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Vitamin D Supplementation and Dental Implant Osseointegration: A Literature Review

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Abstract

The aim of this study was to assess the available literature on the efficacy of vitamin D supplementation on the osseointegration of dental implants in humans. The present literature review explores the question: *"Does vitamin D supplementation have an impact on dental implant osseointegration?"* Relevant publications were identified through electronic searches in PubMed and Google Scholar, covering the period from January 2018 to April 2025, using the MeSH terms: *Vitamin D*, *Dental Implants*, and *Osseointegration*. Only human studies published in English or French were considered. The reviewed literature includes articles such as narrative and systematic reviews, clinical trials, randomized clinical trials, case series, and case reports the electronic search yielded a total of 1,542 articles. Eight articles met the inclusion criteria [2 randomized clinical trials, 2 prospective studies, 1 retrospective study, 1 case report, and 2 literature reviews], comprising clinical data from 316 patients. Vitamin D supplementation may enhance osseointegration, notably in patients with deficiency. More research is needed to standardize supplementation protocols.

Keywords: Dental implants, Vitamin D, Osseointegration, 25-hydroxycholecalciferol, Stability, Bone loss.

INTRODUCTION

As society grows increasingly conscious of aesthetics, the demand for implant-supported prosthetic solutions has risen accordingly[1]. Globally, dental implants market are expected to reach USD 7.25 billion by the end of 2025[2]. This increase in demand should not only be attributed to the global proclivity towards aesthetics, factors like the increased life expectancy, reduction in mortality, and urbanization play a significant role in this trend [3]. Dental implant therapy is regarded as a reliable and predictable choice of treatment with survival rates of 95.6% and 93.1% after 5 and 10 years respectively[4]. Unfortunately, failure due to a lack of osseointegration remains a major challenge for dental implant therapy. Osseointegration is a direct structural and functional link between organized, living bone and the surface of a load-bearing implant. An implant is currently deemed osseointegrated when there is no progressive relative movement between it and the bone to which it is directly attached [5]. A multitude of variables can influence osseointegration including patient's related factors like gender, history of smoking, quantity and quality of bone, and systemic diseases, treatment plan related factors such as the number and location of implants, and implant's related factors such as surface treatment and macro-geometry [6–9]. Recent studies have suggested the influence of dietary supplements and nutraceuticals on osseointegration [10]. Among them is vitamin D, which is a steroid hormone primarily derived from sunlight, food sources, and nutritional supplements. Vitamin D is composed of two major components: Vitamin D2 [ergocalciferol] and Vitamin D3 [cholecalciferol] [11]. Vitamin D plays several major functions in the human body like regulating calcium levels in coordination with PTH which is essential for bone metabolism and health, a multitude of extra skeletal effects such as regulating genes, modulating the innate and adaptive immune responses, and anti-inflammatory and anti-microbial properties which are linked to oral health and oral disease prevention [12–16]. Due to its direct impact on immune responses and bone metabolism, vitamin D is drawing an increasing attention in the field of implantology. Recent literature have shown that vitamin D deficiency can be associated with early dental implant failure [17–19].

Other studies have showed the positive impact of vitamin D serum levels on implant stability such as the one conducted by Bhandage S *et al.,* that showed an increase in the Implant Stability Quotient value [ISQ] by 0.48 at 3 months and 0.62 units at 6 months for each 1ng/ml of vitamin D [20]. Vitamin D deficiency is a widespread global health issue with epidemiological data suggesting that 30% of human adults have low vitamin D levels with elderly population being the most affected [21], raising concerns since they are the most likely candidates for dental implant therapy. We hypothesize that vitamin D supplementation protocols optimize serum levels, enhancing bone-to-implant contact and reducing early failure rates. Our aim, throughout this review, is to assess the current literature to investigate the role of vitamin D supplementation on the success of osseointegration of dental implants which will guide clinical practices towards a better management of patients undergoing dental implant therapy.

MATERIALS AND METHODS

1. Formulating the question:

The question to be answered in this review is: Does vitamin D supplementation have an impact on dental implants osseointegration?

2. Sources and search period:

The electronic search for articles was conducted on the following databases:

- Pub-Med
- Google Scholar

The research covered the following period: from January 1st 2018 to the 9th of April 2025.

