CASE STUDIES in Lifestyle Medicine

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Postmenopausal Osteoporosis: The Role of Lifestyle in Maintaining Bone Mass and Reducing Fracture Risk

Abstract: *Postmenopausal osteoporosis is a significant contributor to morbidity and mortality. Medications can provide effective treatment but their use can be complicated by side effects. This case illustrates the role that diet, supplements, and specific exercises can play in preventing and treating bone loss and reducing fracture risk.*

Keywords: postmenopause; osteoporosis; fracture; diet; exercise; yoga; calcium

Bone loss increases for women in the menopause transition, contributing to a significant increased risk of fracture, morbidity, and mortality. Worldwide, 1 in 3 women older than 50 years will sustain an osteoporotic fracture. Although medications can reduce bone loss and fracture risk, there is a role for nutrition and targeted exercises. These lifestyle approaches have additional benefits of improving bone quality, increasing muscle mass, and reducing falls. This case and accompanying review illustrate how modifying diet, supplements, and

exercise can result in improved bone density and better health outcomes.

CJ is a 55-year-old postmenopausal woman with bone loss who is looking for advice on nonpharmacologic options to maintain bone health. After her first bone density at age 50 years, which showed osteopenia in the hip (femoral neck T score was -1.9), she was placed on alendronate for 6 months. She

angioma 15 years prior, which caused headache, right-sided weakness, and numbness. She could not walk for 4 months but has had a significant recovery. Her primary residual is that movement, listening, talking, and decision making take more effort, and she has some dysesthesias on her right side. She started her menses at 14, had 2 uncomplicated pregnancies and

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developed jaw discomfort for which she was seen by an orthopedist and the alendronate was stopped. Her most recent bone density showed a T score of -1.1 in L1-4 but osteoporosis in L1 with a T score of -2.6 . Her hips showed worsened osteopenia with a T score in the femoral neck of -2.1 .

Her past medical history is notable for a pontine bleed from a cavernous

deliveries, and took progesterone in her early 50s for endometrial hyperplasia. Her last menstrual period was at age 52 years and she took no other hormone therapy.

Her medications include amitriptyline 50 mg at bedtime for sleep, atenolol 50 mg daily, and triamterene/hydrochlorothiazide 37.5 mg/25 mg daily since her pontine bleed. Her

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supplements include calcium carbonate 600 mg twice daily, vitamin D3 800 IU daily, fish oil 1200 mg daily, multivitamin without iron, and glucosamine/chondroitin 1500 mg/1200 mg daily.

She has been married for 33 years and describes this relationship as wonderful. She does not work outside the home; she is an artist and is interested in studying yoga. For breakfast, she eats oat bran with yogurt and 1 cup coffee with skim milk. Lunch is a salad with walnuts and berries, 1 square dark chocolate and green tea. Afternoon snack consists of raw vegetables with white bean dip. Dinner can be eggs or salmon with whole grain bread, vegetables, and an occasional glass of wine. She has been trying to get 15 minutes of aerobic activity 3 times weekly in addition to her yoga 25 minutes 6 times weekly. She has recently added in resistance training 15 minutes 3 times weekly.

On physical examination, she is alert and ambulates slowly but well. Height is 5 ft 7 in., weight 130 lbs, waist:hip ratio 0.75, blood pressure 120/80 mm Hg, pulse 64 beats/min and regular. She has a mild lumbar scoliosis, normal strength, and some dysesthesia to touch on her right side.

Workup for secondary causes of bone loss was negative, including a normal parathyroid hormone level, negative celiac serologies and serum protein electrophoresis, normal thyroid and kidney function, and a 25-OH vitamin D level of 59 ng/mL. *N*-telopeptide:creatinine ratio was normal.

Because of CJ's desire to not take medications for her bones, she met with a dietitian with a focus on increasing nondairy sources of calcium, adding in more dark leafy greens, and changing her calcium supplement to a citrate form that included magnesium. Vitamin K2 50 µg daily was added. With the exercise physiologist, she reviewed her resistance training and was encouraged to consider a vibration plate. Over the next 2 years she became certified as a yoga instructor, added in tai chi to improve her balance, continued to use her vibration plate, and was able to

taper down her nighttime amitriptyline. Repeat bone density showed improvement in the spine (T score -0.9 in L1-L4 and -2.0 in L1) and in the hips (femoral neck T score -1.8). One year later, the T score had increased in L1-L4 to -0.7 and the left femoral neck T score had decreased 4.5% to -2.2. Repeat parathyroid hormone and routine chemistries were normal, and 24-hour urine calcium and cortisol were also normal.

