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Antioxidants and its Role in Periodontitis - A Short Review

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Abstract:

Periodontitis results from the loss of balance between microbial virulence factors and a proportionate host response.Antioxidant is a substance that is present at low concentrations which significantly delays or prevents oxidation of that substrate.Diets low in antioxidant vitamin cannot increase the risk of any developing gum disease.For prevention and treatment of periodontitis daily nutrition should include sufficient antioxidants, vitamin D, and calcium. Inadequate antioxidant levels may be managed by higher intake of vegetables, berries, and fruits (e.g. kiwi fruit), or by phytonutrient supplementation.Nutritional counselling and supplementation may very well reduce inflammation and thereby enhance outcomes of conventional periodontal therapy.Hence this review discusses about the antioxidant nutrients which can play a major role in preventing and treating the periodontal diseases.

Key words:periodontal disease,antioxidants,phytonutrient supplementation.

INTRODUCTION:

Periodontitis is an inflammatory process which is initiated by the plaque biofilm, that leads to loss of periodontal attachment to the root surface and adjacent alveolar bone which ultimately results in tooth loss.

Primary etiological factor for periodontitis is predominantly gram-negative anaerobic or facultative bacteria within the sub gingival biofilm(1). Reactive oxygen species (ROS) encompasses other reactive species which are not true radicals but are capable of radical formation in the intracellular and extracellular environments(2).ROS are normally generated as part of physiological functioning of all cells and their role as mediator in cell signaling is now seen to be crucial for maintaining health. The neutrophils play a pivotal role in host defense and are the first line of defense against this infectious periodontal disease(3).

Neutrophils have several selective mechanisms for controlling bacterial invasion, including both intracellular and extracellular oxidative and non-oxidative killing mechanisms. The oxidative killing mechanism of neutrophils and other phagocytes involves the formation of reactive oxygen species (4).

ROS generation by neutrophils requires a minimum oxygen tension of about 1% and a pH of 7.0–7.5.

Cells require adequate levels of Antioxidants in order to prevent tissue damage caused by excessive production of reactive oxygen species (5). The reactive oxygen species may cause damage to various cellular and extracellular tissues like 1. Protein damage 2. Lipid peroxidation 3. DNA damage.

Effects of ROS on Periodontal Tissues:

The reactive oxygen species cause periodontal tissue damage by,

1. Ground substance degradation

2. Collagenolysis either directly or indirectly or as a result of oxidation of proteases

3.Stimulation of excessive pro-inflammatory cytokine release through NF-κB activation.

Antioxidants are substances present at low concentrations, compared to those of an oxidizable substrate, will significantly delay or inhibit oxidation of that substrate. Antioxidants are available from exogenous and endogenous sources like vitamins, minerals, enzymes and hormones, as well as food and herbal supplements. The antioxidants like vitamin-E, vitamin-C, ceruloplasmin, glutathione peroxidase and superoxide dismutase protect tissue damage induced by free radicals (6). Antioxidants have also been used in combination with dried, fresh, and blended herbal paste.Due to possible health benefits of antioxidants against periodontitis,increased intake of such nutrients have been recommended(7).

CLASSIFICATION OF ANTIOXIDANTS(8):

