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Prevention and Management of Osteoporosis using Vitamin D among Elderly Women

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Abstract

Introduction: Osteoporosis is a condition that is partly caused by a deficiency in vitamin D and results in fragile bones that are prone to fractures. This review studied the prevention of osteoporosis using vitamin d among elderlies.

Methods: In this review, an electronic search was conducted in Medline, EmBase and Cochrane databases. Various primary and secondary subject headings related to vitamin D deficiency and insufficiency were combined and used to perform Boolean searches. The primary focus of the study was to assess the prevalence of vitamin D inadequacy in different populations, with a particular emphasis on elderly population with osteoporosis. The prevalence data were sorted first by vitamin D status and then by age. Only clinical trials that assess the effect of vitamin D in the treatment and prevention of osteoporosis.

Results: This review evaluated 16 studies focused on the effects of vitamin D supplementation on hip fractures and bone density in a group of 2537 participants. The review found that plain vitamin D supplementation did not reduce the incidence of hip fractures. However, the use of alfacalcidol, a form of vitamin D, was found to increase lumbar bone density and inhibit the decrease in total body bone density. It is important to maintain an adequate intake of calcium to maintain a balanced diet.

Conclusions: The best way to meet daily requirements is through the consumption of high calcium-containing foods, or by taking calcium supplements. In the prevention of osteoporosis, many individuals, especially postmenopausal women, do not consume enough calcium from their diet and may need to take supplements.

Keywords: Vitamin D, Awareness, Practices, Osteoporosis, Bone density.

Introduction

Osteoporosis is a condition that weakens the bones and makes them more prone to fractures, especially in elderly women. It is caused by a decrease in bone mineral density and can be influenced by calcium and vitamin D deficiencies. It is a significant burden on healthcare systems due to the high cost of treating fractures, particularly hip fractures [1]. While treatments for osteoporosis have been well studied in women, there is less research on their effectiveness in men. Clinical trials have been conducted to evaluate the use of calcium and vitamin D supplements to prevent fractures in elderly individuals and to reduce the risk of new fractures in patients with osteoporosis. One such trial included 2578 subjects (1916 women and 662 men) between the ages of 70 and 97, living independently in apartments or nursing homes [2].

Osteoporosis is a condition that is partly caused by a deficiency in vitamin D and results in fragile bones that are prone to fractures. The incidence of osteoporosis and related fractures tends to increase in populations with higher levels of economic development. To prevent osteoporosis, it is important to optimize physical activity, nutrition, and the environment. The current recommended dosage of 20 mg per day of vitamin D3 (cholecalciferol) for the prevention or treatment of osteoporosis was originally chosen because it is double the standard dosage of 10 mg per day of vitamin D2 (ergocalciferol). However, there is limited information about the optimal dosage of vitamin D for preventing osteoporosis [3]. There have been many studies examining the use of the hormone calcitriol and its analogs in the prevention and treatment of osteoporosis. Osteoporosis is a common skeletal disease that causes thinning of the bones and weak bone strength, particularly in older people. It is estimated that over 10 million Americans over the age of 50 have osteoporosis, and it affects people of all ethnicities [4]. Fractures caused by osteoporosis or low bone mass can lead to chronic pain, disability, and psychological issues such as depression. There are a number of pharmacologic treatments for osteoporosis that can improve bone mass and reduce fracture risk. Calcium and vitamin D are important in the essential management of osteoporosis, and patients with the condition are often found to have inadequate dietary intake of calcium. Vitamin D deficiency can lead to rickets in children and osteomalacia and osteoporosis in adults [5]. The National Osteoporosis Foundation recommends an intake of 800 to 1000 international units of vitamin D3 per day for adults over age 50. A bone mineral density test is often used to diagnose osteoporosis and predict fracture risk, and the FRAX algorithm takes into account not only BMD at the hip but also nine specific clinical risk factors for osteoporosis and related fractures. Hormone therapy can decrease the incidence of osteoporosis and reduce fracture risk in postmenopausal women [6]. There are a number of prescription therapeutic options for the prevention and treatment of osteoporosis, including teriparatide, a parathyroid hormone derivative that acts as an anabolic agent on bone. However, adequate calcium and vitamin D stores are necessary for pharmacologic treatments to be effective, and both patients and healthcare providers need to be aware of the importance of maintaining these stores to prevent bone loss and osteoporosis [7].

