

Causes, Diagnose and Treatment of Osteoporosis

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Abstract. Osteoporosis is a chronic degenerative bone disease that seriously affects human health. This study analyzes the causes of osteoporosis in detail, expounds the common diagnostic methods, and proposes some corresponding treatment programs. Dual Energy X-ray Absorptiometry has high accuracy, image quality improvement, fast speed, rich clinical applications, and is suitable for scientific research. Quantitative Computed tomography measures true volumetric bone mineral density using initial CT data. This method is not affected by obesity, hyperosteoecplasia, vascular calcification and vertebral size. Osteoporosis has the primary and secondary causes, primary osteoporosis covers the osteoporosis when women go through menopause (Type I), and osteoporosis of senile (Type II), and secondary osteoporosis refers to osteoporosis caused by certain medical conditions or medications. Exercise can help patients treat osteoporosis, and drugs could help prevent falls help prevent fractures. However, the treatment effect of most osteoporosis patients is not satisfactory. To treat osteoporosis, only one drug "single-handedly" has limited efficacy, and to effectively combat osteoporosis, it is necessary to emphasize "multi-service combat".

Keywords: Osteoporosis, Causes, Diagnose, Treatment.

1. Introduction

Osteoporosis is a chronic degenerative bone disease that seriously affects human health. It is characterized by the destruction of bone microstructure, decreased bone mass, and increased bone fragility, leading to an increased risk of secondary fracture. While osteoporosis can occur in any population and age, poor diet is one of the reasons for osteoporosis; the lack of nutrition makes human immunity decline. A balanced diet, adequate sunshine, and regular exercise are conducive to healthy and strong bones and muscles, reducing osteoporosis incidence. In general, underweight people who smoke for a long time, drink excessively, like to drink coffee and carbonated drinks, do not do physical activity, and are deficient in calcium (Ca) and vitamin D in their diet are susceptible to the disease. It is especially common in postmenopausal women and old men. The global population is ageing more and more seriously, and osteoporosis is more common in the elderly, seriously affecting their daily life.

Poor diet is one of the reasons for the occurrence of osteoporosis. The lack of nutrition leads to the decline of human immunity. A balanced diet, sufficient sunshine and regular exercise are conducive to the healthy and strong bones and muscles and reduce the incidence of osteoporosis. Surgery is by far the most common treatment, with either bone compression or locking plate fixation. The advantages of bone compression technology are that it is easy to implement and the initial coupling effect between the implant and the fracture is good, but it may cause secondary damage to the fracture site and is not conducive to healing. Locking plate fixation technology can ensure the normal transportation of nutrients at the fracture site, with less damage to the surrounding tissue, but has a certain probability of forming callus, resulting in bone nonunion. In this paper, the causes of osteoporosis are discussed in detail from the primary and secondary perspectives, the common diagnostic methods are expounded, and some corresponding treatment programs are proposed.

2. Diagnostic methods

2.1. Main characteristics of osteoporosis patients

(1) The pain

Osteoporosis can cause severe pain in the spine.

(2) The hunchback

The anterior vertebrae of osteoporotic patients are prone to compression and deformation, which becomes increasingly obvious with the worsening of osteoporosis.

(3) Respiratory function

People with osteoporosis have decreased respiratory function. Compression fractures of the thoracic and lumbar vertebrae, posterior curvature of the spine, and thoracic deformity can significantly reduce vital capacity and maximum air exchange, and patients often have chest tightness, shortness of breath, dyspnea and other symptoms.

According to data, osteoporosis is responsible for 0.83% of the non-communicable illness burden worldwide. Around 9 million new fragility fractures occurred in the year 2000, of which 1.6 million included the hip, 1.7 million involved the wrist, 700,000 involved the humerus, and 1.4 million involved the thoracic spine [1].

2.2. Diagnostic Methods

(1) Dual Energy X-ray Absorptiometry (DEXA)

DEXA is the most widely used instrument for osteoporosis detection.

1) *Principle of DEXA*

Two kinds of energy, namely, low- and high-energy photon peaks, could be obtained through the X-ray bulb via a certain device. After the photon peak through the human body, the photon scanning system is accepted by the signal sent to the computer for data processing and the bone mineral contents are obtained. This device can measure any part of the whole body bone mass with high precision, which makes it less harmful to the human body. The radiation dose to one site is equal to 1/30 of a chest radiograph. With the development of China's big cities gradually, the prospects are good.