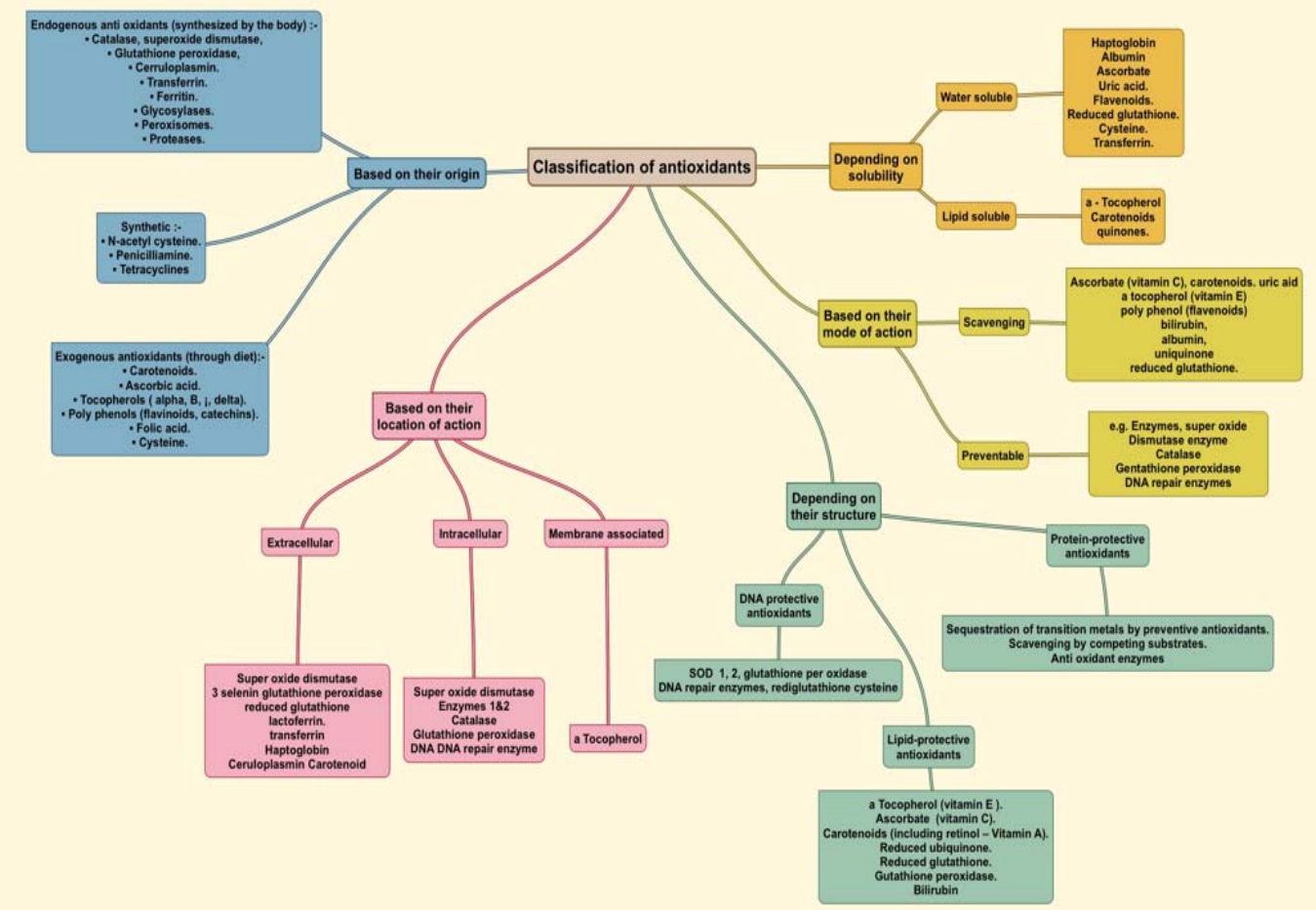


Fig.1. Schematic representation of classification of antioxidants

Antioxidants in oxidative stress:

Oxidative stress was recently defined as"an imbalance between oxidants & antioxidants in favour of the oxidants, leading to a disruption of redox signaling & control and/or molecular damage. Periodontal tissue depends on natural antioxidants to overcome this oxidative stress and maintain homeostasis. When antioxidants are depleted, the ability of gum tissue to overcome oxidative stress, maintain normal tissue and control the bacterial damage appears to be compromised(9). Low levels of most antioxidants are a risk factor for periodontal disease and infection.

Antioxidant micronutrients:-

Micronutrients that play a major role in periodontal disease(10):

- vitamin A (retinol),
- vitamin B complex [vitamin B1 (thiamine),
- vitamin B2 (riboflavin),
- vitamin B3 (niacin),
- vitamin B5 (pantothenic acid),
- vitamin B6 group (pyridoxine, pyridoxal, pyridoxamine),
- vitamin B7 (biotin),

EXOGENOUS ANTIOXIDANTS:

Vitamin C:

Ascorbic acid is the only endogenous antioxidant in plasma that can completely protect against peroxidative damage induced by the oxidants released from activated neutrophils(11). Study done by Mieko Nishida in 2000, stated that dietary intake of vitamin C showed a statistically significant relationship to periodontal disease in current and former smokers.

