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Role of Vitamin D For Oral Health and Overall Health

K.Sheela[1], Dhanasekhar Kesavelu[1]

[1]Senior lecturer Department of Prosthodontics, Dr.M.G.R.Educational & Research Institute, Thai moogambigai Dental College & Hospital, Chennai, [1]Consultant Paediatrician & Paediatric Gastroenterologist,Apollo Childrens Hospital,Chennai

Abstract

Vitamin D, sometimes called the "sunshine vitamin" is produced in our skin in response to sunlight. It's a fat-soluble vitamin in a family of compounds that includes vitamins D-1, D-2, and D-3.Our body produces vitamin D naturally when it's directly exposed to sunlight. Vitamin D has several important functions. Perhaps the most vital are regulating the absorption of calcium and phosphorus, and facilitating normal immune system function. Getting a sufficient amount of vitamin D is important for normal growth and development of bones and teeth, as well as improved resistance against certain diseases. Nowadays, Vitamin D deficiency patients are identified in various medical fields and it is necessary to understand the symptoms, pathophysiology and therapeutic measures to overcome the deficiency of this vitamin in various age groups from pediatric to geriatric.

Key words: *Cholecalciferol, Deficiency, Geriatric, Pediatric*

Introduction

Vitamin D which was once known as "Fat soluble vitamin" now has been reincarnated with a dual role as "hormone" as well. Low vitamin D levels can drastically impact a person's physical and mental well-being. Recently, following the discovery of vitamin D receptors throughout the body, its role in the prevention and treatment of chronic diseases has become an important area of research and interest. Vitamin D deficiency has been associated with various health problems such as cognitive decline, depression, osteoporosis, cardiovascular disease, hypertension, diabetes, and cancer. The process of aging predisposes the risk for vitamin D deficiency. Vitamin D plays a role in maintaining the homeostasis of various biological systems including the neuromuscular, skeletal, cutaneous, cardiovascular, and immune systems. Vitamin D also has properties such as tumor suppressing, anti-inflammatory, and antibacterial properties. It also plays an important role in Dentistry, in the development of teeth, promotion of the immune response to oral microbial infections, and promotion of healing post oral surgery. This article deals with the etiology, pathophysiology of vitamin D deficiency and its role in oral health from pediatric to geriatric.

Corresponding Author:
Dr. K.Sheela, kgeyes Apurva,b block g3,no 1,nolumbur main road,mogappair east,
Chennai-600 037, Phone no: 9840664566
E mail –sheela_bds@yahoo.co.in
E mail- drdskgastro@gmail.com

Discussion

Vitamin D in its inactive form (vitamin D_3 or Cholecalciferol) is a steroid hormone that is synthesized in the skin with adequate exposure to the sun (ultraviolet light-bandwidth or frequency needs mentioning) and/or acquired through diet[1-5]. Foods naturally containing vitamin D are rare, and it can be found in high quantities in oily fish (such as salmon, mackerel, and herring) and commercial oils from fish (e.g., cod liver oil)[6] . Some of the major causes of VDD (Vitamin D Deficiency) is the lack of exposure to sunlight with adequate ultraviolet B rays (exogenous factor). VDD can also arise from a nutritional deficit due to inadequate intake of vitamin D, or hereditary disorders due to intestinal malabsorption and metabolic disorders. Drug related VDD is also possible due to iatrogenic causes such as increased clearance with anti-convulsant drugs phenytoin, carbamazepine, oxcarbazepine.

Vitamin D comprises of two components namely Vitamin D2 and D3. Vitamin D2 is produced via ultraviolet irradiation of ergosterol from yeast, while Vitamin D3 is obtained from ultraviolet irradiation of 7-dehydrocholesterol from lanolin[7], exhibiting the biological activity of cholecalciferol (vitamin D3), and it is synthesized in the human skin. According to the Endocrine Society Clinical Practice Guidelines[8], Vitamin D deficiency is defined as levels of 25(OH)D below 50 nmol/L and insufficiency as 25(OH)D levels of 52.5–72.5 nmol/L. The biomarker used for analysis of vitamin D status is by measurement of serum 25-hydroxyvitamin D (25[OH]D).