Osteoporosis is a condition that causes thinning of the bones and weak bone strength, particularly in older people. It is characterized by a decrease in bone mass and deterioration of the microarchitectural integrity of bone tissues, leading to impaired bone strength and an increased risk of fractures. There are two primary types of osteoporosis: postmenopausal (type I) and senile (type II). Both types have been linked to impaired calcium absorption and secondary hyperparathyroidism, which leads to increased bone resorption, bone loss, and osteoporosis [8]. Vitamin D deficiency has also been associated with senile osteoporosis and fractures. There are two forms of vitamin D replacement therapy for osteoporosis: plain vitamin D therapy, which uses vitamin D2 or D3 as the active agent, and active vitamin D analog therapy, which uses the active metabolite 1,25(OH)D3 or an analog as the therapeutic agent [9]. Both therapies have been shown to increase bone mass and reduce a

fracture risk in patients with osteoporosis. Direct comparisons of the two therapies are scarce, and more research is needed to determine the comparative efficacy of plain vitamin D therapy and active vitamin D analog therapy in the treatment of osteoporosis [10]. This review studied the prevention of osteoporosis using vitamin d among elderlies.

Methods

In this review, an electronic search was conducted in Medline, EmBase and Cochrane databases. Various primary and secondary subject headings related to vitamin D deficiency and insufficiency were combined and used to perform Boolean searches. The primary focus of the study was to assess the prevalence of vitamin D inadequacy in different populations, with a particular emphasis on elderly population with osteoporosis. The prevalence data were sorted first by vitamin D status and then by age. The review included any studies that reported the prevalence of vitamin D inadequacy as a percentage of the population with low levels of serum 25(OH)D, which is the accepted indicator of vitamin D status. The prevalence of vitamin D inadequacy was found to vary by region, and the study also reported the mean serum 25(OH)D levels for the populations studied where available, along with the assay method used to determine these levels. Only clinical trials that assess the effect of vitamin D in the treatment and prevention of osteoporosis.

Results and discussion

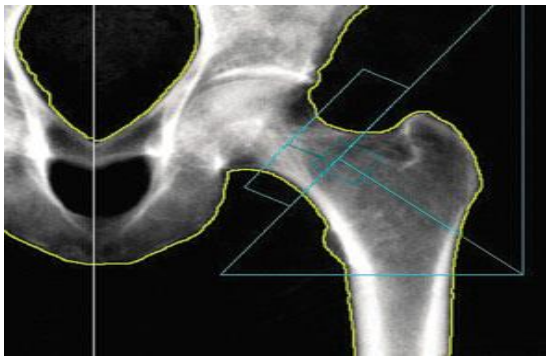
This review evaluated 16 studies focused on the effects of vitamin D supplementation on hip fractures and bone density in a total of 2,537 participants across the included studies. The review found that plain vitamin D supplementation did not reduce the incidence of hip fractures. However, the use of alfacalcidol, a form of vitamin D, was found to increase lumbar bone density and inhibit the decrease in total body bone density [11]. Additionally, patients taking alfacalcidol experienced approximately a third of the number of new fractures as those in the control group, although this difference was not statistically significant. A network meta-analysis by Shao also found that the combination of alendronate and alfacalcidol was significantly better at preventing bone fractures than either alendronate or alfacalcidol used as monotherapy. The combination of alendronate and alfacalcidol was also found to be associated with an 80% reduction in the incidence of back pain after two years of treatment, compared to a 30% reduction in the control group [12]. The use of alfacalcidol was also found to increase bone density at the lumbar spine, total hip, and femoral neck, and decrease the level of intact parathyroid hormone. Side effects of alfacalcidol reported by the manufacturer include rash, hypercalcemia, hyperphosphatemia, and hypercalciuria. In this review, the selected cut-off points for calcium intake were 1200 mg/day and for 25(OH)D serum levels were <50 nmol/l and <75 nmol/l for vitamin D deficiency and insufficiency, respectively. The review focused on elderly, particularly post-menopausal women (PMO) with osteoporosis, and found that the most commonly used therapeutic class was bisphosphonates (70%), followed by selective estrogen receptor modulators (12%), while the remainder (18%) received other drugs for osteoporosis [13].