2) *Characteristics of DEXA*

DEXA has high accuracy, image quality improvement, fast speed, rich clinical applications, and is suitable for scientific research. According to relevant data statistics, about 78% of the people in the physical examination and about 22% of the patients in the ward and outpatient department are on the bill for DEXA use.

3) *The role of DEXA*

According to the International Society for Clinical Bone Mineral Density Measurement, the diagnosis of osteoporosis is based on the bone mineral density values of L1-4 or L2-4, femoral neck and total hip, and the lowest of the above sites. Osteoporosis can be diagnosed as long as one site meets the diagnostic criteria.

DEXA can accurately provide doctors with BMD values of regions of interest, which is helpful for orthopedic surgery and endocrine drug intervention. Considering that elderly people are prone to fractures of femoral neck and distal radius, DEXA physical examination of special groups and sites can effectively indicate the risk of fracture.

4) *The criteria of DEXA*

T values are young normal values below the number of standard deviations (SD). A T value greater than -1 is normal, and the diagnostic criterion for osteoporosis is a T value less than -2.5SD [2]. This method is usually applied to the total hip joint, femoral neck and lumbar spine.

5) *Clinical indications for DEXA*

Primary osteoporosis includes two types: Type I osteoporosis (high conversion type), including female postmenstrual osteoporosis, idiopathic osteoporosis, and adult osteoporosis; Type II

osteoporosis (low transformation type) mainly occurring in the elderly, also known as proliferative osteoporosis;

Secondary osteoporosis includes endocrine system diseases such as crushing syndrome, acromegaly, hyperthyroid disease, hyperparathyroidism, diabetes, hyposexual dysfunction; digestive system diseases such as after gastrointestinal surgery, chronic hepatitis, liver cirrhosis, chronic gastrointestinal dysfunction, small intestinal malabsorption syndrome; malignant tumors including pulmonary hypertrophic bone disease.

(2) Quantitative Computed tomography (QCT) measurement

QCT measures true volumetric bone mineral density using initial CT data. This method is not affected by obesity, hyperosteoplasia, vascular calcification and vertebral size [3,4]. The ISCD and the American College of Radiology (ACR) both recommend QCT for the diagnosis of osteoporosis as lumbar the density of bone (BMD) less than 80 milligrams per cubic centimeter [3,5]. As for dual-energy X-ray absorptiometry, clinical trial scope of QTC is not wide, mainly because the radiation quantity of QTC is higher and the operation is more difficult, so dual-energy X-ray absorptiometry is more preferable.

However, multi-slice spiral CT (MSCT) can collect a large range of CT data in a short time. In addition, QTC technology has been upgraded from liquid phantom to solid phantom, and the data software capable of three-dimensional analysis can detect multiple body parts simultaneously, which makes QTC technology have great potential in osteoporosis diagnosis and treatment, pre-disease monitoring, preoperative evaluation of orthopedics.

3. Category and Causes

3.1. Primary Causes

Primary osteoporosis includes osteoporosis when women go through menopause (Type I), and osteoporosis of senile (Type II) [6]. Type I is primarily due to a lack of female and male hormones. This causes increased bone turnover, and bone resorption would exceed osteoclastogenesis and trabecular bone decreases over cortical bone. Type II, also called the age-related progressive bone loss. It can be seen both sexes caused by systemic aging and caused by loss of stem cell precursors. [7].

Age is one of the most common causes of primary osteoporosis. Demontiero and his colleagues reviewed the new evidence on the pathophysiology of age-related bone loss, focusing on the mechanism of action of current osteoporosis treatments. Elder people have higher the risk of osteoporosis [8].

Genetic cause has attracted scientists to make modern advances in knowledge about the genetic basis of osteoporosis. Genetic factors has effect on osteoporosis, and other phenotypes associated with fracture risk [9]. Linkage studies have identified several quantitative trait loci that regulate BMD, but most causal genes remain to be identified.

