

Osteoporosis, Nutrition, and The Casein Connection

William Cabot, M.D., FAAOS



Introduction

Osteoporosis is the medical term for bones that have lost calcium and become thin or “less dense”. It is a decrease in “bone mineral density” (BMD). It is a normal process of aging; however, we now know that the course it takes can be improved by engaging in weight bearing exercise and what we eat.

We measure *Bone Mineral Density (BMD)* by utilizing a special scanner to obtain what is called a *Dexa scan*. There are alternative ways to determine the density of the bone but this is the most accurate method.

Osteoporosis has become a popular topic in the past fifteen years because of the decline in use of hormone replacement therapy (HRT). HRT is a combination of estrogen and progesterone commonly given to women when they reach menopause. HRT ameliorated many of the unpleasant side effects of menopause such as hot flashes and was also very effective in maintaining bone mass. Estrogen helps build bone and limit calcium loss and thus when it was less widely used the rate of osteoporosis increased.

Many medical studies concluded that it was logical to decrease the dosages commonly prescribed because women utilizing hormone replacement therapy (HRT) were at increased risk for a variety of medical conditions. HRT has been associated with an increased risk of breast cancer, heart attack, deep vein clots, and gallbladder disease (1, 2, and 3). There are now a multitude of drugs to treat osteoporosis effectively but nutrition also plays a significant role. A deficiency of calcium and vitamin D3 is known to be associated with osteoporosis.

Osteoporosis

Osteoporosis is known as a “silent disease” because the first sign a person experiences is usually a fracture. More than one million fractures per year in the United States are the result of osteoporosis (12) and twenty five million people have osteoporosis. Of these 80% are women, predominantly post-menopausal. Men and young women may also be affected.

The good news is that this disease is treatable if you take the time to be tested for it. Don’t wait for a fracture! The three most common sites of fracture are the vertebrae, hip, and wrist (12).

Unfortunately the consequences of osteoporosis are frequently fatal in elderly people who fracture a hip. Death is usually due to the medical complications that follow surgery. Almost 50% of elderly women who fracture a hip and undergo surgery die within one year from medical complications such as heart failure and blood clots to the lung (pulmonary embolus) associated with general anesthesia and immobilization following surgery.

There are a multitude of etiologies for developing osteoporosis. The most common is normal post-menopausal osteoporosis. Below is a partial list of additional causes of osteoporosis.

Causes of Osteoporosis

Smoking

Excessive caffeine or alcohol use

Genetic predisposition

Immobilization and lack of weight bearing exercise

Dietary mineral deficiencies

Drugs such as steroids, methotrexate, Dilantin, and lithium

Connective tissue disorders such as lupus or rheumatoid arthritis

Malabsorption syndromes

Endocrine disorders such as insulin dependent diabetes, hyperthyroidism, acromegaly, Cushing's disease and hypogonadism resulting in decreased production of estrogen or testosterone

The most common is normal post-menopausal osteoporosis, which is frequently associated with living a nice long life and not being attentive to being tested

Calcium

Calcium is a critical mineral. It not only plays a role in bone formation but is necessary for basic activities such as muscle contraction, nerve conduction, and proper functioning of the heart. There is a definite correlation between higher calcium intakes and increased bone mineral density in children, young adults, and post-menopausal women (4). It has been documented that decreased calcium intake is also associated with an increased incidence of diseases such as colon cancer, breast cancer, diabetes, and hypertension (5).

The recommended daily intake of calcium for an adult is 1,000mg. per day. Some feel that post-menopausal women should have an intake of 1,200mg. per day. The diet of the average American contains approximately 600mg. per day of calcium, which is far less than what we need.

Supplementation is therefore important to make up the difference. A recent study in New Zealand casts doubt on the effectiveness of calcium and vitamin D supplementation (23).

Vitamin D3

Vitamin D3 is also known as Calcitriol and 1, 25-dihydroxycholecalciferol. It is the active form of Vitamin D and is necessary for absorption of calcium from the intestinal tract.

In the past it was widely believed by the medical profession that 15 to 30 minutes of sun exposure per day was adequate for Vitamin D production. We now know that is incorrect and at least 30-50% of the

general population is deficient in Vitamin D3 (6). Blood tests can and should be done to check your level. Supplements are readily available. Many people take a Vitamin D3 supplement prophylactically.

Calcium Absorption and the Casein Connection

Milk and dairy products are the principal sources of calcium in our diet (7). Approximately two-thirds of milk calcium is bound to casein proteins (8). Milk products such as skimmed milk and yogurt retain almost all their original calcium present before processing, whereas cheeses retain approximately 80% (8). Ingestion of various dairy sources of calcium is linked to increased bone mineral density and reduction in rates of fracture (9).

It is important that we not only consume foods rich in calcium but that we are able to absorb the calcium from those foods. Casein plays a unique role in the transportation of calcium complexes, thus making calcium available for absorption, predominantly in the small intestine (8).

Two interesting studies were published in the British Journal of Nutrition. Lee found that rats fed a casein diet had higher rates of calcium absorption than those fed a diet containing egg albumin, soy protein, or an amino acid mixture. It was concluded that casein phosphopeptides prevented the formation of insoluble calcium salts (10). The other study by Tsuchita suggested that the addition of casein phosphopeptides to calcium fortified milk facilitated the absorption of calcium (11) from the intestine.

