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Review Article

The Role of Selenium-Containing Compounds in Periodontal and Dental Disease Management

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Abstract

Between the 20th and 21st centuries, periodontal disorders became common. Inflammatory periodontal disorders affect 90–95% of cases, while 80% of children have some kind of periodontal disease and over 95% of people over the age of 35 years have some form of periodontal disease. The gums, cement, alveolar bone, and other periodontal tissues can all sustain damage from the illness known as periodontitis. There are several reasons for this, such as smoking, poor oral hygiene, genetics, and other things. Scientists are currently working to create new instruments and techniques for the successful treatment of periodontitis. Adding selenium to medication formulations is one of the creative approaches that enable the development of a successful medication. One of the trace elements required for the human body's regular operation is selenium. In recent years, it has been found that selenium plays an important role in dentistry. Its anti-inflammatory, antibacterial, and antioxidant qualities create new opportunities for dental practice. However, the human body can be seriously harmed by both too much and too little selenium. The potential applications of selenium in dentistry, particularly in the management of periodontitis, are covered in this review paper. The effects of improper selenium dosages on the human body are also thoroughly explained.

Key words: Dentistry, Periodontitis, Selenium, Caries

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Introduction

The Swedish chemist John Berzelius was the first to describe selenium, a trace element, in 1817. In 1957, it was discovered that giving rats selenium in their diet stopped them from developing liver cirrhosis and muscular dystrophy [1]. Following the discovery that selenium is a crucial component of the enzyme glutathione peroxidase [2], research into the impact of selenium shortage on human health and the potential applications of this element in medicine got underway. It was discovered to play a part in metabolism, cellular homeostasis, carcinogenesis, and the immunological, endocrine, and reproductive systems [3].

Since food is the primary source of selenium for humans, a person's dietary choices affect how much selenium they have in their bodies. Plants vary greatly in their selenium content. It is dependent not only on the growth environment but also on the plant's capacity to absorb and store selenium from the soil. Generally speaking, veggies have a higher selenium level than fruits [4]. Numerous studies indicate that bread, cereals, fish, and animal products are the primary human sources of selenium [5, 6].

Selenium can be found in nature as both inorganic (selenite and selenate) and organic (selenomethionine and selenocysteine) molecules. Some specialists believe that organic forms are the primary ones for the prevention and treatment of disorders brought on by selenium deficiency because they are better absorbed in the gastrointestinal system [7]. Plants, particularly cereals, contain selenomethionine, but animal products are the primary source of selenocysteine.

Smokers have a decreased selenium content, which declines with age for unclear reasons. Additionally, those who drink a lot of alcohol and coffee have decreased selenium levels. Consuming a lot of eggs and rice is also linked to a lower level of selenium in the body [8]. The WHO advises taking 50–55 microgrammes of selenium daily [9].

Both the lack of selenium and its excess are dangerous for humans. Manifestations of deficiency appear when using selenium less than 40 mcg/day, and excess – when using more than 400 µg / day [10]. Severe selenium deficiency leads to the development of Keshan's disease, manifested by heart failure due to cardiomyopathy, atrophy, degeneration, necrosis of articular cartilage, and fever [11]. In some studies, selenium deficiency was associated with an increased risk of cardiovascular disease, which decreased when the deficiency was replenished. Selenium has an anticarcinogenic effect on the prostate, liver, pancreas, and colon [12].

According to certain research, there is a U-shaped correlation between blood selenium levels and overall morbidity; that is, both an excess and a deficiency of selenium can influence incidence [13]. Having too much or too little selenium also raises mortality from all causes.

The potential applications of selenium in dentistry, specifically in the management of periodontitis, are covered in this review paper. The effects of improper selenium dosages on the human body are also thoroughly explained.

Results and Discussion

General directions of selenium application in dentistry

One of the trace elements required for the human body's regular operation is selenium. The importance of selenium in dentistry has been recognized in recent years; its antibacterial, anti-inflammatory, and antioxidant qualities create new opportunities for application in dentistry.

An enzyme called glutathione peroxidase, which is essential for shielding organs from oxidative stress, contains selenium [14]. Selenium is used in dentistry to help shield teeth and oral cavity tissues from harm.

Selenium has been shown in studies to lower the amount of free radicals in oral cavity tissues, which can lessen inflammatory processes and promote wound healing [15].

Due to its antibacterial qualities, selenium is helpful in the treatment of oral infections [16]. Caries, periodontitis, and stomatitis are just a few of the dental issues that it can help prevent by combating bacteria, viruses, and fungus.

Additionally, selenium can strengthen the effects of antibiotics, which may help treat oral infections.

Selenium can aid in lowering oral cavity inflammation, which is a prevalent issue in dentistry. It can lessen the pain and swelling brought on by inflammatory diseases like gum disease.