Hejazi and his group have studied specific effects of different nutrients on BMD (bone mass density). The amount of calcium determines the density of bone. If the amount of calcium is reduced, the high phosphorus content can damage bone tissue. Vitamin D is also linked to bone density. If serum vitamin D levels are below 20 ng per milliliter, bone density will decrease. Both of these factors can have an effect on bones. Meanwhile, the increase in high protein reduces bone mass and calcium content [10].

Endocrine issues may cause osteoporosis. After menopause, estrogen loss could be a major cause of osteoporosis. Also, increasing fat mass may not benefit bone mass.

3.2. Secondary Causes

Osteoporosis brought on by certain illnesses or drugs is referred to as secondary osteoporosis. These might result in bone loss, raise the risk of fracture, have a direct or indirect impact on bone remodeling, or slow the development of bone mass in young people.

There are so much situations can be caused by secondary osteoporosis such as oral corticosteroids, hyperthyroidism, alcohol abuse and so on.

Osteoporosis means that porous bone is a new state. This has more fragile structure than the original one.

4. Treatments

To Stop bone loss and to prevent fractures are goals of treatment for osteoporosis.

4.1. Exercises

Exercise makes people accustomed to weight-bearing activities such as running, walking, tennis, dancing, climbing stairs, aerobic exercise, and lifting weights. When the patients do this regularly, this contributes to bone density, so bones are stronger. Doing this exercise thrice a week for 30 to 45 minutes is suggested. While cycling and using an elliptical machine are good for heart, they may not be the best option to help patients treat osteoporosis because they don't put enough stress on your bones. Therefore, patients can still do their cardio benefits. Just make sure patients do bone strengthening training too.

4.2. Drugs

Drugs could help prevent falls help prevent fractures. People who acquire osteoporosis as a result of other illnesses should work with their doctor to determine and address the root cause. For instance, if a patient takes a drug that increases their risk of developing osteoporosis, their doctor may reduce their dose or prescribe another prescription. Certain drugs may also be used to prevent or cure osteoporosis related to age or menopause in individuals who have a condition that necessitates long-term glucocorticoid therapy, such as rheumatoid arthritis or chronic lung disease. Additionally, doctors may be required to recommend medications including raloxifene, teripatide, abapatide, romozumab, estrogen (also used to treat menopausal symptoms), calcitonin, and bisphosphonates (aronronate, risedronate, ibanphosphonate, and zoledronic acid). Despite the possibility of negative effects, many treatments are successful. Find out from the doctor whether the patient needs the therapy and which course of action is best for them. Numerous medications are approved by the U.S. Food and Drug Administration (FDA) to treat and prevent osteoporosis.

(1) Bisphosphonates

Bisphosphonates are the most commonly used and first class of drugs currently used in anti-osteoporosis therapy. However, such drugs may not achieve the best anti-osteoporosis effect, and there are certain side effects, and other drugs need to be added or replaced with other drugs. When a doctor prescribes such medications after diagnosis, please take them in strict accordance with doctor's instructions. If patients have an active stomach, duodenal ulcer, reflux esophagitis, severe oral illness, need to undergo dental surgery, or have renal abnormalities, they should take such drugs with caution.

(2) Selective estrogen receptor modulators

In addition, it is also suggested to choose selective estrogen receptor modulators drugs such as raloxifene. It is often said that older women are more likely to develop osteoporosis than men. This is well-founded that estrogen in women helps prevent bone loss, while postmenopausal women are more likely to cause osteoporosis due to the reduction of estrogen and the fact that women do not have as many bone reserves as men. But at the same time, it must also be noted that these drugs are only suitable for women who have experienced menopause, and men should not use them indiscriminately.

(3) Calcitonin

When there is severe osteoporosis throughout the body, many elderly people complain of general pain, pain during the day, and pain at night, especially in the lower back spine. At this time, patients can consider using calcitonin, a type of hormone that the body can produce on its own. The reason why it is called calcitonin is because it can reduce the amount of Ca in the body transferred from the

bone to the blood, and at the same time, it has a significant inhibitory effect on osteoclasts (as the name suggests: destroying the bone), inhibiting bone destruction, in a sense, it is also an anti-osteoporosis treatment. Such as salmon calcitonin, used to reduce the activity and number of osteoclasts, directly inhibit bone resorption, and slow down bone conversion.

