirm a diagnosis of osteoporosis, assess bone loss, and guide physicians in developing treatment and prevention plans.<sup>41</sup> Additional laboratory tests may be required to rule out secondary causes of osteoporosis, including thyroid disorders, vitamin D deficiency, and hyperparathyroidism.



**Figure 4.** Algorithm for assessment of the risk of fall and intervention to prevent falls based on guidelines published by the American Geriatrics Society. (Adapted with permission from American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. Guideline for the prevention of falls in older persons. *J Am Geriatr Soc.* 2001;49:664-672.<sup>39</sup>)

### Reducing Fracture Risk

Given their holistic training in patient care, DOs are uniquely attuned to the needs of the individual patient, including risk factors and comorbidities. Once osteoporosis is suspected, DOs are in good position to implement multifactorial intervention strategies to reduce fracture risk.

Effective prevention measures should include nonpharmacologic interventions—and pharmacologic interventions when necessary.

### Nonpharmacologic Intervention

Programs designed to educate patients about nonpharmacologic strategies for reducing osteoporosis risk have been shown to result in long-term beneficial changes in patient behavior and health attitudes.<sup>50</sup> A group of 375 adults treated in the 8-week

Highmark Osteoporosis Prevention and Education program<sup>51</sup> demonstrated acceptable adherence to nutrition and physical exercise recommendations 2 years after completing multidisciplinary education. Nonpharmacologic strategies are important for the primary prevention of osteoporosis and the reduction of bone loss and fracture risk.

■ **Reducing fall risk**—Fracture risk can be addressed immediately by reducing fall risk. A meta-analysis of fall-prevention trials found that multifactorial fall-risk assessment and management programs are the most effective programs at reducing falls.<sup>52</sup> Older patients should be consistently counseled to modify the home environment to improve safety and reduce risk of fall (eg, install railings along stairways, remove loose floor coverings).<sup>39</sup>

Factors related to fall risk, such as visual disturbance and

comorbid medical conditions, should also be identified and corrected as quickly as possible. Medications for comorbid illnesses should be carefully selected with the goal of minimizing the use of agents that have a propensity for aggravating fall risk, such as medications associated with dizziness, hypoglycemia, orthostatic hypotension, and psychological changes.<sup>39</sup>

Fall risk can be reduced in nursing homes through the implementation of comprehensive fall-reduction programs designed to maximize environmental safety, intensify staff training, and improve staff response to falls.<sup>53</sup> The success of such interventions, however, is highly dependent on staff commitment and implementation.

■ **Lifestyle adjustments**—Lifestyle and patient behavior have also been associated with osteoporosis and fracture risk. Patients should generally be counseled to minimize their use of alcohol, caffeine, and tobacco.<sup>54,55</sup> However, determining the contribution of each of these factors to patient risk level is difficult, particularly because smokers are more likely than nonsmokers to be thinner and to consume more alcohol and coffee.<sup>54</sup> In addition, BMD is typically lower in smokers than in nonsmokers—and, after adjusting for differences in age and weight, smokers tend to have more vertebral abnormalities than nonsmokers.<sup>54</sup>

In a prospective survey of 2245 women and 1760 men in Australia who were aged 60 years or older, smoking was shown to be an independent risk factor for fracture.<sup>55</sup> This correlation was found for both sexes (women, hazard ratio=1.43; men, hazard ratio=2.43).<sup>55</sup>

■ **Nutrition counseling**—To maintain bone health, adults need to consume a healthy, balanced diet to achieve adequate mineral and vitamin intake. Vitamin D deficiency is common among patients with osteoporosis and may increase fracture risk.

