Original Article

Vitamin D: A strong cardiovascular connection

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ABSTRACT

Vitamin D is known to affect the contractility of the heart, vascular tone and cardiac collagen content and tissue metabolism. A strong correlation exists between vitamin D deficiency and the pathogenesis of cardiovascular diseases. Scientific data indicates that raising vitamin D levels to normal can substantially reduce the elevated cardiovascular risk associated with this deficiency. Measurement of vitamin D levels is readily available and supplementation is easy. Vitamin D deficiency is present in approximately 30% to 50% of the general population. Our study reveals that an unusually high number (91.2%) of patients being treated in a cardiologist’s office exhibit low levels of vitamin D. This high prevalence in this cohort may be partly related to a high latitude location, a significant presence of African Americans and associated factors like diuretic use and obesity. Given the strong association between vitamin D deficiency and cardiovascular disease, this data is of utmost clinical importance.

Hypovitaminosis D is now recognized as a pandemic, and is estimated to affect 1 billion people worldwide [6]. A strong correlation exists between vitamin D deficiency and the pathogenesis of cardiovascular diseases. [7] Vitamin D is known to deleteriously alter the contractility of the heart, vascular tone, cardiac collagen content and tissue metabolism. Scientific data indicates that raising vitamin D levels to normal can substantially reduce the elevated cardiovascular risk associated with this deficiency. Measurement of vitamin D levels is readily available and supplementation is easy. This study was done to assess the prevalence of vitamin D deficiency in patients with cardiovascular diseases.

1. Introduction

Vitamin D deficiency or insufficiency is prevalent in practically every segment of the U.S. population, including children and young adults [1]. This deficiency is now being reported from virtually all parts of the world, including sunny countries [2,3,4,5]. Hypovitaminosis D is now recognized as a pandemic, and is estimated to affect 1 billion people worldwide [6]. A strong correlation exists between vitamin D deficiency and the pathogenesis of cardiovascular diseases. [7] Vitamin D is known to deleteriously alter the contractility of the heart, vascular tone, cardiac collagen content and tissue metabolism. Scientific data indicates that raising vitamin D levels to normal can substantially reduce the elevated cardiovascular risk associated with this deficiency. Measurement of vitamin D levels is readily available and supplementation is easy. This study was done to assess the prevalence of vitamin D deficiency in patients with cardiovascular diseases.

2. Materials and Methods

A retrospective review of all bloods drawn on patients in the cardiology practice from October 1, 2009 thru January 31, 2010 was done. All patients suffered from hypertension and one or more associated cardiovascular diseases. Vitamin D was measured as 25-hydroxyvitamin D in the blood and reported as ng/ml. The levels were recorded and classified as follows: above 30 ng/ml: normal; 21 to 30 ng/ml: mild deficiency; 11 to 20 ng/mL: moderate deficiency; 10 ng/ml or less: severe deficiency. The charts were reviewed for demographic information and the data compiled.

102 patients had their blood drawn during the four month period. Of these 49 (48.0%) were males and 53 (52.0%) were females. The median age was 50 years. The ethnicity was as follows: Caucasians 8 (7.8%), African Americans 79 (77.5%), Hispanics 14 (13.7%) and Asians 1 (1%). Overall, 93 (91.2%) had low levels and 9 (8.8%) had normal levels of 25-hydroxyvitamin D. Of the 49 males, 45 (91.8) and of the 53 females, 48 (90.6%) had low levels. The severity distribution was as follows: 23 (24.7%) had severe deficiency [13 (56.5%) females, 10 (43.5%) males], 51 (54.8%) had moderate deficiency [26 (51.0%) females, 25 (49.0%) males], and 19 (20.4%) had mild deficiency [9 (47.4%) females, 10 (52.6%) males]. The ethnic distribution of deficiency was as follows: 7 (87.5%) Caucasians, 71 (89.9%) African Americans, 14 (100%) Hispanics and 1 (100%) Asian patients had low levels. There was no statistical significance between the various groups.
4. Discussion

