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Review

Influence and Role of Vitamin D on Dental Implants

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Abstract

Dental implants are one of the methods for replacing missing teeth and their use has become an important part of dentistry. Dental implants have many advantages over traditional fixed partial dentures, including a high success rate of over 97% for 10 years among certain others. Vitamin D is involved in the calcium and phosphate metabolism of bone tissue in the body and in the maxillofacial region. This information can help dentists reduce the risk of complications after different types of surgery, like dental implant surgery and bone grafting. Due to its involvement in bone metabolic processes and regulation of the immune system, vitamin D is currently of particular interest to dentists performing implant procedures. It is believed that the correct concentration of this prohormone is positively correlated with the process of osseointegration. Numerous studies show that vitamin D is potentially important for the process of postoperative tissue repair, as well as the integration of the implant with bone tissue and bone homeostasis around the implant after it is loaded with a prosthetic crown. Furthermore, adequate serum levels of vitamin D may improve peri-implant bone healing. To date, only a few studies have investigated the possible association between serum vitamin D levels and early dental implant failure hence further clinical research is need of time to provide evidence -based results for the role of vitamin D in dental implants. The purpose of this research is to review the available information about influence and role of vitamin D on dental implants.

Keywords: *dental, implant, bone, vitamin D, periodontics*

Introduction

Dental implants are thought to be one of the most important innovations in modern dentistry. Since titanium implants for intra-oral use became available in the late 1950s, dental implantology has become one of the most active and promising areas of dentistry additionally, it is also a popular option among edentulous or partially dentate patients for oral rehabilitation. Because of several factors, osseointegrated dental implants are often better than traditional dentures. Especially for people who cannot get used to traditional dentures or whose local host bone is not as strong as it should be, dental implant treatment may lead to better results. The 10-year survival rate is about 90%, which makes it a fairly predictable treatment method (1).

Osseointegration and healing after insertion or restoration of dental implant is dependent upon various factors including prosthesis, and grafting materials related to dental biomaterials. Other aspects can be linked to the skills and experience of the operator. Patient-related local and systemic factors are critically important for the success of a dental implant. The systemic condition of the patient has a direct effect on how well the dental implant heals. Among the frequently overlooked systemic factors is the vitamin D level of patient, which affects bone growth around the implant and the process of osseointegration that follows (2). Vitamin D is a fat-soluble molecule that can be taken in through food or produced in the skin when it is exposed to ultraviolet light. In its active form (1,25-dihydroxy vitamin D3), vitamin D is a key part of keeping the balance of minerals in the bones. It accomplishes this through calcium and phosphate absorption in intestines. Vitamin D deficiency can cause broken bones and bone loss, and severe vitamin D deficiency greatly increases the risk of infection and even death. Most of the time, vitamin D levels are categorized into three: deficient, insufficient, and sufficient levels. A serum vitamin D level of less than 10 ng/mL is considered deficient, and a level of 10–30 ng/mL is considered insufficient while level greater than 30ng/mL is considered to be sufficient (3).

Maxillofacial surgeons and implantologists are critically interested in determining the effects of vitamin D on immune system and bone metabolism. At each stage of osteointegration of endosseous implants, success may be linked to the adequate amount of vitamin D. Beginning from the day of surgery, it's important to have the sufficient levels of vitamin D3. It modifies the working of immune system by increasing the production of cathelicidin and defensin and decreasing the production of cytokines that cause inflammation. It also has a positive effect on bone metabolism in osteosuppression by causing osteoblasts and osteoclasts to grow and by causing the bone around the implant to keep changing even after the prosthetic restoration has been made. During osteointegration of the implant, a satisfactory concentration of vitamin D is preferable because of the intense processes of resorption and osteogenesis. Over the next few months, changes in the bone tissue will cause the implant to become directly connected to the bone (4). The purpose of this research is to review the available information about influence and role of vitamin D on dental implants**.**

Methodology

This study is based on a comprehensive literature search conducted on March 13, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about influence and role of vitamin D on dental implants**.** There were no restrictions on date, language, participant age, or type of publication.

Discussion

One of the most important factors for successful dental implant therapy is osseointegration, which is attained by functional ankylosis. The foreign material and the living bone grow together to form a functional unit. This is called the first contact

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between the newly formed bone and the implant. Depending on its level, vitamin D can either speed up or slow down the process of making new bone. Vitamin D deficiency is linked to a number of diseases, such as parodontitis, premature tooth loss, a degradative metabolism, osteoporotic fractures, and slow fracture healing (5). Since vitamin D is involved in bone metabolism and controls the immune system, dental surgeons are especially interested in it right now. There is sufficient evidence that the adequate concentration of this prohormone helps the process of osseointegration of dental implants. Several studies have shown that vitamin D may be important for the healing of tissue after surgery, the integration of the implant into bone tissue, and the maintenance of homeostasis around the implant (6, 7).

