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Osteoporosis Disease Management: What Every Orthopaedic Surgeon Should Know

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Introduction

According to recent information from the National Osteoporosis Foundation[1] and the Office of the Surgeon General[2], osteoporosis is a major medical problem. The disease currently affects 8 million women and 2 million men in the United States. An additional 34 million Americans have low bone mass. Each year, an estimated 1.5 million individuals in the United States experience a fragility fracture secondary to osteoporosis, resulting in an annual cost of 18 billion dollars. With the rapidly aging U.S. population, the problem of osteoporosis is now reaching epidemic proportions. There are 75 million baby boomers entering the stage in their lives when they are most at risk for osteoporosis. One-half of all women and one-third of all men will sustain a fragility fracture during their lifetime.

There is a huge cost associated with osteoporosis in terms of morbidity, mortality, and the financial impact on society. The most devastating complication of osteoporosis is a hip fracture. According to the most recent statistics published in the United States Surgeon General's 2004 report on osteoporosis, of the 325,000 patients who sustain a hip fracture each year, 25% will find it necessary to enter a nursing home, 50% will never reach their previous functional capacity, and 25% will die within the first year after the fracture[2]. The first-year mortality rate after a hip fracture is almost twice as high in men as it is in women (30% compared with 17%). The mortality rate associated with osteoporosis-related fractures is greater than the rates associated with breast cancer and cervical cancer combined[1-6].

Only 20% of patients who have had a previous hip fracture or other fragility fracture receive treatment for osteoporosis[7-13]. There are certainly many missed opportunities for fracture prevention[14].

Pathophysiology of Osteoporosis

To achieve a significant decrease in osteoporosis-related hip fractures, it is important to understand the pathophysiology of osteoporosis as well as the risk factors that are associated with hip fractures.

Osteoporosis is characterized by low bone mass and structural deterioration of bone tissue, which leads to bone fragility and an increased susceptibility to fractures. Bone strength is related to bone density as well as changes in the micro-architecture of bone. The micro-architecture of bone is a poorly understood concept and is currently very difficult to measure without a biopsy. A dual x-ray absorptiometry scan provides information about bone density but does not provide any information about the micro-architecture of the bone. As bone strength decreases as a result of changes in bone density and/or changes in bone micro-architecture, the risk of fracture increases[15].

In both men and women of all races, bone mass increases with age until approximately thirty years of age and then begins to decrease. After menopause begins, the rapid drop in estrogen levels may lead to a 1% to 3% drop per year in bone mineral density for as long as ten years, followed by a slower loss of bone density. Men start out with a higher peak bone mass than women, and they lose bone at a slower rate than women do[16,17].

Bone Remodeling

Bone remodeling is a combination of resorption and formation. With osteoporosis, there is a net loss of bone as well as a change in the micro-architecture of the bone[15]. It is important to understand the factors that contribute to normal and abnormal remodeling of bone.

Calcium

Ninety-nine percent of the total calcium in the human body is stored in the bones. In addition to serving as a reservoir for the calcium needs of the body, stored calcium also acts as a bone strengthener. The small amount of calcium that circulates outside of bone plays a crucial role in muscle and nerve function. As serum calcium levels drop, bone resorption increases. Calcium absorption is significantly improved when the circulating levels of vitamin D are adequate[2].

Vitamin D

Even though it is called a vitamin, vitamin D acts more like a hormone in that it helps to increase calcium absorption and decrease calcium excretion. Vitamin D can be synthesized in the skin when the skin is exposed to ultraviolet-B rays from

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sunlight. A five to ten-minute exposure of sunlight to the unprotected arms and legs results in the production of 3000 IU of vitamin D[18]. Proper intake of calcium and vitamin D may decrease fracture rates by up to 25% by maintaining good bone health[19]. Vitamin D has been shown to decrease the types of falls that are often associated with fragility fractures[20].