A study found that within the untreated group, the prevalence of vitamin D deficiency (<50 nmol/l) and vitamin D insufficiency (<75 nmol/l) was 44% and 76%, respectively. Additionally, 78% of PMO women without treatment had a calcium dietary intake of less than 1200 mg [14]. The study also found that 25(OH)D serum concentrations were significantly correlated with body mass index (BMI), serum parathyroid hormone (PTH), phosphate, magnesium, serum C-telopeptide (CTX), osteocalcin, and total alkaline phosphatase. Despite good treatment compliance, as reported by direct questioning of participants, 30% of PMO women were vitamin D deficient and only 37% had 25(OH)D levels above 75 nmol/l. Additionally, 71% of PMO women on osteoporosis treatment had a total calcium intake below 1200 mg. The study found no statistically significant differences in serum vitamin D levels between different regions of sun exposure (less than 2500 h/year and more than 2500 h/year) in PMO women treated and untreated, although there was a statistical difference when considering the results obtained in regions of sun exposure and in coastal areas, which may facilitate sun

exposure [15]. According to guidelines, bone mineral density (BMD) should be used in combination with online assessment tools such as FRAX and QFracture to accurately determine an individual's risk of fracture. Adequate intake of calcium and vitamin D is important throughout life to develop and maintain optimal bone mass, and a daily intake of vitamin D is recommended for all age groups from 3 years and older. However, the results of using vitamin D supplementation for the prevention and treatment of osteoporosis are not always clear. This may be due to the negative feedback mechanism that occurs when serum 25(OH)D levels are sufficient, which means that plain vitamin D supplementation will not increase the production of calcitriol in these individuals. In patients who are clinically deficient in serum 25(OH)D (<50 nmol/L), oral plain vitamin D supplementation may restore these levels, but it may not necessarily improve osteoporosis endpoints. This may be due to factors such as age-related declines in liver and kidney function, disease, or pharmaceutical treatment, which can affect the hydroxylation of vitamin D and lead to a deficiency of 1,25(OH)D in circulation and at target tissues. This deficiency can disrupt the balance of calcium and phosphate absorption from the intestine and lead to dysregulation of mineralization, as the skeleton becomes the main source of calcium for the body [16,17].

A 2018 study by Smith and colleagues evaluated the effects of plain vitamin D supplementation on bone mineral density (BMD) in 194 elderly women with vitamin D insufficiency. The study found that there was no evidence of a threshold change in BMD despite increasing serum 25OHD or free 25OHD in a population treated with daily doses of 400- IU of plain vitamin D with calcium over a year [18]. The authors concluded that there was insufficient evidence to justify the routine use of plain vitamin D, with or without calcium, for the prevention and treatment of osteoporosis, a conclusion that was also reached in a large meta-analysis published the same year. Therefore, it may be concluded that there is little justification for the use of vitamin D supplements to maintain or improve musculoskeletal health in osteoporosis, with or without the addition of calcium. In contrast, alfacalcidol, a form of vitamin D, stimulates the gastrointestinal absorption of calcium and phosphate and the tubular reabsorption of calcium, making it independent of an individual's vitamin D status, age, and kidney function. This allows for the normalization or even increase of calcitriol levels in the body and at local target tissues, rapidly increasing the hormonal activity at these tissues without interference from the negative feedback mechanism that regulates vitamin D activation under similar conditions. However, alfacalcidol treatment may be considered an active hormonal therapy and requires frequent monitoring of serum and urine calcium levels, as well as a review of calcium intake and the use of calcium supplements. Serum calcium should be measured before starting alfacalcidol treatment and after 3-6 months of therapy [19]. If a clinically relevant increase in urinary or serum calcium is observed during treatment with alfacalcidol, it can be easily corrected by reducing calcium supplementation (e.g., below 500 mg/day) or by reducing the dosage of alfacalcidol from 1 to 0.75 or from 0.75 to 0.5 g/day. It is important to confirm any increase in urinary or serum calcium with a second measurement one week later. In daily practice, however, hypercalcemia and hypercalciuria are rare events. The combination of alfacalcidol and plain vitamin D may be advantageous in patients who have both vitamin D deficiency and calcitriol hormone insufficiency, as is often the case in patients undergoing dialysis.