3. Search strategy:

A keyword-based search strategy using MeSH [Medical Subject Headings] terms was executed. The following MeSH terms were used after verifying their existence in the MeSH database:

- Dental Implants [MeSH]
- Vitamin D [MeSH]
- Osseointegration [MeSH]

Boolean operators [AND, OR] were used to build the search strategy across selected databases. The following Boolean search equation was formulated:

[Vitamin D [MeSH] AND Dental Implants [MeSH]] OR [Vitamin D [MeSH] AND Osseointegration [MeSH]]

4. SELECTION CRITERIA

4.1 Inclusion Criteria

Articles were included if they met the following conditions: [1] Published in English or French; [2] Published between January 1, 2018, and April 9, 2025; [3] Belonged to one of the following study types [Literature Reviews, Clinical trials, randomized clinical trials, Case series, Case reports]

4.2 Exclusion Criteria & definitions

Articles were excluded based on the following criteria: [1] Published outside the specified date range [01/01/2018 to 30/04/2025]; [2] Written in languages other than English or French; [3] Not addressing the research question; [4] Only available as abstracts or titles; [5] Systematic reviews covering the same topic.

According to recent literature, osseointegration is defined by 6 criteria [22] : [1] biocompatibility : the implant must not trigger an immune response, [2]bone-implant interface : on a microscopic level, no soft tissue interference between the bone and the implant; [3] stability : primary or mechanical stability and secondary stability or biological stability achieved by bone remodeling, [4] timeframe: the process of osseointegration takes weeks to months to be achieved on a cellular level; [5] assessment : evaluated through clinical exams [stability, symptoms], imaging [bone contact], or histology; [6] success : No radiolucency, pain, infection, or mobility under functional loading.

5. Critical Appraisal of Selected Articles

All included articles, apart from those excluded, were read in full to ensure relevance and quality.

6. Data Extraction Grid

Relevant data from each included article were extracted using a predefined data collection grid. The grid for primary studies included: [1] The title of the article; [2] Authors and year of publication; [3] Type of study & Journal; [4] Population; [5] Material and methods; [6] Results. All extracted data were compiled into a summary table for further analysis. The grid for literature reviews included: [1] The title of the article, [2] Authors, [3] Year, [4] Conclusion

RESULTS

1. Article Selection Process

The initial search on PubMed, using the defined Boolean equation and no filters, yielded 42 articles. A broader search on Google Scholar identified 1500 articles, for a total of 1542 records.

After removing 30 duplicates, 1511 articles remained. Applying the exclusion criteria led to the elimination of 640 articles. Titles and abstracts of the remaining articles were screened, resulting in 27 articles selected for full-text review.

Following a detailed evaluation by the review team, 18 articles were excluded for not aligning with the research question.

2. Articles included

Our review included 8 studies: 2 randomized controlled trials, 2 literature reviews, 2 prospective studies, 1 retrospective study and 1 case report.

All data extracted from primary studies [n=6] is included in Table I with a total of 316 patients

All data extracted from literature review [n=2] is included in Table II.

Table I: Data extracted from primary studies

N°	Title	Author & Year	Type of study & Journal	Population	Material and methods	Results
1	Comparative evaluation of crestal bone level in patients having low level of Vitamin D treated with dental implant with or without Vitamin D3 supplements.	-Pooja Garg *et al.,* - 2020	- National Journal of Maxillofacial Surgery -Prospective study	32 patients Aged between 20 and 40 years	A prospective, randomized clinical trial involved 32 patients aged between 20 and 40 years. Patients were evaluated on the basis of major complaints	It was observed that osseointegration of implants was significantly better in vitamin D-supplemented patients. Bone loss was lower as well.
2	Vitamin D deficiency and dental implant failure: outcomes from a pre-surgical supplementation program on vitamin D levels and antioxidant scores.	- Ana paz *et al.,* -2021	- Oral health and preventive dentistery - Prospective study	20 people between the ages of 26 and 75	Healthy, nonsmoking patients were chosen. Vitamin D levels were measured using three methods: a lab test, RapidRead, and 4D-CQ [both immunochromatographic]. A biophotonic scanner was used to measure the amounts of antioxidants. Tests were performed on day 0 and six weeks after using 3000 IU twice a day of DentaMedica supplements. The next step was statistical analysis.	The vitamin D results obtained by the 3 techniques were similar. A significant increase in vitamin D levels was recorded after supplementation. An average increase in antioxidant levels was also detected. 100% of implants were successfully integrated one year after surgery.
3	Impact of the 25-Hydroxycholecalciferol Concentration and Vitamin D Deficiency Treatment on Changes in the Bone Level at the Implant Site during the Process of Osseointegration: A Prospective, Randomized, Controlled Clinical Trial.	Jakub Kwiatek *et al.,* 2021	-Journal of clinical medicine - Prospective randomized controlled clinical trial	122 patients	Randomized controlled clinical trial that divided 122 healthy patients that will receive dental implants into 3 groups: Group A: 43 patients, VD < 30 ng/mL, no supplementation. Group B: 48 patients, VD < 30 ng/mL, with supplementation [8000 IU/day]. Group C: 31 patients, VD ≥ 30 ng/mL [no treatment needed].	After 6 and 12 weeks: Groups B and C showed significant bone gain at implant sites. Group A showed minimal change. At 12 weeks, Group B had significantly greater bone levels than Group A.
4	Vitamin D deficiency and early implant failure	Dr. Richard J. Miron *et al.,* 2021	-Dentistery today -Case studies	1 patient		After an unexplained loss of osseointegration of the implant, vitamin D supplementation according to the Denta Medica program was carried out for 12 weeks. The second implant placement was then successful and the implant is well osseointegrated.
5	Impact of vitamin D3 supplementation on dental implant stability	Omer W. Salih *et al.,* 2023	- Military Medical Science Letters - Clinical trial	12 patients [6 males and 6 females]	Twelve patients, between the age of 25 to 50, seeking dental implant therapy were involved in this split-mouth clinical investigation. Patients were split up into two	During the three months of the trial, significant differences between the treatment and control groups were detected according to osstell

