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Periodontal disease and gingivitis

Periodontal disease is a chronic bacterial infection that affects the gums (gingivae) and other tissues that support the teeth. If only the gums are involved, it is called gingivitis. The most common type of gingivitis is caused by the accumulation of bacterial plaque, which leads to a chronic inflammatory process. Manifestations of gingivitis may include red, swollen, tender, and bleeding gums; receding gums; pockets separating the gums from the teeth; and bad breath. If gingivitis is not adequately treated, the inflammatory process may spread to the periodontal ligaments and alveolar bone, eventually destroying these structures and causing teeth to loosen and fall out.

Risk factors for periodontal disease include cigarette smoking and poor oral hygiene. Conventional therapy consists primarily of oral hygiene measures (regular tooth brushing, flossing, and dental check-ups). These local measures are frequently, though not universally, successful. In advanced cases, antimicrobial agents, flap surgery to remove plaque below the gum line, or bone and tissue grafts may be recommended.

Dietary factors

The importance of nutrition. Nutritional factors play a role in immune function and tissue integrity, both of which could influence a person's resistance against the microorganisms that cause periodontal disease. The relationship between nutrition and periodontal disease is illustrated by observations regarding “trench mouth” (acute necrotizing ulcerative gingivitis), a common and severe affliction among World War I soldiers that was caused by spirochetes and other microorganisms. This condition was associated almost invariably with signs of pellagra or pre-pellagra (vitamin B₃ deficiency),¹ and improved rapidly after treatment with 250–600 mg/day of niacin.² Similarly, monkeys fed a diet marginally deficient in vitamin C developed more severe gingivitis

from experimentally induced dental plaque than animals fed a normal diet.³

The decrease in micronutrient intake that results from consumption of refined, processed foods might increase a person's susceptibility to periodontal disease. In addition, localized deficiencies of certain nutrients may develop in periodontal tissues as a result of chronic infection and inflammation, leading to a vicious cycle of worsening disease and more severe deficiencies. Various dietary modifications and nutritional supplements may therefore be useful for preventing and treating periodontal disease.

Refined sugar. Periodontal disease developed in hamsters fed a diet containing 56% sucrose.⁴ In a cross-sectional study of 2,437 young adults, high intake of added sugars was associated with an increased prevalence of periodontal disease.⁵ In a study of healthy dental students with minimal gingivitis, those assigned to consume large amounts of sucrose (100 or 225 g/day) had a significant worsening of gingivitis after as little as 4 days. In contrast, students assigned to eliminate refined carbohydrates from their diet had a significant improvement in gingivitis.⁶ These findings suggest that sucrose consumption contributes to the development of periodontal disease.

Allergy. Since periodontal disease is an inflammatory condition, and since allergic reactions cause inflammation, allergies to foods or other substances might exacerbate periodontal disease in some patients.

In a case report, a 32-year-old man with chronic periodontal disease that had failed to respond to conventional therapy reported that every time he drank milk there was a bad aftertaste and odor. Three weeks after discontinuing milk, the foul taste and odor were gone and gingival bleeding had ceased.⁷ While the aftertaste and odor may have been due to lactose intolerance, it is likely that the gingival bleeding was caused by allergic inflammation.

An analysis of 48 toothpastes sold in Finland revealed that nearly half contained one or more compounds widely recognized as allergens. A total of 27 different allergens were identified in these products. Contact with allergens present in toothpaste has been observed to cause gingivitis in some cases.⁸

The frequency with which allergy triggers or exacerbates periodontal disease is not known. However, allergy should be considered as a possible contributing factor to periodontal disease in patients whose clinical history suggests the presence of allergies (chapter 7).

Nutritional supplements

Folic acid. Gingivitis developed in baboons fed a folic acid-deficient diet.⁹ In an observational study, the prevalence of gingivitis was increased in women taking oral contraceptives,¹⁰ which are known to promote folate deficiency.