The cellular actions of Vitamin D are mediated through the Vitamin D receptor (VDR), which is a receptor molecule that binds to the active form of Vitamin D[9]. In contact to solar ultraviolet B (UVB) radiation, 7-dehydrocholesterol (7-DHC) present in the skin is immediately converted to vitamin D3 in a heat-dependent process. Excessive sunlight exposure can destroy Vitamin D3 and convert it into inactive photoproducts. Vitamin D2 from diet is absorbed in the form of chylomicrons when they spread into the bloodstream as Vitamin D (encompassing Vitamin D2 or D3). Vitamin D in the circulation is bound to the vitamin D–binding protein (VDBP), which transports it to the liver. There, Vitamin D is converted by vitamin D-25-hydroxylase (VD-25-hydroxylase) to 25- hydroxyvitamin D (25(OH)D) (used as standard surrogate to determine vitamin D status). Then, 25(OH) D 1,25(OH)2D) circulates, reaching the kidneys where it is activated by 25-hydroxyvitamin-D1-αhydroxylase to 1,25-dihydroxyvitamin D(1,25(OH)2D.Serum phosphorous or calcium can impact renal production of 1,25(OH)2D promotes negative feedback of parathyroid hormone (PTH) by the parathyroid glands. 1,25(OH)2D increases the expression of 25-hydroxyvitamin D-24-hydroxylase (24-OHase), upholding its excretion in the bile. 1,25(OH)2D is recognized in the osteoblasts, causing the induction of mature osteoclast through expression of the receptor activator of nuclear factor-κB ligand (RANKL). Mature osteoclasts remove calcium and phosphorus from the bone, maintaining the serum levels of calcium and phosphorus

The awareness and prevalence of Vitamin D deficiency will need to be considered with special focus on vulnerable population such as children, pregnancy, immuno-compromised individuals. With respect to oral disease, caries and periodontal disease are associated with VDD and its pathophysiologic processes. Teeth are mineralized organs, surrounded by alveolar bone, and formed by three distinctive hard tissues: enamel, dentin, and cementum. The tooth mineralization process occurs parallel to skeletal mineralization, yet if mineral metabolism is disturbed then failures will occur similarly to those that occur in bone tissue. Vitamin D has impact on oral health based on bone metabolism. VDD compromises odontogenesis, resulting in a hypo mineralized dentition susceptible to fracture and caries lesions[10] .Vitamin D plays a key role in bone and tooth mineralization, and when levels are unregulated it can lead to the "rachitic tooth", which is a defective and hypo mineralized organ highly susceptible to fracture and decay[11,12]

Deciduous dentition can be influenced by maternal 25(OH)D levels, despite the influence of inherited defects of the fetus. Fetal serum-circulating levels of vitamin D follow the maternal concentration and can be used as a standard marker to the fetus[13-16]. Therefore, if maternal 25(OH)D levels become unbalanced, this may have direct effect on the baby's health particularly on tooth development. Nowadays, it is known that maternal VDD at 12–16, 20–32 and 36–40 weeks results in defects at the incisal third, middle third and cervical third of crowns respectively.

Vitamin D deficiency can impair the immune response to oral microbial infections, increasing the risk of oral infections and periodontitis. According to WHO, Dental caries is the fourth-most expensive chronic disease to treat [17]. It has a complex and multifactorial etiology. Factors, such as cariogenic diet with a high carbohydrate content, cariogenic bacteria, and poor oral hygiene are risk factors for caries and periodontal infection. Certain evidence also highlights the association of low levels of vitamin D and the high prevalence of caries in both children and adults, although the mechanism remains unclear[18].

Hujoel et al concluded from studies that optimal vitamin D concentration (≥75 nmol/L) is associated with lower odds for dental caries in children[19].A randomized controlled trial concluded that the vitamin D supplementation reduced the risk of caries in about 47%, but with low certainty. Schroth et al showed that caries-free children were twice as likely to have optimal vitamin D concentrations (≥75 nmol/L) and those with severe early childhood caries were at nearly three times the odds of having deficient levels (<35nmol/L)[20]

The impact of nutrition on periodontal health, particularly Vitamin D deficiency, has been investigated and a recent European study stated that an inadequate vitamin D status impacts periodontal health and oral functions[21], vitamin D concentrations were associated with higher periodontal destruction, severe periodontitis stages and higher tooth loss [22].NHANES III study, from the USA, showed that individuals with the highest levels of vitamin D experienced 20% less bleeding on probing than those with the lowest levels[23]. The inflammatory and immune actions against periodontal pathogens are triggered by the host immune system. salivary low levels of vitamin D were associated with higher levels of inflammation biomarkers in periodontitis patients when compared to periodontally healthy patients (namely IL-35, IL-17A and transforming growth factor), supporting the presence of an inflammatory microenvironment[24]. A more recent study from 2019 showed vitamin D supplementation was linked to a decrease of salivary cytokines before nonsurgical periodontal treatment [25].The association between periodontitis and maternal VDD reveal that pregnant women with moderate to severe periodontitis are diagnosed with lower serum levels of vitamin D[26].Non-surgical periodontal treatment during pregnancy was proved to be successful in reducing adverse pregnancy outcomes along with vitamin D supplementation showed mild clinical improvements in birthweight as shown by Khan et al [27]