Parathyroid Hormone

Parathyroid hormone plays a crucial role in helping to maintain calcium homeostasis. At physiologic levels, parathyroid hormone acts at the level of the osteoclast to increase bone resorption and it also acts in the gut to help assist in calcium absorption. At pharmacologic levels, parathyroid hormone stimulates osteoblasts to increase bone formation. Low vitamin-D levels may cause secondary hyperparathyroidism and a resultant increase in bone resorption[2].

Estrogen

Estrogen suppresses osteoclast activity in women and, surprisingly, also in men. The decrease in estrogen at the time of menopause leads to a rapid loss of bone mineral density[16].

Testosterone

Testosterone helps osteoblasts to form bone. Men on medications that suppress testosterone may experience a >4% drop in bone mineral density per year[21].

Secondary Causes of Osteoporosis

It is vital not to forget all the secondary causes of osteoporosis, such as primary hyperparathyroidism or tumors, when bone loss has been detected[22].

Laboratory Tests

There is no established set of laboratory tests for the routine evaluation of osteoporosis. Prior to the initiation of treatment, however, laboratory tests can be used to identify low blood calcium levels, vitamin-D deficiencies, and renal problems.

The following common routine laboratory tests may be helpful in the diagnosis and management of osteoporosis[2]:

- **Serum calcium level.** This level is usually normal in patients with osteoporosis but may be elevated in patients with other bone diseases.
- **25-hydroxyvitamin-D level.** Deficiencies may lead to decreased calcium absorption. Vitamin-D deficiency is extremely common in elderly persons.
- **Complete blood-cell count.** Determination of the complete blood-cell count can be helpful in checking for secondary osteoporosis.
- **Twenty-four-hour urine calcium level.** The urine calcium level can be measured to check for hyperexcretion of calcium.
- **Parathyroid hormone level.** This level can be measured to screen for hyperparathyroidism.
- **Testosterone level.** The testosterone level can be measured to check for testosterone deficiencies in men.
- **Protein electrophoresis.** This test can aid in the identification of multiple myeloma.
- **Thyroid function tests.** The measurement of thyroid function can be helpful in screening for thyroid disease.

Risk Factors for Osteoporosis

There are modifiable and nonmodifiable risk factors for osteoporosis and fragility fractures that should be considered in all patients[2].

The *nonmodifiable risk factors* for osteoporosis fractures[2] include the following:

- **The genetic profile.** In the future, there may be a potential for treatment with gene suppression or manipulation.
- **History of fracture in a first-degree relative.** This may be related to the genetic profile.
- **Female sex.** Compared with men, women have twice the risk of sustaining a fragility fracture.
- **Advanced age.** The risk of a hip fracture doubles every five years past seventy years of age.
- **Caucasian race.** Compared with Blacks, Caucasians have twice the risk of sustaining a fragility fracture.

The *modifiable risk factors* for osteoporosis fractures[2] include the following:

- **Currently smoking cigarettes**
- **Low body weight** (<127 lb [57.6 kg] in women and <154 lb [69.9 kg] in men) or **low body mass index** (<20 in women and <25 in men)
- **Low calcium intake and low vitamin-D intake.** A single multivitamin tablet a day does not provide enough calcium or vitamin D.
- **Excessive alcohol intake**
- **Recurrent falls**
- **Poor physical activity**
- **Poor health or being frail**
- **Estrogen deficiency.** Early menopause or surgical menopause increases the risk of sustaining a fragility fracture.

Osteoporosis and Fracture Prevention and/or Treatment

Medications

Calcium and Vitamin D

Calcium: Depending on a patient's age, the daily calcium requirement varies. For patients who are more than fifty years of age, 1200 mg of calcium per day is recommended[1].

Vitamin D: Over the past several years, the recommended daily dose of vitamin D has increased. The newest recommendations suggest that 1000 IU of vitamin D is needed daily[1].

Antiresorptive Agents

Oral bisphosphonate: Bisphosphonates are considered the mainstay of preventative prescription treatment for patients with osteoporosis. Most patients with osteoporosis now take a generic bisphosphonate medication once a week. Bisphosphonates