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Vitamin D Deficiency & Early Implant Failure

What Every Clinician Should Know

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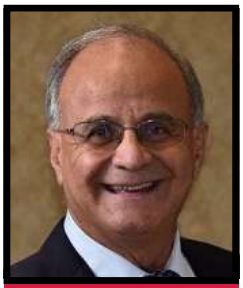

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INTRODUCTION

Dental implants are generally considered a safe and highly predictable surgical procedure performed by many clinicians with the aim of replacing missing teeth. Yet, to this day, a number of implants placed in adequate bone volume are lost each year within a 2- to 8-week period following implant placement for unexplained reasons.

As society continues to consume lower-quality foods and rely more heavily on fast foods, a large percentage of today's population is increasingly demonstrating generic vitamin deficiency upon testing, owing to this lack of nutritional intake.

These deficiencies are even more pronounced in the aging population, where a greater percentage of dental implants are placed. Unfortunately, one of the most prominent deficiencies known to mankind is that of vitamin D, a water-soluble vitamin critical for proper immune function as well as bone homeostasis.

VITAMIN D DEFICIENCY

Vitamin D deficiency is a worldwide public health problem that spans across all age groups from children to adults. Naturally, as we age, our ability to absorb vitamin D is also decreased. The major source of vitamin D is directly from sunlight exposure along with the very few foods that naturally contain sufficient doses. Unfortunately, direct sunlight has tremendously decreased in modern society with the increased number of desk-related jobs. Epidemiological studies have now shown that roughly 70% of society is deficient.1

Vitamin D deficiency is most known for its association in osteoporotic and menopausal women. Few realize, however, its drastic and substantial role in various other diseases. These include depression, dementia, Alzheimer's disease, asthma, cancer, cardiovascular disease, and diabetes, among others. Vitamin D is essential for gastrointestinal calcium absorption, mineralization of osteoid tissue, and maintenance of serum-ionized calcium levels.

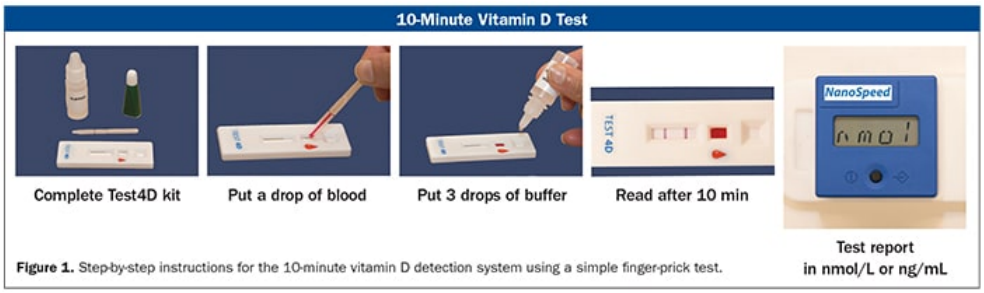

Figure 1. Step-by-step instructions for the 10-minute vitamin D detection system using a simple finger-prick test.

It is also important for other physiological functions, such as muscle strength, neuromuscular coordination, hormone release, and immune cell function.2 More recently, vitamin D deficiency has also been linked with up to a 300% increase in dental implant failure, and associations with other dental-related complications are increasing.3-12 Optimizing vitamin D levels prior to surgery, therefore, becomes fundamental for maximizing wound healing, and this article aims to discuss the relevant research on the topic and its association with dental implant-related failures and bone grafting complications.

Supplemental Recovery Program: The Science Behind Dental Healing

Owing to the impact of vitamin D deficiency-related complications and failures in dentistry, clinicians are advised to use vitamin D supplements when deficiency is observed. Typically, 5,000 IU/day is recommended by the AACE; however, an 8- to 12-week supplementation period is needed to reach adequate levels.

Figure 2. DentaMedica's 6-week recovery program aimed at optimizing vitamin D and antioxidant levels prior to implant placement.

Vitamin D Deficiency & Early Implant Failure: What Every Clinician Should Know

OPTIMIZING VITAMIN D LEVELS

Serum 25-hydroxy vitamin D (25-OH) is the reliable marker of vitamin D status, and a level below 20 ng/ml defines deficiency. Optimal levels above 30 ng/ml are required to maximize the bone health and non-skeletal benefits of vitamin D (Table 1). For individuals undergoing any type of dental-related procedures, levels between 40 and 60 ng/ml are generally recommended since it is known that levels may decrease substantially following a period of stress (simply, a dental surgical intervention). Unfortunately, foods do not contain sufficient levels.