Functions of vitamin c are:

- Scavenger of water-soluble peroxyl radicals;
- Scavenger of superoxide and perhydroxyl radicals;
- Scavenger of hypochlorous acid;
- Prevention of damage mediated by hydroxyl radicals on uric acid;
- Scavenger of singlet oxygen and hydroxyl radicals

Amaliya et al in 2007, studied the relationship between Vitamin C and severity of periodontitis, concluded that the association between plasma Vitamin C level and periodontal Attachment loss suggest that Vitamin C deficiency may contribute to severity of periodontal breakdown.

Dosage recommended : 40 – 60 mg.

Vitamin E:
The biological form of vitamin E is α-tocopherol. It is a fat soluble antioxidant, found mostly in nuts, seeds and vegetable oils(14).Vitamin E transfers phenolic hydrogen to the recipient free radical and gets converted into phenoxyl radical. However, this phenoxyl radical is no longer an antioxidant and it must be recycled or repaired. Studies done by Goodson and Boules 1973, demonstrated that patients with periodontitis who rinsed their months with Vitamin E daily for 21 days experienced a significant decrease in GCF compared with unsupplemented control group. vitamin E might help in diabetics, control their blood glucose levels thereby it might help reduce the side effects of the disease including the development of periodontal disease.
Dosage recommended:30-400 IU

Vitamin D and Calcium:
Vitamin D and calcium are essential for optimal skeletal development and maintaining bone mass. However, vitamin D is not only important in relation to bone metabolism but also to a number of other diseases(16). With regard to periodontal disease ,vitamin D and calcium are important determinants of periodontal health. Data from various studies suggest that periodontal alveolar bone loss is greater in subjects with osteoporosis and low dietary intake of calcium results in more severe periodontal disease(17).

Carotenoids:
Carotenoids like alpha carotene, beta-carotene, crytoxanthin, lutein, lycopene, zeanxantin are a group of natural colored pigments, usually yellow, red or orange.They act as free radical traps and has an protective effect on vitamin C and E(18). ß-carotene is efficient at scavenging singlet oxygen (O2) and other carotenoid antioxidant activities include the scavenger of peroxyl radicals.It has been found that patients with low levels of α- and β-carotene and total carotenoids were more likely to have high interleukin-6(19).
A recent study by Wood N et al 2004 investigated the relationship between monthly tomato consumption and serum lycopene levels, and a self reported history of congestive heart failure (CHF) in individuals with periodontitis, and concluded that a relationship exists between periodontitis and CHF risk, and high monthly tomato consumption appears to affect this relationship in a positive direction in periodontitis subjects.
Dosage recommended:15000-25000 IU

Flavonoids:
Flavonoids are found in fruits, vegetables and certain beverages .They are polyphenolic compounds and their Dietary intake is high compared to other dietary antioxidants. They have antioxidant,anti inflammatory, anti-allergic, anti platelet and anti tumor activities(21). Flavonoids has the property of inhibiting LPS thus reducing bone resorption .Therefore increased intake of flavonoids may proved to be beneficial prevention of periodontal disease.
Dosage recommended:100-500mg

Lazaroids:
They are a newly identified compounds that are derived from glucocorticoids, but they lack both glucocorticoid and mineralocorticoid activities. These compounds scavenge lipid peroxyl radicals and inhibit iron-dependent lipid peroxidation by a mechanism similar to that of vitamin E (22).