It has been suggested that localized folate deficiency may exist in inflamed gingival tissue despite normal plasma levels, and that this localized deficiency may reduce the resistance of gingival tissue to irritants. Folic acid has also been found to bind to plaque-derived endotoxin, thereby potentially reducing the level of antigenic stimulation and inflammation caused by plaque.¹¹ In several clinical trials, folic acid supplementation reduced the severity of gingivitis. Folic acid administered as a mouth rinse tended to be more effective than folic acid in tablets. The greater efficacy of the mouth rinse may be due to direct absorption of topically applied folic acid into gingival tissue, as demonstrated by a 6-fold increase in the gingival tissue folate concentration after a single dose (5 ml of a 0.1% solution, swished for 5 minutes).¹²

Thirty dental students and auxiliary personnel (aged 21–32 years) were randomly assigned to receive, in double-blind fashion, 0.1% folic acid mouth rinse or placebo mouth rinse for 60 days. The subjects used 5 ml of the solution twice a day, rinsing for 5 minutes before expectorating. Gingival inflammation, as assessed by the gingival index and bleeding index, was less in the group receiving folic acid than in the placebo group ($p < 0.05$).¹³

Sixty patients with gingivitis were randomly assigned to receive, in double-blind fashion, 0.1% folic acid mouth rinse or placebo mouth rinse for 4 weeks. The patients used 5 ml of the solution twice a day, rinsing for 1 minute before expectorating. Compared with placebo, folic acid improved parameters of gingival health (i.e., reduced the mean number of color change sites and bleeding sites; $p < 0.001$).¹¹

Thirty healthy volunteers were randomly assigned to receive, in double-blind fashion, 4 mg/day of folic acid orally or placebo for 30 days. Gingival inflammation decreased in the folic acid group ($p < 0.05$) and worsened slightly in the placebo group.¹⁴

Thirty women in their eighth month of pregnancy were randomly assigned to receive, in double-blind fashion, placebo mouth rinse and placebo tablets, placebo mouth rinse and folic acid tablets (5 mg/day), or 0.1% folic acid mouth rinse and placebo tablets for 4 weeks. The women used 5 ml of the mouth rinse twice a day, rinsing for 1 minute before expectorating. Compared with placebo, folic acid mouth rinse reduced the severity of gingivitis

($p < 0.001$). Oral folic acid was nonsignificantly more effective than oral placebo ($p < 0.1$).¹⁵ Similar results were seen in another study in which the respective treatments were administered for 14 days during months 4 and 8 of pregnancy.¹⁶

Coenzyme Q₁₀ (CoQ₁₀). Biochemical evidence of localized CoQ₁₀ deficiency (demonstrated by an enzyme stimulation assay) was found in diseased gingival tissue of patients with periodontal disease, when compared with healthy gingival tissue from the same patients and with gingival tissue from healthy controls.^{17–20} While it is not clear whether localized CoQ₁₀ deficiency is a cause or a consequence of periodontal disease, such a deficiency could lead to impaired immune function and reduced healing capacity. Oral CoQ₁₀ supplementation has been shown to increase CoQ₁₀ levels in gingival tissue of patients with periodontal disease.²¹ Several clinical trials found that CoQ₁₀ is an effective treatment for periodontal disease.^{21–25}

Seven patients with advanced periodontitis requiring surgical intervention received 50 mg/day of CoQ₁₀ for 3 weeks. Disease severity, as measured by the periodontal score, improved significantly. Pocket depth also decreased significantly; such an improvement is said to be uncommon in patients with advanced disease.²¹

Eighteen patients with periodontal disease were randomly assigned to receive, in double-blind fashion, 50 mg/day of CoQ₁₀ or placebo for 3 weeks. Outcome measures included pocket depth, purulent exudate, tooth mobility, gingival swelling, bleeding, redness, pain, and itching. Improvement was seen in all 8 patients receiving CoQ₁₀ and in 3 of 10 patients receiving placebo ($p < 0.01$).²²

In a study of 10 men with periodontitis, 30 periodontal pocket sites were randomly assigned to topical application of CoQ₁₀ (85 mg/ml dispersed in soybean oil) or placebo (soybean oil alone). The solutions were applied with a small syringe once a week for 6 weeks. During the last 3 weeks, root planing and subgingival scaling were performed at all sites. During the first 3 weeks, significant reductions in gingival crevicular fluid flow, probing depth, and attachment loss were found only at sites treated with CoQ₁₀. After root planing and scaling were performed, significant improvements were seen at all sites. However, only CoQ₁₀-treated sites showed significant improvements in the modified gingival index and in bleeding.²³ Thus, topical application of CoQ₁₀ improved periodontitis, when administered as sole treatment or in combination with conventional periodontal therapy.

