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Relationship Between Low Serum Vitamin D Levels and Dental Implant Osseointegration: Systematic Review

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Abstract

Background: To assess the effect of vitamin D on the osseointegration of dental implants, this review analyzed publications in the literature on the relationship between vitamin D levels and osseointegration of dental implants.

Methods: A systematic review was conducted in the Google Scholar, Medline, Scopus, Web of Sciences, PubMed. Inclusion criteria were relationship between levels vitamin D serum and osseointegration, Vitamin D Supplementation for Prevention of Dental Implant Failure in type II diabetic patient.

Result: The slight result of a review of studies showed a significant relationship between low serum vitamin D levels and dental implant osseointegration, and a positive effect of vitamin D supplementation on osseointegration was determined

Conclusion: In patients with diabetes, Vitamin D Supplementation may increase the effectiveness of osseointegration of dental implants and reduce Dental Implant Failure. However, to confirm these assumptions, further long-term clinical studies with a larger number of diabetic patients are needed to elucidate the relationship between serum vitamin D levels and osseointegration.

Keywords: vitamin d; implant success; osseointegration

Introduction

Research has shown that the incidence and prevalence of diabetes mellitus has increased significantly throughout the world over the past few decades [1-3]. To avoid the harms of hyperglycemia, international guidelines recommend a plasma glucose level of less than 180 mg/dL (10 mmol/L) and a minimum of 79 to 144 mg/dL (4.4 – 8 mmol/L) in most adult patients [4]. Long-term hyperglycemia in diabetes often leads to damage and/or dysfunction of multiple tissues and organs, including bone tissue, leading to metabolic disorders of bone tissue [5-8]. Pathological changes in the tissues of the oral cavity are also observed in patients with diabetes mellitus [9-11]. One possible explanation for bone loss and increased tooth mobility in people with hyperglycemia is decreased blood supply to tissues. Insufficient blood supply leads to a lack of oxygen in periodontal tissues. Low blood oxygen levels can cause osteoclast stimulation, which causes bone resorption and tooth mobility36, which can lead to tooth extraction [14]. After tooth loss in patients with diabetes due to bone resorption of the alveolar processes, the effectiveness of treatment with removable plate dentures is low [15]. This leads to impaired chewing function in this group of patients and can lead to poor nutritional status and metabolic disorders. The development of dental implants opens up new opportunities in the orthopedic rehabilitation of patients with diabetes, however, due to slower wound healing and deterioration of bone tissue metabolism, osseointegration processes may be disrupted [16-19]. Many factors are important in the osseointegration of dental implants (properties of the implant surface, surgical protocol, timing of functional load, local and systemic factors associated with the patient, etc.) [20]. Among these factors, the systemic patient-related factors play (osteoporosis, use of antiresorptive medications, diabetes mellitus, immune deficiency) a very important role on the healing of the dental implant [21-24]. There are studies that have shown an increased risk of peri-implantitis and associated bone loss in diabetic patients with poor glycemic control [24,25]. However, there are also studies that show that normal HbA1c levels and good oral hygiene may be a good prerequisite for successful osseointegration in diabetic

patients [24-26]. Diabetes also has a detrimental effect on the bone matrix and bone density, accompanied by metabolic disorders of bone tissue, changes in bone biochemical markers in the blood, which can have a significant impact on the long-term survival of implants 62,63. An additional approach to studying the effect of diabetes on bone metabolism is to evaluate serum markers of bone metabolism, namely osteocalcin and β-Cross-Laps the blood levels of which are reduced in patients with diabetes and inversely correlate with blood glucose levels [28,29]. According to H Khachatryan and G Hakobyan (2023) Osteocalcin and concentrations β-Cross-Laps in serum Monitoring of markers of bone metabolism in patients with type 2 diabetes may have predictive value for implants and will encourage the practitioner to apply corrective drug therapy in case of marker abnormalities [30]. Monitoring markers of bone turnover in patients with type 2 diabetes may have prognostic value for implants and guide drug therapy if markers are abnormal. Along with bone metabolism disorders, vitamin D disorders are also observed in patients with type 2 diabetes; hypovitaminosis D is very common in this category of patients. Vitamin D3 is the main form of the vitamin D family and is activated by hydroxylation in the liver [31]. Vitamin D3 is produced in the skin from 7-dehydrocholesterol under the influence of UV radiation, which cleaves the B ring to form primary D3 [32]. Vitamin D is also found in small amounts in the diet. The liver and other tissues convert vitamin D from the skin or food. Vitamin D has anti-inflammatory and antimicrobial effects. The influence of vitamin D regulates the level calcium and phosphorus ions in bone tissue, for proper mineralization of bones and teeth. Vitamin D stimulates osteoclastic activity and the production of extracellular matrix proteins by osteoblasts. Moreover, it increases the absorption of calcium in the intestines. Low vitamin D levels in patients with type 2 diabetes mellitus are due to two factors [33].