Casein helps to keep calcium in a soluble form until it reaches the part of the intestine where it is absorbed. Studies were done comparing whey and casein with regard to their effect on mineralization of bone. Casein was found to be superior (8).

Vitamins and Minerals Affecting Bone Density (a partial list)

Magnesium

- Helps regulate calcium transport and increases BMD (13, 14, 15, 16).
- Stimulates osteoblasts which are bone forming cells.
- Facilitates the transport of calcium in and out of bone.

Vitamin K

- Required for the production of the bone protein osteocalcin (17, 18).
- Some patients with spine and hip fractures have been found to have low levels of vitamin K.

Vitamin C

- Necessary for the production of collagen, the substrate of bone (19).

Zinc

- Low blood levels of zinc and high urinary levels of zinc have been found in patients with osteoporosis (20).

Vitamin B12

- Low plasma B12 is associated with lower BMD (21).
- Strict vegetarians who were B12 deficient had low levels of alkaline phosphatase and osteocalcin, indicating decreased bone formation.

Copper

- Low copper levels in post-menopausal women were found to be a risk factor for developing osteoporosis (22).

Summary

There is no doubt that nutrition plays a critical role in the evolution of osteoporosis. Ensuring the adequacy of many nutrients besides calcium is essential for bone health, just as weight bearing exercise is critical for the maintenance of bone mass. Dairy products are excellent sources of calcium. Individual requirements vary with age, prescribed medications, dietary preferences and the presence or absence of other diseases.

BIBLIOGRAPHY

1. Dhiman RK et al; Is there a link between estrogen therapy and gallbladder disease. *Expert Opin Drug Saf* 2006Jan;5(1); 117-129.
2. Nelson HD et al; Postmenopausal hormone replacement therapy: scientific review. *JAMA* 2002 Aug 21;288(7);872-81.
3. Hunter D et al; Oral contraceptive use and breast cancer: a prospective study of young women. *Cancer Epidemiol Biomarkers Prev* Oct 2010;19(10) 2496-2502.
4. Heaney RP; Calcium, dairy products, and osteoporosis. *J Am Coll Nutr* 2000 Apr;19(2 Suppl):83S-99S.
5. Nicklas TA; Calcium intake trends and health consequences from childhood through adulthood. *J Am Coll Nutr* 2003 Oct;22(5):340-356.
6. Lee JH et al; Vitamin D deficiency an important, common, and easily treatable cardiovascular risk factor? *J Am Coll Cardiol* 2008 Dec 9;52(24):1949-56.
7. U.S. Department of Agriculture, Agricultural Research Service. 2011. USDA National Nutrient Database for Standard Reference, Release 24.
8. Park Y; Bioactive components in milk and dairy products. Wiley Blackwell, 2009.
9. Volek JS; Increasing fluid milk favorably affects bone mineral density responses to resistance training in adolescent boys. *J Am Diet Assoc.* 2003 Oct;103(10):1353-6.
10. Lee YS et al; Phosphopeptides and soluble calcium in the small intestine of rats given a casein diet. *Br J Nutr* 1980 May;43(3):457-467.
11. Tsuchita et al; The effect of casein phosphopeptides on calcium absorption from calcium fortified milk in growing rats. *Br L Nutr* 2001 Jan;85(1)5-10
12. Germano C, Cabot W; *The Osteoporosis Solution*. Kensington Books 1999.
13. Dimai HP et al; Daily oral magnesium supplementation suppresses bone turnover in young adult males. *J Clin Endocrinol Metab* 1998 Aug; 83(8):2742-8.
14. Rude RK et al; Magnesium deficiency induces bone loss in the rat. *Miner Electrolyte Metab* 1998;24(5):314-20.
15. Sojka JE et al. Magnesium supplementation and osteoporosis. *Nutr Rev* 1995 Mar;53(3):71-4.
16. Tucker KL et al; Potassium magnesium, and fruit and vegetable intakes are associated with greater bone mineral density in older men. *Am J Clin Nutr* 1999 Apr;69(4):727-36.
17. Feskanich D et al; Vitamin K intake and hip fractures in women: a prospective study. *Am J Clin Nutr* 1999 Jan;69(1):74-9.
18. Shiraki M et al; Vitamin K2 (menatetrenone) effectively prevents fractures and sustains lumbar bone mineral density in osteoporosis. *J Bone Miner Res* 2000 Mar;15(3):515-21.
19. Leveille SG et al; Dietary vitamin C and bone mineral density in postmenopausal women in Washington State, USA. *J Epidemiol Community Health* 1997 Oct;51(5):479-85.
20. Hyun TH et al; Zinc intakes and plasma concentrations in men with osteoporosis: the Rancho Bernardo Study. *Am J Clin Nutr* 2004 Sept;80(3):715-721.
21. Tucker KL et al; Low plasma vitamin B12 is associated with lower BMD:the Framingham Study. *J Bone Miner Res* 2005 Jan;20(1):152-8.
22. Okyay E et al; Comparative evaluation of serum levels of main minerals and post-menopausal osteoporosis. *Maturitas* 2013 Dec;76(4)320-5.
23. <http://www.nbcnews.com/health/diet-fitness/calcium-supplements-or-dairy-doesnt-strengthen-bones-study-finds-n45726>.