Osteoporosis is considered a "silent disease" but a recent review found that in US women older than 55 years, more were hospitalized for osteoporotic fractures than for breast cancer, myocardial infarction, or stroke.¹ This underscores the importance of identifying people at risk of osteoporosis through absolute fracture risk assessment tools and bone mineral density testing, for both primary and secondary prevention of fractures. Lifestyle factors such as diet, exercise, and balance training may provide benefits above and beyond improvements in measurable bone density, by increasing muscle mass, improving balance and strength, and reducing fall risk. A comprehensive review for clinicians on the prevention and treatment of osteoporosis was published by the National Osteoporosis Foundation (NOF) in 2014.²

Dietary patterns associated with lower risk of osteoporosis include lower intake of candy and higher intake of fruits, vegetables, ocean fish, and specific flavonoids found in foods such as onions, soy, and berries.³⁻⁶ A Mediterranean dietary pattern, with its inclusion of many of these foods, has been associated with higher bone density.⁷⁻⁹ Adequate calcium intake is important, with the current NOF guidelines recommending 1200 mg daily for women. Absorption of calcium citrate may be as much as 24% more than with calcium carbonate.¹⁰ High intake of supplemental calcium has been associated with higher risk of cardiovascular disease in men but not women^{11,12}; however, focusing on dietary sources of calcium first is prudent in light of these concerns and because of the

other bone-beneficial nutrients such as magnesium¹³⁻¹⁵ and vitamin K present in many food sources of calcium.

Maintaining adequate protein intake is critical for preventing both bone and muscle loss with aging,^{16,17} and protein intake higher than the current recommended dietary allowance of 0.8 mg/kg may be needed. Some studies have suggested that plant-based proteins may be more favorable than animal sources, but others show a positive association between dairy protein intake and bone mineral density.¹⁸⁻²¹

Supplemental vitamin D has been associated with reduced fall risk and mortality along with preservation of muscle mass, but not consistently with reduced fracture risk.²²⁻²⁴ The NOF recommends maintaining a vitamin D level of at least 30 ng/mL. The amount of supplementation required to achieve and maintain those levels may vary depending on the time of year and the presence of conditions that affect absorption and metabolism of vitamin D (such as intestinal or kidney disease). The general recommendation by NOF is 800 to 1000 IU vitamin D daily, but many patients will need higher doses to achieve and maintain blood levels of at least 30 ng/mL. Another fat-soluble vitamin, vitamin K₂, may have a unique role in both reducing vascular calcification and improving bone mineral density by reducing undercarboxylated osteocalcin and promoting osteoblast differentiation.²⁵⁻²⁹ Vitamin K₂ is produced by intestinal bacteria from vitamin K₁ (present in dark leafy greens). Natto, a fermented soy product, provides the richest dietary source of vitamin K₂, and it is also found in aged and curd cheeses. Doses used in supplementation range from 45 to 100 µg daily.

Thinness and weight loss are risk factors for bone loss in both men and women.³⁰ A combined approach to exercise may yield the best benefits for bone health. Weightbearing exercise is important for maintaining bone mass and may have other benefits that reduce fracture risk. A review of walking found no effect on spine bone density but was associated with improved hip bone

density.^{31,32} A short-term trial of brisk walking in women older than 50 years with a sedentary occupation found improvements in postural stability.³³ Adding a weight vest improved balance more than walking without a vest.³⁴ Resistance training, especially when combined with weightbearing exercise, has been shown to improve both hip and spine bone density and functional performance, and can be done safely in people who have already experienced bone loss.^{35,36} Yoga may also improve bone density,³⁷ but extreme spinal flexion has been associated with increased risk of vertebral fracture in a few case reports.³⁸ Guided instruction with a yoga teacher trained in adjusting postures for people with osteoporosis is important.³⁹

Studies evaluating the impact of whole body vibration on bone density have been mixed,^{40,41} but 2 recent meta-analyses found overall benefit in improving bone mineral density in the lumbar spine and hip. In addition, it may have benefit in improving lower limb strength, balance, and fall rates.⁴²⁻⁴⁴ Whole body vibration may be particularly useful in people who have limited mobility and balance.

In summary, CJ's story illustrates a common clinical problem: managing bone loss in postmenopausal women, especially when there are concerns about side effects of medications. She had no identifiable secondary causes of bone loss and was not vitamin D deficient. A combination of dietary modifications; modifying her calcium supplementation and adding vitamin K₂; starting a vibration plate; and increasing her weightbearing exercise, yoga and strength training were associated with progressive improvement in her spine bone density and initial improvement then subsequent decrease in her hip bone density. Although she may eventually need pharmacologic management of her bone loss, the gains in balance and strength from her lifestyle changes will independently reduce her risk for falls and fracture.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **AJLM**

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