

## Effect of Vitamin C in Dental Implant Practice

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### Abstract

The body's nutritional elements can have a significant role in assisting and enhancing the dental treatments we provide to our patients.

Tissue injury such as dental decay, mucosal ulceration, or surgical extraction, creates the so called Oxidative stress, which renders the tissues in a state of inflammation and that would in turn triggers a significant demand of some of these elements, that are capable of interfering and perhaps reversing the inflammation and at the same time promoting cellular turn over to optimize the recovery. Such elements are Vitamin E, Vitamin C, Omega 3 and 6. All of which have recently been investigated to have a direct and indirect effect on wound healing and recovery.

Noteworthy, is Vitamin C, which has an astonishing effect on modulating the body's response to stress and to enhance the body repair processes starting from improved chemotaxis, minimized inflammation, to bone and soft tissue formation.

Besides the systemic effect of ascorbic acid, it's bioavailability in the plasma during or immediately after dental implant insertion surgery, was also found crucial in many or almost all the steps of wound healing and the osseointegration process.

Therefore, the employment of vitamin C, was found not only to be safe and significantly effective in eliminating the tissue injury of any type, but it has also been advocated to be employed specifically in patients with a medical compromise that are expected to suffer a delayed healing.

**Keywords:** *Vitamin C; Dental Implant*

### Introduction

Vitamin C, also known as ascorbic acid, is a water-soluble element which has been found to exist in almost 100% of the human foods in varying percentages and concentrations, yet it cannot be synthesized or stored in the human body, and thus must always be out-sourced.

It is well understood that, inside our bodies, vitamin C functions as an essential cofactor in numerous enzymatic reactions, e.g. in the biosynthesis of collagen, carnitine, and catecholamines, and as a potent antioxidant [1].

Furthermore, the physiologic process of bone formation and maturation, seems to be affected -at the different stages- by the plasma concentration of ascorbic acid [2].

Dr. Linus Pauling (1901 - 1994), the Nobel prize-winning American biochemist, was a chief advocate of the importance of supplementing our diets with Vitamin C to promote optimum health and cure disease. He stated that "All infections and even all toxins cause damage

via Oxidative Stress and are associated with laboratory evidence of increased oxidative stress, and that vitamin C can prevent and Reverse the oxidative damage, while strongly stimulating the natural antimicrobial and antitoxic properties of the immune system”.

In implant dentistry, the surgical access and osteotomy done prior to implant insertion are considered a type of tissue injury which creates a state of tissue oxidative stress. Therefore, and according to Pauling, “reversing” the oxidative stress can result in a more predictable bone formation cascade.

### Aim of the Research

Viable osteoblasts are crucial for the osseointegration to occur. This in turn requires generous blood supply to the osteotomy site.

This is a literature review study to explore the significance of vitamin C plasma and tissue concentration and its efficacy and impact on the different physiologic processes of the body; including the osseointegration phenomenon

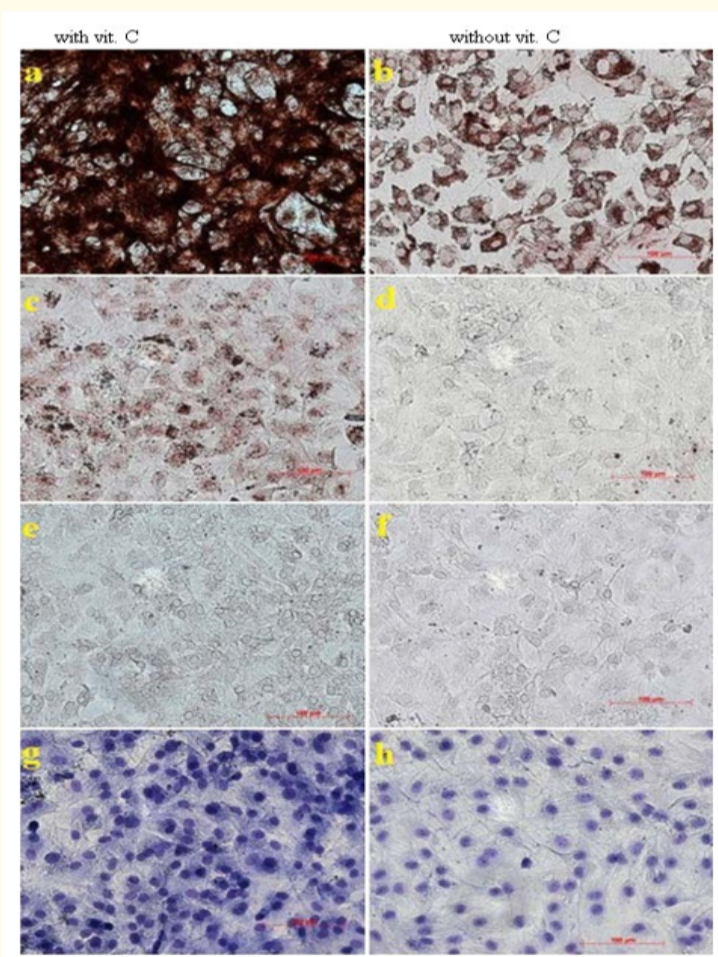
This requires exploring the literature to find out any data that may support the following points:

1. Minimizing the critical inflammatory phase (which is a risk factor in the immediate phase after implant insertion, in order to avoid pressure necrosis that may form in Type “D1” bone).
2. Minimizing damage at the implant bed specifically on osteoblasts caused by the torque and potential heat generation of the implant drills. By reversing the claimed oxidative stress.
3. Examining the ability of vitamin C to increase the tissue perfusion to the site, and hence providing more viable osteoblasts.
4. Examining the possibility of enhancing the density of type 1 collagen infrastructure in both Bone and Soft tissue
5. Decrease the failure rate of dental implants in patients suffering from generalized oxidative stress such as that found in smokers and uncontrolled diabetic patients.

### Review of Literature

#### Effect of vitamin C on cell growth and collagen synthesis

Vitamin C plays the key role in the synthesis of collagen, the major component of the extracellular bone matrix. The effect of ascorbic acid on the proliferation and differentiation of primary bovine osteoblasts *in vitro* has been tested. An improved growth and increased synthesis of the extracellular matrix proteins collagen type I, osteonectin and osteocalcin was observed while increasing the ascorbic acid concentration up to 200 µg/ml [3].



**Figure 1:** Immunohistochemical analyses (a-f) of collagen I (a, b), osteonectin (c, d), osteocalcin (e, f) of osteoblast like cells (staining toluidine blue) (g, h) in media with 200 µg/ml ascorbic acid (left column) and without ascorbic acid (right column) after 14 days [3].