Vitamin C and flavonoids. Vitamin C and flavonoids each contribute to gingival health by promoting tissue integrity and exerting anti-inflammatory effects. In monkeys and guinea pigs, feeding a diet containing suboptimal amounts of vitamin C increased the severity of experimentally induced gingivitis.^{26,27} In healthy male volunteers, restriction of vitamin C intake to 5 mg/day for 4 weeks resulted in a significant increase in gingival inflammation and bleeding. These changes were reversed by vitamin C supplementation.²⁸

In an observational study, a significant inverse correlation was found between dietary vitamin C intake and the extent of periodontal disease. Periodontal health appeared to improve with increasing vitamin C intakes up to 126 mg/day, beyond which no further improvement was seen.²⁹ Plasma vitamin C levels were significantly lower in 20 patients with periodontal

disease than in healthy individuals. In patients with periodontal disease associated with low vitamin C levels, gingival inflammation could not be eliminated by local treatment unless vitamin C supplements were also given.³⁰ In several clinical trials, vitamin C supplementation (alone or in combination with flavonoids) decreased the severity of gingivitis.^{31–35}

One hundred two healthy volunteers with varying degrees of gingivitis were randomly assigned to receive, in double-blind fashion, placebo or 300 mg/day of vitamin C, with or without 300 mg/day of citrus flavonoids, for 3 weeks. Half of the subjects also received local therapy (scaling of one-half of the mouth). Mean improvement in gingivitis was significantly greater in people receiving vitamin C than in those receiving placebo, both on the scaled and unscaled sides. The combination of vitamin C and flavonoids was significantly more effective than vitamin C alone. The beneficial effect of vitamin C plus flavonoids alone (i.e., without local therapy) was at least as great as that of local therapy alone.³⁴

Fifty-eight patients (mean age, 45 years) with chronic periodontitis were assigned (apparently without randomization) to consume 2 grapefruits per day for 2 weeks or to serve as a control group. Grapefruit is a good dietary source of vitamin C and flavonoids. Prior to treatment, the mean plasma vitamin C concentration was significantly lower in the patients than in healthy controls. Gingival bleeding improved ($p < 0.001$) in the group consuming grapefruit, but did not change in the control group.³⁵

In other studies, supplementation with 100–500 mg/day of vitamin C, with or without flavonoids, for 3–6 weeks had no beneficial effect on gingivitis.^{36–38} While there is no clear explanation for these conflicting results, they might be explainable in part by differences in baseline nutritional status, gingivitis severity, and oral hygiene.

Vitamin C and flavonoids are safe and inexpensive, and they have multiple health benefits. Therefore, despite the conflicting results of research, patients with gingivitis should be advised to consume adequate amounts of these nutrients, either through dietary modification or supplementation.

Topical vitamin C. According to anecdotal reports, some dentists have obtained “uniformly excellent” results using topical sodium ascorbate (buffered vitamin C) for prophylaxis and treatment of gum disease. After the teeth are brushed and the mouth is rinsed, 1–2 g of sodium ascorbate is placed in the dry palm of the hand, picked up on the wet toothbrush, and massaged gently into all areas of the teeth and gums. The mouth is not rinsed; rather, the sodium ascorbate is left in contact with the mouth tissues. If it causes excessive salivation, it may be swallowed. This treatment is said to soothe damaged gum tissue and to increase the healing rate.³⁹ Ascorbic acid should not be used topically, as its acidity can erode dental enamel.