- Vitamin D stimulates the secretion of insulin by B cells of the pancreas, so vitamin D deficiency is associated with insulin resistance.
- Vitamin D deficiency causes inflammation and increases inflammatory markers and is associated with the development of metabolic syndrome.

Vitamin D deficiency is defined as any serum level between 21 and 29 ng/mL, deficiency as less than 20ng/mL, and severe deficiency as 10 ng/mL less than [34]. In addition, genetic polymorphisms of vitamin D may lead to impaired glycemic control. Vitamin D affects the modulation of the immune system, increases the production of cathelicidin and defensin and reduces the production of pro-inflammatory cytokines, modulates the activity of lymphocytes, and has a positive effect on bone metabolism. Apart from the most obvious function, i.e., regulation of calcium, homeostasis and bone metabolism, affects cell differentiation, the influence of vitamin D on a number of processes of the immune system is especially important, it is also involved in the regulation of insulin secretion [35]. Vitamin D is involved in the regulation of calcium and phosphate balance, which is necessary for proper mineralization of bones and teeth. Blood hypocalcemia stimulates the secretion of parathyroid hormone, which increases the absorption of calcium from bones. This leads to osteomalacia or osteoporosis. Therefore, the role of vitamin D in the regulation of calcium balance is extremely important [37]. Along with many other factors, vitamin D also affects various stages of osteointegration of intraosseous implants [38]. Vitamin D has also been found to be essential for the maturation and proper functioning of bone cells. Vitamin D also increases osteoid cell mineralization [39]. This mechanism also plays an important role in the osseointegration phase of the implant. Adequate concentration of vitamin D correlates with success at each stage of osteointegration of the implant because the vitamin D receptor (VDR) is present on osteoblasts and osteoclast precursors [40]. The first period after implantation depends significantly on the role of vitamin D, it reduces the level of pro-inflammatory cytokines, thereby reducing the body's reaction to surgical intervention [41]. During osteointegration, vitamin D affects the differentiation processes of osteoblasts and osteoclasts [42]. Based on the available literature, it can be concluded that there is a relationship between the concentration of vitamin D and the process of osteointegration [43]. Animal experiments have shown positive effects on the relationship between implant osseointegration and vitamin [44, 45]. A systematic review Werny JG et al (2022) concluded that vitamin D deficiency has a negative effect on implant osseointegration in animals [46]. Little evidence supports the hypothesis that humans similarly benefit from vitamin D supplementation in terms of osseointegration [47]. A large number of experimental studies and several clinical studies have shown conflicting results linking vitamin D to implantation success [52-54]. **Alaa Makke** (2022) based on the results of a systematic

review recommended vitamin D supplementation to improve osseointegration in patients whose serum vitamin D levels are not within the normal range [55]. By Study Karaoglu A et al vitamin D deficiency may compromise oral bone healing and therefore the success of implantation [56]. Study Mangano F did not demonstrate an association between low serum vitamin D levels and an increased risk of early implant failure [57]. A. Vesala and Ismene Dontas (2020) concluded in their study that systemic vitamin D supplementation several weeks before dental implantation in patients suffering from severe vitamin D deficiency may enhance the effect of osseointegration [58]. Although the function of vitamin D in regulating the level of glucose in the blood has not yet been fully studied, the status of vitamin D apparently plays a role in the development and treatment of diabetes. Most of the studies studying the effect of vitamin D on glucose metabolism have confirmed the hypothesis that adequate vitamin D supplementation can improve the metabolic regulation of glucose levels in type 2 diabetes [59]. Mostafa Heeba et al in their treatment of seven patients with diabetes summarized that topical application of Vit D on dental implants reduced periimplant marginal bone loss and slight increase in bone density [60]. Vitamin D is important for bone metabolism, alveolar bone resorption, preventing tooth loss, and promoting bone formation around dental implants,

Conclusion

In patients with diabetes, Vitamin D Supplementation may increase the effectiveness of osseointegration of dental implants and reduce Dental Implant Failure. However, to confirm these assumptions, further long-term clinical studies with a larger number of diabetic patients are needed to elucidate the relationship between serum vitamin D levels and osseointegration of dental implants.

Declarations

Conflict of interest and financial disclosure

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Statement of authorship

Authors gave final approval and agreed be accountable for all aspects of work enusuring integrity and accuracy.

HKh: contributed to design, analysis and interpretation, and drafted the manuscript. critically revised the manuscript, final wrote.

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