Co-enzyme Q 10 :
It exerts as an oxidized form (ubiquinone / co Q) and a reduced form (ubiquinone / co Q H_2). CoQ10 is also regarded as a pro-oxidant molecule in response to various pathophysiological events. Co-enzyme Q10 deficiency has been demonstrated by Hansen IL et al in 1976 in the gingival tissues of periodontitis but there is currently a lack of intervention studies in human periodontitis to substantiate clinical therapeutic benefit.
Dosage recommended:90-150mg

Polyphenols:
Battino et al in 1999, stated that they are absorbed following dietary intake of, in particular, vegetables, fruits, Red wine, tomatoes, red wine and tea. E.g. water soluble cateclin, epigallo-catechine gallate, and poly phenol,
Their function :-
1. Radical scavenging;
2. Terminating lipid peroxidation;
3. Iron chelation;
4. Sparing vitamin E;
5. Restoration of vitamin.
Dosage recommended :100-300mg

ENDOGENOUS ANTIOXIDANTS:-

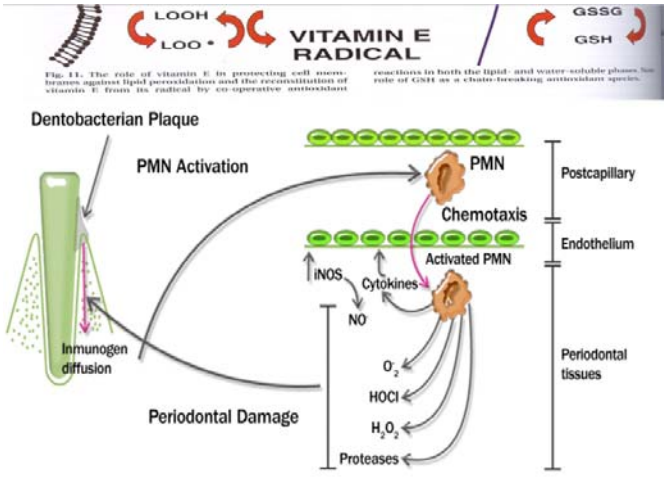
Glutathione:
Glutathione plays a major role in maintaining the intracellular redox balance and thus regulating signaling pathways which are affected by oxidative stress(25). Systemic glutathione (GSH) is decreased with inflammation.The functions of GSH include antioxidant defense and immune regulation(26). For periodontitis there is dose dependent reduction of periodontal GSH as a result of smoking.Study done by Chang Y C in 2003 proved that GSH protect against the cytotoxic actions of nicotine in periodontal fibro blasts.
Dosage recommended :100mg

Role of antioxidants in periodontal health:
An antioxidant is a molecule which inhibits oxidation reaction. Antioxidants terminate the chain reaction caused by free radicals of oxidation reaction , preventing cell damage or death of the cells. Major sources of antioxidants in the human diet include cereals,fruits, vegetables, chocolate, oils and beverages such as tea, coffee, wine and fruit juices etc.Dietary antioxidants which possess strong antioxidant activities include vitamin C (ascorbate), vitamin E, beta-carotene and the polyphenols(28).

Foods rich in antioxidants:

- Broccoli
- Spinach
- Berries
- Beans
- Avocados
- Red wine
- Kiwi
- Dark chocolate

Panjamurthy et al. (2005) found lower plasma vitamin C, vitamin E, and GSH in periodontitis patients even after adjusting for protein levels, whereas antioxidant enzyme levels were raised, the authors attributing this to a protective response to oxidative stress (thiobarbituric acid reactive substance levels were raised in periodontitis subjects).



Battino et al 2005**,** addressed the anti oxidant activity of tooth paste formulation and found that particles containing sodium ascorbyl phosphate displayed clear anti oxidant activity in vitro. The anti oxidant activity of Zncl and NaF were significant, which was because of the ability Zn 2+ to protect thiol groups and prevent H2 O2 and super oxide formation by transition metals and the ability of F to complex divalent iron ions.

CONCLUSION:

For the prevention and treatment of periodontitis adequate daily intake of natural antioxidants, fish oils (omega-3 PUFAs), vitamin D and calcium are recommended.antioxidant nutrients have opened a new window for prevention and treatment of periodontal diseases and diet should be supplemented with natural antioxidants.These vitamins support immune functions and are involved in the maintenance of structural and functional integrity of epithelial tissues and physiological or metabolic parameters relevant to periodontal health .There is increasing evidence from various studies, that an increased intake of antioxidants is associated with a diminished risk for several diseases.

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