N°	Title	Author & Year	Type of study & Journal	Population	Material and methods	Results
					groups: the treatment group and the control group. Dental implants were placed in the posterior maxillary extraction sites for every patient in both groups. The radio frequency analysis [RFA] was carried out at several time intervals to assess the stability of dental implants using the Osstell Mentor device.	meter device at the time of insertion [primary stability] and 3 months later [secondary stability]
6	Resonance frequency analysis of dental implants in patients with vitamin D deficiency	-Vesile Elif Toy & Arife Sabancı -2024	-Clinical oral investigation -Retrospective study	129 patients	This study comprises 129 patients all of which underwent dental implant therapy. They were grouped based on their vitamin D levels and supplement use: Group A [deficiency with supplements], Group B [insufficiency with supplements], Group C [insufficiency without supplements], and Group D [sufficiency]. Implant stability was measured using resonance frequency analysis [RFA] at placement and after 3 months. Patients with low vitamin D [Groups A and B] were prescribed supplements. Pearson correlation was used to assess the relationship between vitamin D levels and implant stability.	Primary stability of Group D [76.34 ± 6.55] was significantly higher than Groups A, B and C at baseline [$p < 0.05$]. At 3 months, Group C scored significantly lower than the other groups [$p < 0.05$]. The results revealed a correlation between serum levels of vitamin D and RFA measurements at 3 months [$p < 0.05$]

Table II: Data extracted from literature reviews

N°	Article	Author	Year	Conclusion
1	The Role and Importance of Lipoproteins, Vitamin D3, Vitamin K and Magnesium in the Osseointegration of Titanium Dental Implants	Kreena Shah *et al.,*	2021	This review concluded the following: Micronutrient like Vitamin D3, magnesium, vitamin K2 and factors like cholesterol levels influence bone metabolism Before implant surgery the levels of these micronutrient especially vitamin D3 should be assessed Long term success of implant therapy can be correlated to supplementation in vitamin D3
2	Vitamin D Screening and Supplementation-A Novel Approach to Higher Success: An Update and Review of the Current Literature	Thomas G Wiedemann *et al.,*	2025	This review showed that deficiency of this vitamin can result in impaired peri-implant bone formation. Vitamin D deficiency resulted in nearly a fourfold increase in overall EDIF incidence. Presurgical supplementation of vitamin D3 demonstrated increased levels of implant osseointegration, increased bone-implant contact, enhanced bone level maintenance, and decreased EDIF even in at-risk demographics [i.e., diabetic subjects]

DISCUSSION

1. Summary of the results

Jakub Kwiatek *et al.,* [23] in a large scale randomized controlled trial [n=122] provided a crucial dose response data after dividing patients into 3 groups [A, B and C]: group A insufficient with no supplementation, group insufficient with supplementation and group C sufficient. After 6 and 12 weeks: Groups B and C showed significant bone gain at implant sites. Group A showed minimal change. At 12 weeks, Group B had significantly greater bone levels than Group A. In the same context, Pooja Garg *et al.,* studied the long term effects of vitamin D supplementation [24] in her prospective study involving 32 patients provided clear radiographic evidence, [through standardized Digimizer analysis of parallel-technique periapicals] that vitamin D supplementation [at a dosage of 60,000 IU/month] significantly enhanced crestal bone preservation compared to non-supplemented controls. With a p-value of less than 0.001. The 3-month supplementation protocol not only improved early bone remodeling but also showed lasting effects at 6 months, indicating that vitamin D's role extends beyond the initial healing phases and this is mainly due to its long-term impact on bone remodeling physiology. Interestingly, Ana Paz *et al.,* found a correlation between the levels of vitamin D and the levels of antioxidants. In her prospective study on 20 patients, she had 2 majors' findings: [1] A significant increase in the levels of antioxidants following vitamin D supplementation and [2] 100% success rate after 1 year of follow-up. This study suggests that vitamin D levels may have a positive impact on the levels of antioxidants effectively reducing the oxidative stress and creating a more favorable environment for bone healing. Richard J Miron *et al.,* showed another positive side of vitamin D supplementation by documenting the success of a patient with previous implant failure after targeted vitamin D correction. The success of the 12-week "DentaMedica" program in this challenging case indicates that even patients who have experienced osseointegration failures in the past may benefit from structured supplementation. Vitamin D supplementation may have a long term effect as shown by Omer Salih *et al.,* [25] in his randomized clinical trial [n=12]. Where he utilized advanced RFA technology [Osstell] to capture the temporal dynamics of vitamin D's effects: while primary stability remained unchanged [p=0.896], the significant improvement in secondary stability at 3 months [p=0.001] indicates that vitamin D operates mainly through biological [bone remodeling] rather than mechanical mechanisms.