While such an approach may potentially be of interest in correcting vitamin D deficiency in conditions such as cancer, autoimmune diseases, tuberculosis, and cardiovascular disease, the use of this combination is not recommended in guidelines for the treatment of osteoporosis [20]. In the treatment of osteoporosis, serum and urinary calcium levels should be monitored from the start of alfacalcidol treatment and throughout the course of treatment. Adding cholecalciferol (plain vitamin D) to alfacalcidol treatment would increase the risk of hypercalcemia with no clear clinical benefit. The positive effects of alfacalcidol on bone health may be due to its ability to increase intestinal calcium absorption compared to plain vitamin D. Short-term treatment with low-dose alfacalcidol (0.5 μg/day) has been shown to increase calcium absorption. The efficacy of alfacalcidol has been directly compared with that of plain vitamin D in three studies. Alfacalcidol stimulates calcium absorption and their



osteoblast activity and its activation is independent of vitamin D status, age, and kidney function. Studies of alfacalcidol in combination with frequently used osteoporosis treatments have been performed, including a large trial by Orimo and colleagues that enrolled over 2,000 patients and found that the combination of alfacalcidol and alendronate was not more effective for overall vertebral fracture prevention. However, subgroup analysis showed that it was more effective for fracture prevention in patients with severe vertebral deformity, multiple prevalent vertebral fractures, and for non-vertebral weight-bearing bone fracture prevention. The superior efficacy of the combination of alendronate and alfacalcidol may be due to their different but complementary modes of action. Another study with three arms in patients with established postmenopausal or male osteoporosis found that alfacalcidol in combination with alendronate was statistically significantly more effective than plain vitamin D in combination with the bisphosphonate or alfacalcidol alone for the total number of new fractures, either vertebral or non-vertebral [21].

Osteoporosis is a condition characterized by reduced bone mass and strength, which leads to an increased risk of fractures. It is more common in women, particularly postmenopausal women, but men can also be affected. The lifetime risk of osteoporotic fractures in women is high, and the risk in men is lower but still substantial, approximately half that of women. The aging of European populations will double the number of osteoporotic fractures over the next 50 years unless preventive measures are taken [22]. An adequate intake of calcium is important for the development of a maximum bone mass during adolescence and for mitigating the progressive loss of bone mass with age. The effects of sunlight on vitamin D production are influenced by age, skin pigmentation, sunscreens, clothing, and even window glass, making it difficult to measure the duration and intensity of sunlight exposure. Measurement of serum 25-hydroxyvitamin D provides more direct information about vitamin D intake and stores, as its half-life in the serum is much longer than that of calcitriol (weeks versus hours). Vitamin D deficiency can be caused by restricted sunlight exposure, reduced skin production of vitamin D, and reduced dietary intake of vitamin D, and can be compensated for by consuming fortified foods or vitamin D supplements [23].

It is important to not excessively increase calcium intake, as a recent meta-analysis suggested that very high levels might increase the risk of cardiovascular disease. Some meta-analyses have shown that calcium should be added to vitamin D in order to be effective. There is debate about whether vitamin D should be prescribed to all elderly individuals or targeted to specific risk groups. Large-scale, double-blind, randomized clinical trials are needed to examine the effect of different doses of vitamin D3 with and without calcium on fall and fracture incidence in different ages, populations with different vitamin D status, and considering the influence of genetic profile, chronic disease, and other medications on treatment response [24].

Conclusions

It is important to maintain an adequate intake of calcium to maintain a balanced diet. Calcium is primarily excreted through the kidneys, with some minor loss through gastrointestinal tract. The best way to meet daily requirements is through the consumption of high calcium-containing foods, or by taking calcium supplements. In the prevention of osteoporosis, many individuals, especially postmenopausal women, do not consume enough calcium from their diet and may need to take supplements. Calcium carbonate and calcium citrate are the most common and well-studied calcium supplements. Calcium citrate may be preferred by some patients because it requires fewer tablets to achieve optimal intake.

Conflict of interests

The authors declared no conflict of interests.

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