A survey of 448 patients with osteoporosis found vitamin D deficiency or insufficiency in approximately one-third of patients.<sup>56</sup> Interestingly, the prevalence of vitamin D deficiency was similar among patients younger than 50 years (33%) as well as those older than that age (31%).<sup>56</sup>

Supplementation with calcium and vitamin D is a critical component of osteoporosis management, having been shown to improve BMD and reduce fracture risk.<sup>65-67</sup> The NOF recommends that postmenopausal women consume at least 1200 mg per day of calcium and 800-1000 IU per day of vitamin D through diet or supplementation.<sup>18</sup>

The two major forms of vitamin D are ergocalciferol (vitamin D<sub>2</sub>) and cholecalciferol (vitamin D<sub>3</sub>). Ergocalciferol is derived from fungal and plant sources, while cholecalciferol is synthesized in the skin on irradiation of 7-dehydrocholesterol.<sup>60,61</sup> Ergocalciferol has less than one-third the potency of cholecalciferol.<sup>60</sup> Because cholecalciferol increases circulating levels of vitamin D more effectively than ergocalciferol, supplementation with cholecalciferol is preferred.<sup>60</sup>

Benefits derived by patients from vitamin D supplementation depend on formulation and dosage. A meta-analysis of 12 randomized clinical trials assessing patients with hip

fracture (N=9294) and other nonvertebral fractures (N=9820) who were treated with cholecalciferol (700-800 IU/d) revealed a significant fracture reduction of 23% (relative risk [RR]=0.77; 95% confidence interval [CI], 0.68-0.87).<sup>61</sup> This fracture reduction was lost at the lower dosage of cholecalciferol (400 IU/d) evaluated in the meta-analysis.

Consumption of carbonated beverages has been inconsistently associated with increased risk of osteoporosis. Recently, Tucker et al<sup>62</sup> linked cola intake to lower hip BMD in a group of 1413 women enrolled in the Framingham Osteoporosis Study. This link was present for regular, diet, and noncaffeinated cola beverages, but not for noncola carbonated beverages.<sup>62</sup> These data suggest that physicians recommend limited cola intake to reduce risk of osteoporosis.

■ **Physical exercise**—Patients should be encouraged to participate in structured exercise programs or to otherwise increase their levels of physical activity to help decrease fracture risk.<sup>63,64</sup> In general, weight-bearing and resistance exercises that maintain healthy muscle mass offer the best fracture prevention.<sup>65,66</sup>

A 2-year study<sup>65</sup> evaluating the effects of adding physical exercise to calcium supplementation in 126 postmenopausal women showed a significant increase in critical hip BMD in those women who participated in progressive strength training, compared with women in either an aerobic fitness program or a nonexercise control group ( $P<.05$ ). Furthermore, adding weight-bearing and resistance exercise to a standard medication regimen resulted in greater improvements in BMD than using physical exercise or medication alone.<sup>66</sup>

Physical exercise programs should be tailored to the needs of the individual patient. Such recommendations should take into account the severity and progression of the patient's bone loss as well as the location of any previous fractures. All recommendations for physical activity need to be appropriate to the patient's risk level, balancing fracture risk with the potential benefits of exercise.<sup>41,67</sup> Exercise programs should include balance training, postural training, resistance training, stretching, and weight-bearing aerobic exercise.<sup>67</sup> For patients with severe osteoporosis, activities that require vigorous flexing or rotation of the spine should be avoided.

■ **Osteopathic manipulative treatment**—The main goals of OMT are to normalize joint motion, balance soft tissue tension, support the body's inherent motion, improve circulation, and maximize the patient's feelings of well-being.<sup>68</sup> Various OMT techniques applied during rehabilitation can help remove somatic impediments to normal activity and facilitate patient involvement in gait and balance retraining as well as structured physical exercise programs. These techniques include Strain-Counterstrain, Osteopathy in the Cranial Field (ie, craniosacral manipulation), muscle energy (ie, reciprocal inhibition and isometric manipulation), myofascial release, and the Still Technique.<sup>68</sup> Strain-Counterstrain is the safest of these techniques to use in cases involving fracture.<sup>68</sup> Indirect myofascial release and the Still Technique should be used cautiously once fractures have stabilized.<sup>68</sup>

Extra caution must be used if patients experience pain during OMT. For patients with severe osteoporosis, DOs need to evaluate carefully the risk vs benefit for this treatment modality, keeping in mind that though certain techniques have demonstrated efficacy anecdotally, large controlled clinical trials are lacking.<sup>68</sup>

■ **Hip protectors**—Studies testing the benefits of anatomic hip protectors for patients at risk of fracture have produced equivocal results. Although some studies have indicated that hip protectors reduce the rate of hip fracture,<sup>69</sup> others have shown no significant effect for this preventive measure.<sup>70-72</sup>