Examples are cod liver oil (400 to 1,000 IU/teaspoon); fresh-caught salmon (600 to 1,000 IU/3.5 oz vitamin D3); tuna (236 IU/3.5 oz vitamin D3); egg yolk (20 IU/yolk vitamin D3 or D2); and fortified milk, cheese, or yogurt (100 IU/3 oz, usually vitamin D3). These are low levels considering deficiency should be treated with 4,000 to 6,000 IU/day for a 6- to 8-week period to restore levels to sufficient values. According to AACE and ACE guidelines, it is recommended that supplementation maintain levels above 30 ng/ml.13 The Endocrine Society in the United States recommends achieving a concentration of more than 30 ng/ml (> 75 nmol/L) of serum 25-OH,considering the optimal range is 40 to 60 ng/ml (100 to 150 nmol/L).

The Endocrine Society also advocates an intake of 1,500 to 2,000 IU/day (37.5 to 50 μg) in adults, and that obese patients (BMI > 30 kg/m2) should take 3 times more than the normal adult daily vitamin dose.13 Unfortunately, epidemiological studies across the United States have routinely shown that deficiencies of vitamin D are typically found in approximately 70% of the population, and this deficiency is only expected to increase as the population works more indoors. The following research articles focus on the link between these deficiencies and the associated risk for early dental implant failure.

RELATED DENTAL COMPLICATIONS ASSOCIATED WITH VITAMIN D DEFICIENCY

Vitamin D plays an important role in supporting the immune system and the integration of various biomaterials. It is also relevant for decreasing general oxidative stress and minimizing additional inflammation caused by surgery. As expressed previously, vitamin D is also involved in biomaterial integration and other metabolic processes, such as bone remodeling. Therefore, some complications have been related to vitamin D deficiency in the dental field.

In 2009, a first animal study investigated the role of vitamin D in dental implant osseointegration.9 Utilizing a rat model, implants were placed in both normal control and vitamin D-deficient animals and subjected to implant push-out tests, as well as histological analysis. The push-out tests revealed an approximate 66% decrease in value in the vitamin D-deficient group and also revealed significantly lower bone-to-implant contact as early as 14 days post-implant placement. It was concluded from this study that the effect of vitamin D deficiency was unexpectedly profound. It was further addressed that future clinical research would benefit patient care, owing to these observations.

Table 1. Vitamin D concentrations in humans in terms of deficient, optimal, and toxic levels.

Status	Serum Vitamin D 25-OH	Vitamin D Concentration
Severe Deficiency	< 10 ng/ml	< 25 nmol/L
Deficiency	< 20 ng/ml	< 50 nmol/L
Insufficiency	21 to 29 ng/ml	50 to 74 nmol/L
Sufficiency	30 to 100 ng/ml	75 to 250 nmol/L
Optimal	30 to 60 ng/ml	75 to 150 nmol/L
Toxic	> 150 ng/ml	> 375 nmol/L
Pre-surgery	40 to 60 ng/ml	100 to 150 nmol/L

THE ROLE OF ANTIOXIDANTS IN WOUND HEALING

In addition to bone-related deficiencies, several additional factors can impair wound healing, such as infection found in periodontal disease, poor diet, aging, diabetes, alcohol overuse, smoking, stress, and impaired nutritional status.14-16 In recent years, reactive oxygen species (ROS) have gained attention because of their central role to the progression of many inflammatory diseases.

17 Excessive production of ROS or impaired ROS detoxification causes oxidative damage, which has been shown to be a main cause of non-healing chronic wounds and tissue degeneration.18,19To combat oxidative stress, all cells in the body require an intrinsic store of molecules known as “antioxidants,” which prevent tissue damage.20 When this balance is shifted, however, high levels and activity of ROS cause DNA damage, protein damage, and lipid peroxidation. This leads to impairments in wound healing and many long-term chronic degenerative diseases and whole-body tissue inflammation, which are linked to common diseases such as dementia and various cancers.

Unfortunately, a large percentage of the population today suffers from vitamin and mineral deficiencies directly linked to antioxidant levels (Table 3). As a result, it is clear that prior to any major surgery, vitamin recovery programs are indispensable to help restore the patient’s levels prior to surgery to prevent failure and/or delayed wound healing. Furthermore, restoring patient antioxidant levels remains a relatively easy and inexpensive task. Vitamin C is, perhaps, one of the most well-known antioxidants and has a primary function as a radical scavenger and in the synthesis of collagen hydroxylation in humans.21

Table 3. Vitamin deficiency in the general US population.

Vitamin A	=	34% deficient
Vitamin C	=	25% deficient
Vitamin D	=	70% deficient
Vitamin E	=	60% deficient
Calcium	=	38% deficient
Magnesium	=	45% deficient

It also contributes to immune defense by supporting various cellular functions of both the innate and adaptive immune systems. Vitamin C deficiency results in impaired immunity and higher susceptibility to infections.22 Vitamin C is found in many natural fruits and vegetables, yet the population remains relatively deficient, owing to the poor nutritional status encountered in many patients.

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