Toy and Sabancı *et al.,* in a retrospective study [n=129] found that patients with vitamin D deficiency [p<0.05], those whose vitamin D levels were adequate [≥30 ng/mL] demonstrated greater initial implant stability [ISQ 76.34±6.55]. This underlines the essential function of vitamin D in early implant fixation, corroborating Bhandage *et al.,* [2020], which found that a rise of 1 ng/mL in vitamin D is linked to an improvement of 0.48–0.62 ISQ. Patients with deficiencies who were given supplements reached a comparable 3-month stability to vitamin D-sufficient controls [p<0.05], whereas those without supplements fell short. These outcomes reflect the findings of Kwiatek's RCT [2021] and show that: [1] In patients with deficiencies, the use of vitamin D supplements can bring osseointegration outcomes into the normal range. [2] During the critical bone remodeling phase [the first 3 months], it is especially beneficial to have sufficient vitamin D levels.

In a more holistic approach, Kreena Shah *et al.,* [26] shifted the paradigm from an isolated view of vitamin D to one that recognizes its interdependence with co-factors [such as vitamin K and magnesium] and metabolic markers [like LDL]. The suggested pre-surgical optimization protocol [e.g., LDL<100 mg/dL, magnesium 3.8-6 mg/dL] embodies a comprehensive strategy for bone metabolism, which could elucidate the differing results of previous studies that did not account for these cofactors. In a recent comprehensive review Thomas G Wiedemann *et al.,* [28] This thorough examination of peer-reviewed research uncovered two essential findings regarding the function of vitamin D in implant dentistry : [1] Vitamin D deficiency [<30 ng/mL] was correlated with a four-fold EDIF, reduced peri-implant bone formation and a reduced BIC. [2] pre-surgical vitamin D supplementation reduced EDIF and improved osseointegration, BIC and a better bone healing. Therefore, the authors recommended a systematic vitamin D screening before implant surgery and systemic or topical supplementation in case of deficiency.

2.Clinical recommendations:

After careful analysis of the results of our review, we recommend the following:

- Encourage patients to follow a vitamin D rich diet [oily fish, fortified dairy products, eggs] and moderate exposure to the sun for the general population
- Patients' serum 25- hydroxyvitamin D [25[OH]D] levels be measured to assess their vitamin D status before undergoing implant therapy.
- The 25[OH]D levels should be between 30 and 50 ng/mL [75- 125 nmol/L], the optimal threshold for good bone health and effective osseointegration.
- For patients with vitamin D deficiency [levels of 25[OH]D
- < 20 ng/mL], prescribe supplementation with 50,000 IU of vitamin D2 or D3 per week for 6 to 8 weeks, followed by a daily maintenance dose of 1,000 to 2,000 IU.
- For patients with insufficient levels [20-30 ng/mL], we recommend daily supplementation with 1,000-2,000 IU of vitamin D3.

- We recommend continuous monitoring of vitamin levels after implant placement to ensure optimal osseointegration and prevent bone complications.

3. Limitations of this review:

- Selected articles are exclusively in French or English, which excludes publications other languages such as German, Italian or Spanish.
- The search was carried out in only 2 : PubMed and google scholar.
- A limited number items included.
- No diversity studies.
- Lack of long-term patient follow-up in some studies.
- Publication bias: Studies with positive results tend to be published.

CONCLUSION

We conclude that vitamin D supplementation, particularly in patients with baseline deficiency [<20 ng/mL], may enhance osseointegration through improved bone metabolism and reduced inflammatory responses. The analyzed studies demonstrate consistent benefits in implant stability and bone-to-implant contact when serum 25[OH]D levels exceed 30 ng/mL. However, the optimal supplementation regimen remains unclear due to significant variability in dosing protocols [2,000-50,000 IU weekly], treatment durations [4-12 weeks], and measured outcomes across studies. Further research is recommended to standardize supplementation protocols.

Conflict of interest: The author declares no conflict of interest.

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