(4) Ecalcitonin

Ecalcitonin is used to treat osteoporosis and pain caused by osteoporosis. From the clinical manifestations, the overall treatment effect of calcitonin drugs is good. It can be used in all groups except those with a history of allergies to calcitonin components and pregnant women. Normal bone mineral density is one important factor. This factor can improve the homeostasis of bone formation and resorption. Osteoporosis occurs when the amount or rate of bone formation is lower than bone resorption.

(5) Teripatide

Teripatide can promote the proliferation and differentiation of osteogenic progenitor cells, directly inhibit the apoptosis of osteoblasts, prolong the osteogenic action time, and promote the transformation of lining cells into osteoblasts. However, it should be noted that the drug is contraindicated in people allergic to teripatide, pregnant and lactating women, patients with hypercalcaemia, patients with severe renal insufficiency, and patients who have previously received radiation therapy for external radiation or bone implantation. Other mechanisms of this class of drugs can slow down bone reconstruction, both inhibit bone resorption and stimulate the growth of osteoblasts, such as strontium salt ranerinate for the treatment of postmenopausal osteoporosis, to reduce the risk of vertebral and hip fractures; Isoflavone derivatives epheflavones are used to improve osteopenia in osteoporosis.

4.3. Diet

Food sources of Ca and vitamin D include skim milk, low-fat yogurt, vegetable milk or Ca-rich orange juice, cauliflower, salmon, tofu and green leafy vegetables. If patients are 19-50 years old, consume 1,000 mg of Ca daily. If patients are women 51 years of age or older, or men 71 years of age or older, patients need 1200 mg per day. It is best to get Ca from food. If patients want to take supplements, talk to the doctor first. The doctor can tell patients if they need to take Ca supplements at different times. To help the body absorb Ca from food or supplements, doctors recommend taking vitamin D. Patients can get vitamin D from fortified foods and sunlight. There are other simple ways to get more Ca at home. For example, patients can add skim milk powder to daily food and drink, including soups, stews, and casseroles. Each cup of dry milk can increase daily Ca requirements by a third.

4.4. Combined treatments

However, the treatment effect of most osteoporosis patients is not satisfactory, and low back pain and fractures caused by osteoporosis have become a serious threat to the elderly. To treat osteoporosis, only one drug "single-handedly" has limited efficacy, and to effectively combat osteoporosis, it is necessary to emphasize "multi-service combat". The commonly used "coordinated combat" method is as follows.

Ca + vitamin D: is the basic choice for the treatment of senile osteoporosis, and the drug is cheap and easy to take for a long time. Ca + vitamin D + bisphosphonate, or Ca + vitamin D + calcitonin: is the most commonly used means of osteoporosis treatment. The combination of three drugs can give full play to their respective advantages and avoid each other's deficiency. This combination may be available to patients with some affordability.

Estrogen + "1": that is, estrogen + vitamin D, estrogen + bisphosphonate or estrogen + calcitonin, suitable for postmenopausal osteoporosis patients. Studies have shown that the combination of vitamin D, bisphosphonate or calcitonin in estrogen therapy can obtain better clinical efficacy with estrogen therapy alone, and the effective dose of estrogen is reduced, and the incidence of adverse reactions is reduced. For osteoporosis, the public usually feels that this is not a disease, and it is good

to eat some Ca tablets to supplement Ca. Drug intervention is an important part of osteoporosis intervention and treatment. As long as patients pay attention to it and strictly implement the drug intervention in strict accordance with the doctor's instructions, then the symptoms of osteoporosis can be greatly alleviated.

5. Conclusion

Osteoporosis increases risk of fractures, causes pain, and decreases respiratory function. Main diagnostic method is to use dual-energy X-ray absorptiometry and quantitative CT to measure MBD. When T values less than -2.5SD or lumbar bone mineral density less than 80 mg/cm³, it should be diagnosed as osteoporosis.

Drug-induced osteoporosis (DIO) seriously affect the patient's quality of life, easy to cause fall, fracture and even life-threatening, so clinicians should master relevant knowledge and update DIO, when drug applications may induce DIO, completes the osteoporosis-related knowledge of medicine education, regular monitoring of the patient's bone metabolism index, regularly measuring bone mineral density. Treatment with necessary anti-osteoporosis drugs was administered. Where possible, use a variety of methods to intervene, such as reducing the dosage, shortening the duration of medication, and considering alternative medications.

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