Part of the discrepancy among studies may reflect differences in patient compliance with treatment protocols. In some patients, compliance can be low overall, fluctuate during the course of the day, and diminish over time.<sup>72</sup>

### Pharmacologic Intervention

The NOF recommends pharmacologic treatment for any woman who has a T score less than or equal to -2.0 and for any woman who has a T score less than -1.5 with one or more additional risk factors.<sup>18</sup> Pharmacologic treatment should also be prescribed for those who have sustained vertebral or hip fractures.<sup>18,41</sup> Given the heightened risk of recurrence after a patient has sustained a fracture, physicians should consider all pharmacologic treatments proven to reduce this risk.

In addition to listing the medications currently approved by the US Food and Drug Administration (FDA) for the prevention and management of postmenopausal osteoporosis, *Figure 5* also describes the earliest point in treatment that each medication has demonstrated efficacy in reducing fracture risk.<sup>73-84</sup> Although most of these medications have demonstrated efficacy in reducing vertebral fracture, because of the high morbidity and mortality associated with hip fracture,<sup>6</sup> selections should also be made to reduce the risk of nonvertebral fracture, including hip fracture, whenever possible.

There are two primary classes of osteoporosis medications—antiresorptive and anabolic agents. Antiresorptive agents include bisphosphonates, calcitonin, and estrogen therapies.<sup>73-83</sup> Teriparatide (recombinant parathyroid hormone [1-34]) is the only FDA-approved anabolic agent for treatment of patients with osteoporosis.<sup>84</sup>

■ **Antiresorptive agents**—The North American Menopause Society's evidence-based consensus guidelines<sup>85</sup> for the treatment of patients with osteoporosis recommend bisphosphonates as first-line treatment. This recommendation is based on the ability of these agents to reduce or prevent both vertebral and nonvertebral fracture.<sup>85</sup> The effectiveness of bisphosphonates against nonvertebral fracture, such as hip fracture, is particularly important considering the substantial morbidity and mortality associated with nonvertebral fracture.<sup>6</sup>

In a rigorously designed meta-analysis of phase III, randomized, placebo-controlled clinical trials with a duration of at least 3 years, both alendronate and risedronate effectively reduced the risk of nonvertebral fracture in patients with

osteoporosis.<sup>86</sup> In a randomized, double-blind, placebo-controlled study of nearly 3000 women with osteoporosis and prevalent vertebral fractures, risk of subsequent vertebral fracture was reduced by 62% at 3 years with daily (2.5 mg/d) and intermittent (20 mg every other d, for 12 doses every 3 mo) use of ibandronate.<sup>76</sup> However, incidence of nonvertebral fracture was the same among patients treated with either an ibandronate regimen or placebo. Nevertheless, a subgroup of 375 high-risk patients (femoral neck T score <-3.0) experienced a significant decrease in nonvertebral fracture, compared with placebo, when treated with daily ibandronate ( $P=.01$ ).<sup>76</sup>

Some bisphosphonates have been shown to reduce fracture risk after relatively brief periods of use. Both Black et al<sup>74</sup> (N=3658) and Pols et al<sup>87</sup> (N=1908) found that women treated with alendronate (5-10 mg/d) had a lower relative risk for symptomatic vertebral and nonvertebral fractures within 1 year of treatment, compared with placebo.<sup>74,87</sup> Clinical trials with risedronate (5 mg/d) have demonstrated reduction in risk of nonvertebral fracture as well as symptomatic vertebral fracture as soon as 6 months postinitiation.<sup>82,83</sup>

Intranasal calcitonin (200 IU/d) yielded a significant reduction in vertebral fracture in a group of 287 postmenopausal women with osteoporosis after 5 years of treatment, compared with placebo ( $P=.03$ ).<sup>75</sup> Likewise, raloxifene (60 mg/d), a selective estrogen-receptor modulator, reduced the risk of symptomatic vertebral fracture in a group of 2557 postmenopausal women after 1 year of treatment, compared with placebo ( $P<.001$ ).<sup>79</sup> Neither calcitonin nor raloxifene has been shown to reduce nonvertebral fracture risk significantly.

Although hormone replacement therapy has long been an option for osteoporosis prevention, recent findings from the Women's Health Initiative<sup>88,89</sup> resulted in new recommendations to limit its prophylactic use.