Evidence from literature

The role of vitamin D in producing more anti-inflammatory cytokines and less pro-inflammatory cytokines is crucially important during the first few weeks after implant surgery as this reduces the body response to surgery. It has been proven that people with chronic kidney disease and a low level of vitamin D in their blood are more likely to get bacterial and viral infections. During osteointegration of the implant, a satisfactory concentration of vitamin D is preferable because of the intense processes of resorption and osteogenesis. Over the next few months, changes in the bone tissue will cause the implant to become directly connected to the bone (4). There are several factors responsible for the failure of dental implants including smoking, infection, reduced keratin in gingiva and improper healing of the bone around implant among certain others. It is challenging to identify a direct link or cause and effect between a low serum vitamin D level and early failure of dental implants. But the serum level of vitamin D may play a critical role in osseointegration and the success of dental implants or the predictability of how long they will last because of how it affects the immune system and the healing process (8).

Vitamin D can affect osseointegration through the healing process and the seals made by the soft tissues around the implant. It can also help prevent bacterial infections and peri-implantitis occurence. The level of bone around the implant is much higher in people who take vitamin D supplements. This suggests that this biomolecule may be a factor that speeds up the remodeling process and helps bone tissue grow around the dental implant. Since osseointegration of dental implants depends on the ability of bone to grow back, it is thought that a lack of vitamin D slows down the healing process and the growth of bone tissue around the implant (9). Results of a prospective study revealed that for every 1 ng/ml increase in Vitamin D levels, the implant stability quotient increased by 0.48 units at 3 months and 0.62 units at 6 months, which was significant statistically at $P = 0.01$ and $P = 0.002$, respectively. Vitamin D has a positive impact on the stability of the implant hence, determination of vitamin D levels prior to implant is important (10).

Results of a randomized, double-blind placebo-controlled study demonstrated that ten patients were in the test group and were given calcium and vitamin D. The other ten patients were in the control group and only received calcium. Six to eight months after surgery for bone regeneration, bone samples were taken for histological analysis during implant placement. Even though vitamin D supplementation increased serum vitamin D levels, which could be good for bone remodeling at the cellular level, no statistically significant difference was found between the two groups (11). Findings of a prospective cohort study depicted that patients were categorized into one of three groups based on vitamin D concentrations in their blood. Group 1 had vitamin D deficient population, while group 2 had insufficient levels and group 3 had sufficient levels of vitamin D. Marginal bone loss was the difference between the bone level right after loading and the level 12 months later, total 90 patients were included with 30 in each group. In group 1, the mean marginal bone loss was 1.38±0.33 mm, in group 2 it was 0.89± 0.16 mm, and in group 3, it was 0.78±0.12 mm. Analysis of the data showed that the mean marginal bone loss was significantly different between the three groups ($P< 0.001$). Additionally, there was a significant relation between marginal bone loss and vitamin D serum

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concentration ($P < 0.001$). It seems that a reduced serum level of vitamin D may be linked to elevated marginal bone loss (12).

Guido Mangano et al. performed a large-scale retrospective study to find out if low serum levels of vitamin D were linked to early failure of dental implants. The study population was split into three groups based on vitamin D levels in blood. No significant difference between the three groups regarding implant failure was reported, even though the highest rate was seen in people with severe vitamin D deficiency. However, the authors suggested that administration of vitamin D a few weeks before a dental implant might be helpful, especially for people with a severe lack of vitamin D. Furthermore, vitamin D supplements should be taken only until the required serum levels are reached (13). Another retrospective study was conducted by same authors in 2018 which further confirmed the findings of their first study. Patients with normal levels of vitamin D in their blood had low rates of implant failure, while a severe lack of vitamin D was linked to four times as many implant failures. But no statistically significant difference was found ($p = 0.105$) (14). Bryce and Macbeth reported a case of 29-year-old male with an immediate implant. Five months after the surgery, there was no sign that the implant had fused with the bone. The patient had a severe lack of vitamin D, which may have been the reason for failure of implant. The patient was then advised vitamin D supplements until normal levels were achieved (15).

Markopoulos et al. described that vitamin D deficiency may have a negative effect on the formation of cortical bone around implants, which suggests that it may also have a negative effect on graft incorporation. Few clinical studies have shown that offering vitamin D helps bone and grafts grow together. On the other hand, severe vitamin D deficiency is linked to implant osseointegration failure. At the moment, it is not possible to fully support the use of vitamin D as an adjuvant in bone grafting. But there is some theory behind using vitamin D after surgery and using bone grafts to support bone structure, relieve pain, and help the body absorb the graft better. More clinical studies are needed to back up the use of vitamin D and its analogues in these situations (16). Karaoglu et al. stated that raising awareness among dental care providers about maintaining optimal vitamin D status is essential for maintenance of disease-free oral health. Even though vitamin D has a strong link to bone metabolism and was thought to have a strong link to implant success, many experimental studies and a few clinical studies had contradictory results, and there were no direct studies that showed a link between vitamin D and implant success. Because of this, it is important to conduct large-scale studies to prove or disprove the existence of this link (17). There is dire need of further clinical trials additionally including follow-up studies to determine the evidence-based role of vitamin D on dental implants since the available studies in literature are quite scarce and limited.

Conclusion

Vitamin D affects different stages of implants and their fusion with bones. Because of its role in the metabolism of bone tissue and the immune system, it has become an important field of study in dental surgery and implantology, and hence its suggested to assess the levels of vitamin D before implant procedure to attain optimal outcomes. However further research is warranted to generate guidelines and strategies for management of insufficient vitamin D levels in implant patients.

Disclosure

Conflict of interest

There is no conflict of interest

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Ethical consideration

Non applicable

Data availability

Data that support the findings of this study are embedded within the manuscript.

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Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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