Calcium, Vitamin D and Bone

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Abstract

Calcium, protein and vitamin D are the main nutrients relevant to bone health. This short article discusses the importance of vitamin D and its relation to calcium homeostasis. The various causes, clinical manifestations and treatment are outlined.

Vitamin D deficiency and effects on bone

The main nutrients relevant for bone health are calcium, protein and vitamin D. Calcium intake has been shown to be weakly related to bone mineral density and in two recent meta-analysis[1] was found to be associated with a modest reduction of fracture risk. The ideal calcium allowance is unclear. It is reasonable to intervene with calcium supplementation when dietary calcium intake cannot be increased above 800mg/day. The problem is complicated by the observation that

Vitamin D is important in calcium homeostasis and may also need supplementation.

Vitamin D deficiency which occurs with serum 25-hydroxyvitamin D levels below <25nmol/l results in osteomalacia in adults and rickets in children. Commonly patients are asymptomatic or may present with non-specific bone pain, fractures, hypocalcaemia and myopathy.

Vitamin D insufficiency is defined by consensus as a serum 25-hydroxyvitamin D level of <75nmol/l. When vitamin D levels fall below 75nmol/l, parathormone (PTH) secreted by the parathyroid glands starts to rise. The clinical consequences are debatable but it may be associated with osteomalacia, bone aches and poor bone mineralisation.

Pathophysiology

Vitamin D is formed from the effect of UVB-sunlight on 7-dehydrocholesterol in the skin[2,3]. There are 2 forms of vitamin D: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Both forms are hydroxylated to the 25-OH form in the liver. Further hydroxylation of the 25-OH vitamin D in the kidney results in production of the active form 1,25-dihydroxyvitamin D. Vitamin D production in the skin declines with advancing age, such that elderly people rely more on vitamin D dietary intake. Some studies[1] have suggested that vitamin D3 may be more active than vitamin D2 but more recently it was demonstrated that they are equally effective.

Vitamin D functions

- Enhances calcium and phosphate absorption from the gut;
- Stimulates osteoblast production;
- Decreases PTH synthesis.

Causes of osteomalacia and rickets

- Dietary deficiency;
- Reduced sun exposure;
- Pseudovitamin D deficiency rickets (autosomal recessive, presents in 1st year of life);
- Hereditary vitamin D resistance rickets (autosomal recessive, presents in infancy);
- Hypophosphataemic vitamin D resistant rickets (X linked, presents in childhood);
- Autosomal dominant hypophosphatemic rickets (autosomal dominant, presents in infancy).

People at risk of vitamin D deficiency

- Elderly particularly those in institutions;
- Excessive use of sunscreen;
- Dark skinned people living at high altitudes;
- Ethnic/religious reasons which may demand coverage of all the skin;
- Malabsorption conditions eg: coeliac disease, short bowel syndrome, cystic fibrosis;
- Chronic liver disease;
- Drugs eg: prolonged anticonvulsant use, cholestyramine, aluminum containing antacids.

Vitamin D insufficiency is not exclusive to the elderly. Studies have shown that up to two thirds of healthy adults have vitamin D insufficiency and this tends to be worse after winter and improves after summer[4,5].

Treatment of vitamin D insufficiency may decrease the risk of hip and nonvertebral fractures. In the elderly vitamin D supplementation has been associated with a reduction in falls and enhanced muscle strength[6]. A meta-analysis[1] demonstrated that vitamin D supplementation resulted in a reduction in falls of about 22% in ambulatory institutionalized elderly subjects, compared with controls. A Cochrane Review[1] including 50 randomized, controlled trials involving close to 100,000 individuals, has found vitamin D3 supplementation to be associated with significant reduction in mortality while other forms of vitamin D (vitamin D2, calcitriol, and alpha-calcidiol) did not.

Lab investigation

- Serum calcium is usually normal, serum phosphate maybe normal or low, serum Alkaline Phosphatase may be normal or raised.
- The level of 25-OH vitamin D is usually < 25nmol/l.
- PTH is usually > 5pmol/l although this does not need to be measured in all patients.
- Other tests such as liver and renal function, anti-TTG, folate and thyroid function may be needed to rule out other associated conditions or conditions which may mimic symptomatology.

Imaging

Pseudofractures (small radiolucent lines through bone cortices) may be seen characteristically in the femoral neck, pelvis and ribs.

In children growth plate abnormalities such as blurring of the growth plate, widening of the epiphyses and splaying of the long bone metaphyses can be observed.

Treatment

Maintenance

The recommended daily intake of vitamin D is controversial. The daily maintenance dose of vitamin D varies by age, but most children and adults generally require 400-2000 IU of vitamin D daily (1 mcg = 40 International Units (IU)). Caution is needed when recommending vitamin D supplements as some brands which are not classified and registered as medicines (and hence do not have to comply with the stringent regulations and quality, medicines have to comply with) may not contain the amount of vitamin D stated on the packaging.

Prevention and treatment of osteoporosis

- 800-1,000 IU orally daily with calcium.

Treatment of Vitamin D deficiency

Cholecalciferol orally

- 50,000 units weekly for 6 weeks
- 20,000 units weekly for 12 weeks

Ergocalciferol im

- 300,000 units stat repeat after 6 weeks if still low.

For the references log on www.thesynapse.net