Movement of tooth depends on the application of predetermined forces that cause mechanical stimuli with two simultaneous processes such as bone resorption on the pressure site, through osteoclastic activity; and bone formation on the tension site, by osteoblastic action[28,29]. These processes may result in rapid tooth movement. Albeit animal observational in nature, there is an increasing evidence from a study by Kale et al[30] showing that local application of vitamin D results in a faster tooth movement

VDD is common in patients with oral neoplastic lesions. In a case-control study, direct association between VDD and increased risk of squamous cell carcinoma of the esophagus, oral, and pharyngeal cancers, which were more prevalent in heavy smokers and severe alcoholism[31]. Anand et al demonstrated that vitamin D receptor expression was increased in premalignant lesions and oral cancer, and vitamin D supplementation significantly diminished therapy-related toxicities in late-stage oral cancers, with less morbidity and better quality of life[32]

Vitamin D is well known to be essential for the geriatric population[33]. Osteomalacia in adults, like childhood rickets, develops in vitamin D deficiency, commonly presenting with severe aches in bones and muscles, marked proximal muscle weakness making standing up and walking difficult and painful and a marked 'waddling' gait. This condition is common in older people, vitamin D repletion is associated with increased risk, and severity of osteoporosis. Better vitamin D availability may contribute to reducing chronic inflammatory problems such as periodontitis[34,35]. and atheromatous disease, and may reduce acute vascular events due to arterial plaque disruption where inflammation is a major factor in progression of atheromatous disease.

Low baseline vitamin D status predicts reduced healing in the year after surgery for periodontitis, a common problem in older people, and giving vitamin D to subjects with severe periodontal problems improved post-operative bone defect resolution, supporting suggestions that hypovitaminosis D may worsen periodontitis[36,37].In Dental implants, osseointegration depends on bone metabolism, there is a possibility that low levels of vitamin D in the blood can negatively affect healing processes and new bone formation on the implant surface. The relationship between serum levels of vitamin D and osseointegration of dental implants is controversial and has been evaluated in a few case reports and animal studies. Most studies suggest that adequate serum levels of vitamin D can enhance the healing of peri-implant bone tissue. Patients with vitamin D deficiency (serum levels of vitamin D <10 ng/mL) showed an early implant failure rate of 11.1% Vs. failure rate of 2.9% in patients with normal levels of the vitamin (>30 ng/mL).

Owing to the impact of vitamin D deficiency-related complications and failures in dentistry, it is necessary that the clinician uses vitamin D supplements when deficiency is observed. Typically, 5,000 IU/day is recommended by the AACE (American Association of Clinical Endocrinologists) but a 8 to 12-week supplementation period is needed to reach adequate levels. This timeframe makes implant dentistry quite inconvenient, owing to the often-encountered need to restore teeth at earlier time points, along with the necessity to satisfy patient expectations within reasonable time frames. Over the years, it has become increasingly clear that vitamin D absorption is further optimized with several co-factors. These include vitamin K, magnesium,

calcium, manganese, and boron, among others. These co-factors, when present, help absorb vitamin D toward optimal levels in shorter healing periods.

Interestingly, the striking overlap between risk factors for severe COVID-19 and vitamin D deficiency, including obesity, older age, has led some researchers to hypothesize that vitamin D supplementation could hold promise as a preventive or therapeutic agent for COVID-19[38].However a study conducted by Meltzer et al [39] in September 2020 concluded that persons who are likely to have deficient vitamin D levels at the time of COVID-19 testing were at substantially higher risk of testing positive for COVID-19 than the persons who were likely to have sufficient levels and the patients who are under treatment for Vitamin D deficiency were not found to have increased risk for COVID-19. Further research is underway to confirm the efficiency of Vitamin D supplementation and its role in prevention of COVID 19 infection which is a very challenging area of research for the researchers in this current pandemic.

Conclusion

It's imperative to understand the importance of Vitamin D deficiency, its role in metabolism, growth, in maintaining the mileu interior in a wide range of population from pediatric to geriatric age groups, where particularly vulnerable age groups are now identified. Its role in regulating the immunopathology inflammatory response in various systems of the body also shows its antioxidant property. It is necessary to adhere to the daily recommendation of vitamin D according to the age of the individual for the maintaining of bone health.

This review article aims to sensitize the clinician about the metabolism, the pathway and the current evidence on Vitamin D and the panorama of diseases and disorders that it may bring about and its role in oral health with particular emphasis on dental health. Role of Vitamin D has gained momentum and it has now become the norm for it to be supplemented and deficiency treated to achieve optimal outcomes both in well-being and interventions.

Ethical Clearence: Nil

Not required as it is a review article

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