Vitamin E. Thirty-eight patients with chronic periodontitis received scaling and root planing and were randomly assigned to receive or not to receive 300 IU of vitamin E every other day for 3 months. Compared with no vitamin E, vitamin E supplementation significantly improved median scores for plaque index, gingival index, bleeding on probing, and clinical attachment level.⁴⁰

Calcium and vitamin D. Dogs fed a low-calcium (0.12% by weight), high-phosphorus (1.2% by weight) diet developed periodontal disease, characterized by progressive loss of alveolar bone.⁴¹ It has been suggested that calcium deficiency or a low calcium-to-phosphorus ratio in the diet might contribute to the development of periodontal disease in humans.

Observational data suggest that suboptimal vitamin D status is a risk factor for periodontal disease. In cross-sectional studies of participants in the Third National Health and Nutrition Examination Survey, inverse associations were found between serum concentrations of 25-hydroxyvitamin D and the prevalence of both gingivitis and periodontal disease.^{42,43} In some studies, supplementation with calcium, alone or in combination with vitamin D and other nutrients, resulted in an improvement in periodontal disease, although no benefit was seen in one study.

In an uncontrolled trial, administration of 1 g/day of calcium for 6 months to 10 patients with periodontal disease resulted in the disappearance of or marked improvement in bleeding; a reduction in tooth mobility and pocket depth; and improvement in or disappearance of gingivitis. The osseous structures of the alveolar region showed radiographic improvement in 7 of 10 cases.⁴⁴

Thirty-three patients with generalized periodontal disease were randomly assigned to receive, in double-blind fashion, placebo or a daily supplement providing 750 mg of calcium, 375 IU of vitamin D, and trace amounts of iron, copper, magnesium, silica, manganese, and zinc for 1 year. More patients improved in the supplement group than in the placebo group (60% vs. 17%; $p < 0.01$).⁴⁵

Healthy subjects ($n = 145$; mean age, 71.5 years) were randomly assigned to receive calcium (500 mg/day) and vitamin D (700 IU/day) or placebo. After 18 months, 52% fewer subjects in the calcium/vitamin D group than in the placebo group had lost one or more teeth (13% vs. 27%; $p < 0.05$).⁴⁶ Whether or not the tooth-preserving effect of calcium and vitamin D was due to an improvement in periodontal disease was not addressed in this study.

In another double-blind study, supplementation with 1 g/day of calcium for 6 months resulted in a slight improvement in plaque index, gingival index, and probing depth, but these improvements were not greater than those seen in the placebo group.⁴⁷

Assuring adequate calcium and vitamin D intake should be a component of the overall management of periodontal disease. Administration of other nutrients that promote bone health (chapter 166) might also be useful for preventing and treating the alveolar bone loss that occurs in periodontal disease.

Fatty acids. In a small double-blind trial, supplementation with 3 g/day of borage seed oil (BSO) for 12 weeks resulted in clinical improvement in patients with periodontitis. BSO appeared to be more effective than 3 g/day of fish oil or the combination of 1.5 g/day of BSO and 1.5 g/day of fish oil.⁴⁸ In another double-blind study of patients with periodontitis, supplementation with the fatty acids present in fish oil (equivalent to 1 g/day of fish oil) for 12 weeks as an adjunct to scaling and root planing improved parameters of periodontal health (gingival index, sulcus bleeding index, pocket depth, and clinical attachment level; $p < 0.05$ vs. placebo for each).⁴⁹

Zinc and copper. Zinc and copper have anti-inflammatory activity and also play a role in immune function and bone health. Observations in cattle suggest that deficiencies of zinc, copper, and other trace minerals can promote the development of periodontal disease.⁵⁰ The potential relevance of those findings to humans warrants further study.

Multivitamin-multimineral. In double-blind studies of children and adults who did not have periodontal disease, supplementation with a multivitamin or a multivitamin with minerals for 3–4 weeks improved measures of periodontal health.^{51,52}

B vitamins after flap surgery. In a double-blind trial, supplementation with a B-complex vitamin enhanced healing after flap surgery for periodontitis.