■ **Anabolic agents**—The only anabolic medication currently approved by the FDA for the management of osteoporosis is teriparatide.<sup>84</sup> In a large, randomized, placebo-controlled clinical trial,<sup>84</sup> treatment of postmenopausal women (N=1637) with teriparatide (20 µg/d) significantly reduced patient risk of vertebral and nonvertebral fracture after 21 months of therapy ( $P<.001$ ). One or more vertebral fragility fractures occurred in 20% of patients treated with teriparatide, compared with 64% of patients treated with placebo. One or more nonvertebral fragility fracture occurred in 14% of patients treated with teriparatide and 30% of those treated with placebo.<sup>84</sup>

A post hoc analysis of the data generated by Neer et al<sup>84</sup> revealed that 30% to 41% of the vertebral fracture reductions associated with teriparatide could be attributed to increases in BMD.<sup>90</sup>

### Conclusions

The comprehensive treatment strategies and holistic approach that are characteristic of osteopathic medicine are uniquely

Medications for Prevention/Management of Postmenopausal Osteoporosis		
Medication	Administration/Dosage*	Impact on Fracture Risk†
Alendronate	Oral 5 mg/d (prevention) 10 mg/d (management)	47% reduction in vertebral fracture risk in 3 y <sup>73</sup> 59% reduction in clinical vertebral fracture risk in 1 y <sup>74</sup> 26% reduction in nonvertebral fracture risk in 2 y <sup>74</sup>
Calcitonin	Intranasal 200 IU/d (management)	33% reduction in vertebral fracture risk in 5 y <sup>75</sup>
Ibandronate	Oral 150 mg/mo (prevention/management)	61% reduction in vertebral fracture risk in 2 y <sup>76</sup> 49% reduction in clinical vertebral fracture risk in 3 y <sup>76</sup>
	Injection 3 mg every 3 mo (management)	60% reduction in vertebral fracture risk in 3 y <sup>77</sup>
Raloxifene	Oral 60 mg/d (prevention/management)	30% reduction in vertebral fracture risk in 3 y <sup>78</sup> 68% reduction in clinical vertebral fracture risk in 1 y <sup>79</sup>
Risedronate	Oral 5 mg/d (prevention/management)	65% reduction in vertebral fracture risk in 1 y <sup>80,81</sup> 69% reduction in clinical vertebral fracture risk in 6 mo <sup>82</sup> 66% reduction in nonvertebral fracture risk in 6 mo <sup>83</sup> 74% reduction in nonvertebral fracture risk in 1 y <sup>83</sup>
Teriparatide	Injection 20 µg/d (management)	65% reduction in vertebral fracture risk in 21 mo <sup>84</sup> 53% reduction in nonvertebral fracture risk in 21 mo <sup>84</sup>

**Figure 5.** Medications approved by the US Food and Drug Administration for the prevention and management of osteoporosis. The earliest point in treatment that each medication has demonstrated significant risk reduction for fracture is noted.<sup>73-84</sup> \*Dosages approved by the US Food and Drug Administration for postmenopausal women with osteoporosis. †Includes prospective and pooled analyses. Clinical vertebral fracture risk was based on symptomatic fracture as the study endpoint. Fracture risk was typically based on radiographic fracture as the study endpoint.

suiting to the diagnosis and clinical management of osteoporosis. Unidentified or inadequately managed BMD loss can lead to vertebral and nonvertebral fractures, both of which are associated with substantial morbidity and mortality among patients. To prevent fracture and disability resulting from osteoporosis, at-risk individuals—including men—must be identified routinely. Then they must be prescribed treatment that not only preserves bone strength but reduces the biomechanical stress that may lead to fracture.

Osteopathic physicians should develop a multifactorial management program for patients with osteoporosis that includes risk factor modification, nutrition guidance and dietary supplementation, physical exercise, OMT, and pharmacologic treatment. Any medications that are used in treating patients should have demonstrated rapid effects and efficacy for fracture reduction.

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As a member of the US Bone and Joint Decade, the American Osteopathic Association (AOA) is committed to reducing suffering from bone and joint disorders. Publishing articles such as this one is among the ways that the AOA is supporting this initiative.