Vitamin D refers to cholecalciferol and ergocalciferol, both biologically inactive precursors. Cholecalciferol or Vitamin D3 is produced photochemically in the skin after exposure to sunlight [8], while ergocalciferol or Vitamin D2 is produced exogenously and enters the circulation after gastrointestinal absorption from ingesting food such as fortified dairy products, fatty fish, and eggs [9]. Both types of vitamin D are hydroxylated in the liver to form 25-hydroxy-vitamin D 25(OH)D3, the major circulating form of vitamin D in the blood. The kidneys convert 25(OH)D3 to two principal dihydroxylated metabolites, namely 1α,25(OH)2D3 and 24R,25(OH)2D3, which are then transported to distal target organs [10, 11]. Parathyroid hormone regulates the hydroxylation in kidney. Vitamin D status is best measured by 25(OH)D concentrations. Although some previous studies had established 27 nmol/l as the lower limit of the normal range [12], the accepted lower limit is usually accepted to be 30 nmol/l [13]. Most laboratories define the normal range of vitamin D as being 30 to 74 ng/mL.

4.1. Role of vitamin D in non-cardiovascular conditions

Although traditionally associated with defects of bone and calcium metabolism [14], it has now become recognized as an important vitamin for good health. Besides neonatal tetany, rickets, osteomalacia and osteoporosis, its deficiency has recently been linked to several other diseases, including autoimmune diseases such as multiple sclerosis, Crohn’s disease, lupus, rheumatoid arthritis, colorectal cancer, and chronic lymphocytic leukemia [15]. Adequate vitamin D levels may also play a role in cancer prevention [16]. Its deficiency may increase the risk of type 1 diabetes, some infectious diseases such as active tuberculosis [17] and periodontal disease [18]. Deficiency is associated with an increase in overall mortality [19].

4.2. Cardiovascular Implications of vitamin D deficiency

Adequate levels of Vitamin D are necessary for optimal cardiovascular health [20]. Several studies have found that vitamin D deficiency is associated with hypertension [21, 22] and cardiovascular disease [23, 24], including stroke [25], heart failure, [26] cardiac arrhythmias [27] coronary artery disease [28] and myocardial infarction [29]. Its deficiency has also been linked to several cardiovascular risk factors, including obesity [30] diabetes [31], metabolic syndrome [32], hyperlipidemia [33] peripheral arterial disease [34], and chronic renal disease [35]. Its deficiency has also been linked to excess cardiovascular mortality [36].

4.3. Cardiovascular Effects

The actions of vitamin D on the cardiovascular system are multiple and complex. Its blood pressure effects are related to its decreasing renin activity [37]. Increased intracellular calcium leading to decreased renin activity. It also affects endothelial function, smooth muscle reactivity and vascular calcification, thereby affecting coronary and peripheral blood vessels [38, 39]. It improves myocardial contractility [40] and reduces myocardial hypertrophy [41]. Some of these actions may be related to vitamin D associated secondary hyperparathyroidism [42]. Vitamin D deficiency is also associated with increased peripheral insulin resistance [43], while the effects on intracellular calcium leads to decreased insulin secretion [44]. Low Vitamin D also associated with lipid abnormalities [45]

4.4. Causes of Vitamin D deficiency

Besides individuals with cardiovascular diseases, certain special populations are more prone to develop vitamin D deficiency. The increased skin pigmentation in African Americans and other groups with high levels of cutaneous melatonin reduces vitamin D production in the skin [46]. The elderly not only have a diminished cutaneous synthesis of vitamin D, but also may purposely avoid sun exposure or be deficient in this exposure due to institutionalized living [47]. Populations with limited sun exposure are particularly at risk. Sun exposure may also be inadequate in depending on the latitude, time of day, and season of the year. Above and below latitudes of approximately 40° N and 40° S, respectively, vitamin D3 synthesis in the skin is absent during most of the three to four winter months [48]. The far northern and southern latitudes extend this period for up to 6 months [49]. Complete cloud cover reduces UV energy by 50%; shade (in duding that produced by severe pollution) reduces it by 60% [50]. UVB radiation does not penetrate glass, so exposure to sunshine indoors through a window does not produce vitamin D [51]. Sunscreens with a sun protection factor of 8 or more appear to block vitamin D-producing UV rays, although in practice people generally do not apply sufficient amounts, cover all sun-exposed skin, or reapply sunscreen regularly [52]. Skin likely synthesizes some vitamin D even when it is protected by sunscreens typically applied. Adequate sun exposure may also be denied due virtually complete covering of the skin for medical, social, cultural, or religious reasons. Vitamin D deficiency may also occur in infants, adolescents and pregnant and lactating women, primarily due to increased needs [53, 54].