Thirty patients undergoing flap surgery were randomly assigned to receive, in double-blind fashion, a B-vitamin supplement or placebo for 30 days following surgery. The supplement provided daily 50 mg each of thiamine, riboflavin, niacinamide, calcium pantothenate, and pyridoxine; 50 µg each of biotin and cyanocobalamin; and 400 µg of folic acid. Compared with placebo, the B vitamins improved wound healing, as demonstrated by better clinical attachment levels ($p < 0.03$) at 6 months after surgery.⁵³

Probiotics. In most,^{54–58} but not all,⁵⁹ double-blind trials, administration of lozenges containing *Lactobacillus reuteri* DSM 17938 and *L. reuteri* ATCC PTA 5289 (sold under the name Prodentis) was beneficial for patients with chronic periodontitis. In a study that included long-term follow-up, the improvements persisted for at least 49 weeks after the treatment was discontinued. In another double-blind trial, the use of one Prodentis lozenge twice a day during the last half of the third trimester of pregnancy significantly improved pregnancy-associated gingivitis compared with placebo.⁶⁰

Thirty patients with chronic periodontitis were treated with scaling and root planing and were randomly assigned to receive, in double-blind fashion, probiotic lozenges twice a day (morning and evening after tooth brushing) or placebo lozenges for 3 weeks. The probiotic lozenges (Prodentis; BioGaia, Lund, Sweden) contained at least 10^8 colony-forming units each of *Lactobacillus reuteri* strains DSM 17938 and ATCC PTA 5289. Evaluations were performed at baseline and on days 21, 90, 180, and 360. Compared with placebo, the probiotic significantly improved plaque index, gingival index, bleeding on probing, probing depth, and attachment gain at every time point.⁵⁵

Lozenges containing *Bifidobacterium animalis* subsp. *lactis* HN019 (10^9 colony-forming units per lozenge, given twice a day for 30 days) have also been reported to be beneficial in the treatment of chronic periodontitis.⁶¹

Case report. I saw a 49-year-old woman with moderately severe periodontal disease who had been told by her periodontist that she needed extensive surgery. She was advised to take 60 mg/day of CoQ₁₀, to use 5 ml of 0.1% folic acid mouth rinse twice a day, and to brush buffered vitamin C (calcium ascorbate) powder gently into the gums once a day. After 1 month of treatment, the periodontist remarked with

surprise that her condition had improved substantially and that she no longer needed surgery.

Conclusion

In my experience, nutritional interventions are frequently beneficial for patients with periodontal disease and gingivitis. Dietary modifications that may be worthwhile include avoidance of refined carbohydrates and, when appropriate, identification and avoidance of allergens. Nutritional supplements that may be useful include folic acid mouth rinse, CoQ₁₀, vitamin C and flavonoids, buffered vitamin C topically, calcium and vitamin D, and borage seed oil. A specific probiotic preparation also appears to be of value. As is frequently the case with nutritional therapy, a combination of treatments may be more effective than any one treatment by itself.

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Xerostomia

Xerostomia is dryness of the mouth resulting from insufficient saliva production. Consequences of xerostomia may include halitosis, impaired speech and taste sensation, altered dietary habits, and an increased incidence of dental caries (saliva contains factors that prevent caries).

More than 400 medications can cause xerostomia, and medication use is the most common cause of this disorder. Other causes include Sjogren's syndrome and certain other autoimmune diseases, diabetes, mouth-breathing, excessive alcohol intake, nutritional deficiencies, and radiation therapy. The prevention of radiation therapy-induced xerostomia is discussed in chapter 337.

Conventional treatment focuses in large part on measures to prevent dental caries. In particular, regular use of xylitol chewing gum may be worthwhile, because it stimulates saliva flow and reduces the growth of cariogenic bacteria (i.e., *Streptococcus mutans*). Chewing of hard cheese at the end of meals also stimulates saliva flow and appears to promote re-mineralization of enamel. These interventions are discussed in chapter 258. Commercially available artificial saliva preparations are also used.

Dietary factors. Because patients with xerostomia may have altered dietary habits, a diet history should be obtained, and