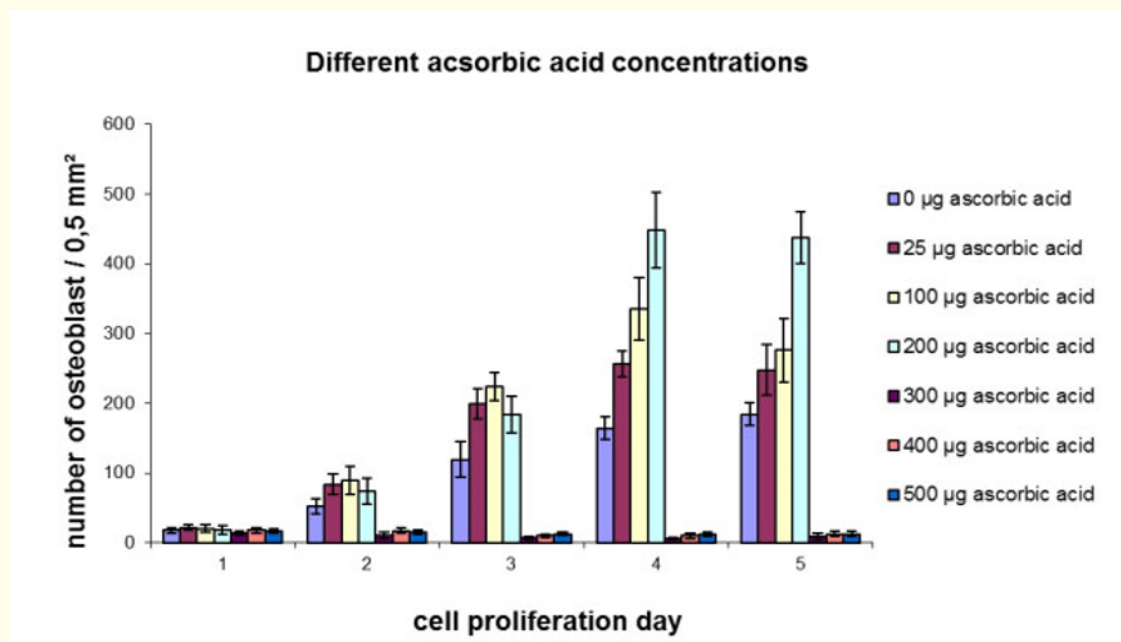


Figure 2

### Effect on tissue perfusion

Vitamin C may enhance endothelial function by scavenging oxygen-derived free radicals, including superoxide anion, and thus preventing the superoxide from interacting with the vasoactive (vasodilator) nitric oxide [4].

The cause of endothelial dysfunction in smokers is not known, but it has been attributed to increased oxidative stress that may reduce the bioavailability of endothelium-derived nitric oxide, leading to impairment in vasodilator function [5]. As smokers have low levels of antioxidant vitamin C, presumably due to increased consumption by pro-oxidants in cigarette smoke, antioxidant therapy is one solution [6].

Preserved nitric oxide bioavailability may be a particularly important protective mechanism in the vessel wall as nitric oxide has anti-platelet property [7,8] which is in turn essential in implant integration.

### Effect on bone regulation

It has been known that growth factors such as bone morphogenetic protein (BMP) and IGF-1 positively regulate osterix expression in osteoblasts. It has been suggested that Ascorbic Acid regulates osterix expression through modulation of local growth factor actions or there is a cross talk between AA and growth factor signaling pathways and thus AA is required for increased osterix expression during osteoblast differentiation [9].

Franceschi, *et al.* noted that ascorbic acid is necessary for the expression of osteoblast phenotype and examined Na<sup>+</sup> dependent transport required for MC3T3-E1 Preosteoblast cells to respond to vitamin C [10].

Vitamin C can also enhance wound repair following dental extractions through the strengthening of socket blood clots, as well as by increasing the body's construction of scar tissue and the synthesis and deposition of collagen [11].