Periodontitis as a serious problem in modern dentistry

Gums, cement, and alveolar bone are among the periodontal tissues that can sustain damage from the illness known as periodontitis [17]. One of the most prevalent dental conditions is this one.

Gum disease, which turns red and swollen, is the first sign of periodontitis. Bacteria may be able to enter deeper and target more periodontal tissues as a result of creating pockets between the gum and the tooth **(Figure 1)**. Consequently, tooth loss may arise from the breakdown of alveolar bone and cement [18]. **Table 1** displays the primary features of this illness.
When bacteria produce plaque on teeth and in the surrounding tissue, periodontitis results. Microbes found in plaque have the potential to inflame the gums and the bones that support teeth.

Table 1. General characteristics of periodontitis

Causes and risk areas of the disease	Symptoms and signs of the disease
Smoking and tobacco use	Bleeding gums during brushing or chewing
Stress and fatigue	Detachment of the gums from the teeth
Genetic predisposition to gum disease	An increase in the notches on the surface of the teeth when the gum moves away from them
Poor nutrition and lack of vitamins	Calcareous deposits on teeth
Other diseases such as diabetes, cardiovascular diseases, and diseases of the immune system	Periodic pain in the teeth and gums

Periodontal diseases became widespread in the XX—XXI centuries. Almost 95% of the world's population is over 35 years old and 80% of children have periodontal diseases of varying severity, while inflammatory periodontal diseases occur in 90-95% of cases [19].

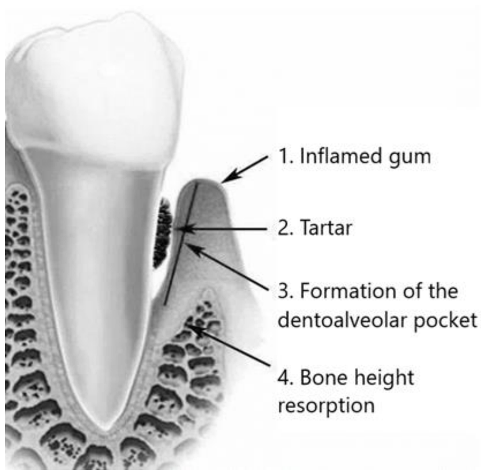

Figure 1. The principle of the occurrence of periodontitis

Numerous authors are interested in studying the pathophysiology of periodontitis. According to certain writers, the microbial component plays a significant part in the development of periodontal disorders. The whole 20th century was spent researching how microbes affect the development of periodontal diseases [20]. At the same time, it was discovered and acknowledged that inflammatory mediators, including prostaglandins, interleukins, and their enzymes, metalloproteinase matrix, play a significant role in the degeneration of periodontal tissues [21]. By influencing the inflammatory process, the discovery of antibiotics allowed for the management of periodontal disorders.
This idea was initially called into doubt in 1982 when researchers reported that only 8% of 600 individuals between the ages of 40 and 70 had a severe type of periodontitis, according to their findings [22]. A new era in the study of periodontal disease epidemiology was ushered in by this discovery. Contrary to the notion that periodontal illnesses are bacterial in origin, several further scientific studies conducted in 1983 supported the idea that they do not always develop at a steady pace if treatment is not received.

The oxidation of lipids in the oral cavity by peroxide is becoming increasingly important in modern dentistry science. In contemporary dentistry, chronic periodontitis—damage to cellular and subcellular membranes—is becoming a more pressing issue.

Carcinogenesis, immunological damage to cell membranes, aging, radiation illness, inflammatory diseases, lack of vitamins and certain trace elements, and exposure to different stressors all exacerbate the processes of lipid peroxidation [23]. The results of free radical reactions are known to affect protein synthesis, and this is also the case for the alveolar bone. The significance of free radicals produced during macrophage vital activity is particularly high in the early phases of periodontal tissue destruction, according to multiple authors [24]. In other investigations, it was demonstrated that lipid peroxidation was activated at the onset of the process in the soft tissues of the periodontal period in rats under the impact of emotional and painful stress [25]. Tissue sections showed edema, resorption of the alveolar process, enlargement of the gum base, and loosening of the epithelium. The action of antioxidants controls the strength of free radical activities, enabling the use of different antioxidants to treat patients with chronic periodontitis [26].

Since selenium-dependent glutathione peroxidase is a homotetrameric selenoprotein that is the first line of defense for cells and requires selenium to form, it is known that a living organism has a unique antioxidant defense that counteracts the development of the harmful effects of reactive oxygen species [27]. A comprehensive characteristic has been developed for the entire class of plasma glutathione peroxidases that modern scientists have discovered [28]. Nitrite hydroperoxide, which is generated when endothelial cells, macrophages, and neutrophils are active, is crucial to the physiology of oxidant stress [29]. The activity of selenium-dependent glutathione peroxidase, which converts peroxide to a nitrite ion, protects from the compound's action, but the ion's potent oxidizing properties determine its primary role in the development of inflammatory processes as an inducer of toxicity [30]. Furthermore, antioxidant protection plays a direct role in the development of numerous metabolic processes in addition to being a crucial component in the process of eliminating free radicals.