Obese individuals tend to deposit vitamin D3 from cutaneous and dietary sources in the body fat compartments, leading to reduced bioavailability [55]. Individuals with fat malabsorption syndromes and inflammatory bowel disease may also develop hypovitaminosis [56]. Obese individuals who have undergone gastric bypass surgery may become vitamin D deficient without a sufficient intake of this nutrient from food or supplements, since part of the upper small intestine where vitamin D is absorbed is bypassed [57, 58].

4.5. Vitamin D and interactions with medications

Certain medications may also interfere with vitamin D absorption or metabolism. Orlistat, a commonly used weight-loss drug and cholestyramine, a cholesterol lowering drug can reduce the absorption of vitamin D and other fat-soluble vitamins [59, 60]. Corticosteroids and epilepsy drugs Phenobarbital and dilantin interfere with the metabolism of vitamin D, reducing active levels [61, 62].
4.6. Sources of Vitamin D

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4.6. Sources of Vitamin D

Since the majority of circulating 25(OH)D originates from cutaneous synthesis upon exposure to sunlight, adequate ultraviolet band radiation should be the ideal source of vitamin D. It is estimated that approximately 30 minutes of direct skin exposure of the arms and face to sunlight can provide all the daily vitamin D needs of the body [63]. Although dietary sources of vitamin D are minor compared to cutaneous formation, it can still be an important source of vitamin D in these populations. Ordinary dietary sources usually provide 100 IU of vitamin D per day, and fortified foods may provide up to 200 to 400 IU of vitamin D daily. Fatty fish, such as salmon, mackerel, herring and sardines are the richest natural sources of vitamin D and an important way to maintain optimal levels [64]. Although organ meats, such as liver, have a healthy vitamin D content, their intake is restricted because of the high cholesterol content. Edible mushrooms and eggs from hens that have been fed vitamin D are also a good food source of vitamin D [65]. Fortified foods are an important source of vitamin D and can help reduce hypovitaminosis across all age, race, ethnic, gender and special groups. Western societies often fortify foods such as fruit juices, grains, milk, cereal and oils with calcium and vitamin D [66]. Vegetables are not a good source for vitamin D in most medical patients, oral supplementation with vitamin D will be required. The generally recommended daily dose of vitamin D is 400 IU [67]. However for most patients with cardiovascular disease, this recommended daily allowance may not raise the low levels to optimal [68]. Cardiovascular patients with vitamin D deficiency should be prescribed a daily vitamin D dose of 1,000 to 2,000 IU. Several doses of 50,000 IU may be initially required to raise the serum levels [69]. Vitamin D is fat soluble and should be taken with a snack or meal containing fat.

4.7. Side Effects of Vitamin D

Vitamin D toxicity is extremely rare. Prolonged massive doses may result in hypercalcemia. Symptoms include anorexia, nausea, and vomiting, weight loss, constipation and weakness [70]. Toxicity may also cause confusion and cardiac arrhythmias [71].

5. Conclusions

Vitamin D deficiency is now a recognized pandemic. Our data is consistent with extremely high rates of low vitamin D serum levels in patients with cardiovascular diseases. Given the strong link between cardiovascular diseases and vitamin d deficiency, all patients with hypertension and cardiovascular diseases should be tested for vitamin d deficiency. Although the effects of vitamin d replenishment and its cardiovascular benefits are still not proven conclusively in these patients, oral supplementation should be initiated.

6. References