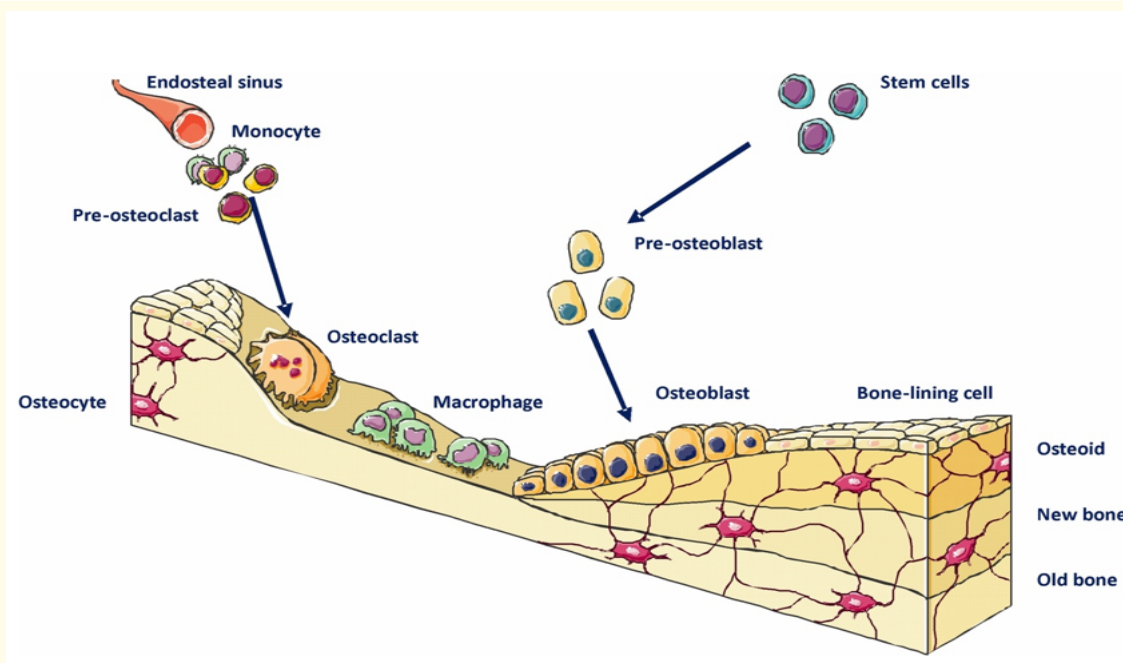


Figure 3

AA induces different gene expression, which covers cell growth; metabolism; morphogenesis; cell death; cell communication. The first genetic portrait of Early stage stimulation of pre-osteoblasts by AA [12].

### Effect on immune system

Vitamin C has been demonstrated as effective in stimulating the immune system and subsequently reducing the potential for post-surgical infection. Furthermore, it acts -itself- as antimicrobial and natural killer cell activities, assists lymphocyte proliferation, and chemotaxis [13,14].

Chemotaxis was inversely correlated to blood histamine ( $r = -0.32, p = 0.045$ ), and, compared to baseline and withdrawal values, histamine levels were depressed 38% following AA supplementation. Blood histamine and neutrophil chemotaxis did not change 4 hours following a single 2g dose of ascorbic acid, although plasma ascorbate rose 150%. These data indicate that AA may indirectly enhance chemotaxis by detoxifying histamine *in vivo* [15].

### Effect on oral soft tissues

Vitamin C plays a critical role in the maintenance of a normal mature collagen network in humans (anti-scurvy properties) by preventing the auto-inactivation of lysyl and prolyl hydroxylase, two key enzymes in collagen biosynthesis [16].

Pussinen., *et al.* evaluated vitamin C concentrations in plasma with regard to periodontitis serology in Finnish and Russian men. They reported that antibody levels to *Porphyromonas gingivalis* correlated negatively with the vitamin C concentrations. They concluded that *P. gingivalis* infection is associated with low concentrations of vitamin C in plasma [17].

### Significance in diabetic patients

Insulin and many other drugs have long been used to control blood sugar, but Ihnat., *et al.* found that cells have a “memory” that causes damage to continue even when blood sugar is controlled. By adding antioxidants like Vitamin C, Ihnat found that cell “memory” disappeared and cell function and oxidation stress were normalized.

And hence an antioxidant-based therapy combined with glucose control seems essential to avoid the complications of diabetes” [18].

Most studies have found that diabetics have at least 30% lower circulating ascorbic acid levels than normals, Active glands (e.g. pancreas) tend to absorb and store ascorbate from plasma [19].

What is more interesting to implant dentists is that Insulin modulates the differentiation and synthetic activity of osteoblasts. Via minimizing the abnormal cellular accumulation of sorbitol, and besides nitric acid indirect synthesis, vitamin C thus improves the diabetic microangiopathy.

### Conclusion

Vitamin C has extensively been researched in the past few decades, and has been found to be an essential constituent for a healthy life; yet the nature of our diets sometimes lead to a serious lack of this essential nutrient specifically when it’s needed the most, i.e. at times of tissue stress.

Furthermore, vitamin C has also been investigated to improve many medical conditions such as CVS, Diabetes mellitus, and smoking-induced endothelial malfunction, the fact that dictates an increased consumption (from natural or medicinal sources) is almost inevitable to improve such systemic conditions.

On the other hand, in implant dentistry, improving the performance of the “local environment”, via enhancing osteoblast motility and production rate, and also enhancing the chemotaxis and leukocytic function, and finally maintaining soft tissue stability via dense collagen substructure, has also been proven to be of significance in increasing the success as well as the survival rate of dental implants.

In certain instances such as diabetes and smoking, vitamin C must be considered an essential component of the implant therapy protocol, and must be incorporated in the medicinal recipe, and not be regarded as an adjuvant therapy.

The literature has provided hundreds of evidences that the AA is the most powerful Anti-Oxidant, which can combat the Reactive oxygen species “ROS”, and reverse any type of “Oxidative stress”, the process by which all basic pathophysiological mechanism of any human disease take place [20].

“Vitamin C should be given to the patient while the doctors ponder the diagnosis”: Linus Pauling.

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