Prospects for the use of selenium in the treatment of periodontitis

As a crucial component of selenium-dependent glutathione peroxidases and thioredoxin reductases, selenium holds a significant position among the substances with antioxidant qualities that are receiving an increasing amount of attention in contemporary literature sources. As a gel toothpaste that contains zinc chloride, cobalt nitrate, copper sulfate, and selenium sulfate—that is, the primary structural trace components of enzyme antioxidants—the therapeutic dental toothpaste “Anthoxide” was created and patented in Russia in 2005.

As a component of glutathione peroxidase production, selenium is of special significance. To maximize glutathione peroxidase tissue activity in the thyroid gland and avoid the potential onset of oxidative stress, further selenium treatment may be advised [31].

Many trace minerals and vitamins are insufficient in the population in a sizable portion of Russia [32]. The delivery of a small child is triggered by a lack of iodine, selenium, and cobalt chemicals during pregnancy. A greater proportion of moms had a combined iodine and selenium deficit that was discovered during the physiological course of pregnancy [33]. Therefore, it is vital to investigate the effects of selenium deficiency on the human body further because numerous studies have confirmed that it poses a threat not only to the development of periodontal diseases but also to the formation of various somatic pathologies [34].

In the Russian Federation, inorganic selenium-containing medications are widely utilized as biologically active additions and as components of multivitamins to treat inflammatory illnesses of the periodontal tissues.

Research has demonstrated that selenium supports healing in the diseased focus and restores the equilibrium of antioxidant protection [35]. Reparative processes in the mandibular bone tissue have been shown to take place in the context of microcirculation abnormalities, tissue hypoxia, and the activation of oxidative stress in an infected bone wound against the backdrop of a marked deficiency in bone tissue restoration [36]. In individuals with mandibular fractures, selenium deficiency was associated with lipid peroxidation product accumulation and inhibition of antiradical defense, which slowed the healing process in the fracture zone [37]. The study's findings support the notion that patients with mandibular fractures have an imbalance in their “lipid peroxidation — antioxidant protection” system [38]. In contrast to its increased excretion in urine and saliva, they found a selenium shortage when they examined the blood. Blood parameters do not have the dynamics necessary for complete normalization when using standard therapeutic techniques [39]. The addition of a medication that contains selenium to complex therapy helped to restore normal selenium levels and eliminate an imbalance in the antioxidant system's parameters in biological fluids, both of which had a major positive impact on the treatment's outcome.

However, it should be remembered that several studies show that inorganic selenium formulations are harmful. Laboratory white male rats that were acutely intoxicated with sodium selenite were used to do a morphological analysis of the lower jaw bones. It has been demonstrated that acute sodium selenite poisoning activates hypertrophic processes in bone tissue [40].

Because of the restricted ability to neutralize their most poisonous metabolite, hydrogen selenium, inorganic selenium compounds have a low minimum threshold of toxicity.

Research has demonstrated that the organic form of selenium is preferable when providing the body with a trace element for preventive purposes because its toxicity is significantly lower than that of inorganic selenium, reducing the risk of an overdose. Additionally, organic selenium's bioavailability in the body is typically lower than that of inorganic selenium [5].

It is important to understand that in the natural environment, selenium enters the human and animal bodies primarily in the form of selenium-containing amino acids - selenomethionine (Se-Met) and selenocysteine (Se-Cys). The intake of selenium artificially with its alimentary deficiency into the body is carried out in the form of selenite or sodium selenate. At the same time, the protein thioredoxin may quickly convert food-derived selenium and selenite anions back into hydrogen selenium, which is mostly found as a hydroselenide anion at physiological pH levels. Selenoprotein synthesis, which includes elements of essential antioxidant systems, is a highly specialized process that uses just a specific amount of selenium, which is a component of hydrogen selenium. Inorganic selenium can build up in tissues as a free hydroselenide anion, which is highly toxic and hazardous if it enters the body in excess.

Conclusion

One of the trace elements required for the human body's regular operation is selenium. Selenium has been significant in dentistry in recent years. According to studies, selenium can lower the amount of free radicals in the oral cavity's tissues, which can lessen inflammation and promote wound healing. Additionally, selenium can strengthen the effects of antibiotics, which may help treat oral infections. It can lessen the pain and swelling brought on by inflammatory diseases such as gum disease.

Selenium is a crucial component of the body's antioxidant defense system. The use of selenium preparations in periodontal illnesses lessens the impact of lipid peroxidation, which speeds up the healing of periodontal tissues and enhances patient outcomes.

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