Java project on periodontal disease. Periodontal condition in relation to vitamin C, systemic conditions and tooth loss

Amaliya, A.

Publication date
2014

Document Version
Final published version

Chapter 6

General discussion

Periodontitis is a multifactorial disease caused by an imbalance between environmental factors such as periodontal pathogens, and the host defense. Host defense mechanisms may be influenced by genetic factors, hormones and nutrition. With regard to the latter, especially vitamin C has received much attention in the periodontal literatures suggesting that insufficient intake of vitamin C could aggravate the progression of periodontal breakdown. The study population from the Purbasari tea estate on West Java and has been described in detail in the most recent report of this longitudinal study (Van der Velden et al. 2006). In this study it was shown that 20% of the population developed severe periodontitis. Unfortunately, at the start of the project evaluation of nutritional aspects were not included in the study protocol although it is not unlikely that in this rural area the vitamin C intake may be low. Therefore, a study was initiated in 2005 to investigate the relationship between vitamin C, as assessed by plasma vitamin C levels and dietary habits, and the severity of periodontitis. Results revealed that lower plasma vitamin C levels were related to more periodontal breakdown (chapter 2). In contrast, the study carried out in 2011 in the same population (chapter 3) showed that the plasma vitamin C levels were not related to the severity of periodontitis in terms of alveolar bone loss (ABL). Analysis of ABL levels of 2011 and the amount of attachment loss of the same subjects in 2002 showed a highly significant correlation (chapter 3). Also, a further analysis showed that the plasma vitamin C values as assessed in 2002 were significantly related to the bone loss in 2011 ($p<0.0001$). A major difference between the two studies is that in 2002 non-fasting blood samples were taken whereas in 2011 fasting blood was obtained.

Previously published studies that showed an inverse relationship between plasma vitamin C and the amount of periodontal breakdown, were also based in non-fasting blood analysis (Väänänen et al. 1993, Amarasena et al. 2005, Panjamurthy et al. 2005, Chapple et al. 2007). Therefore it was suggested that non-fasting blood samples reflect in a better way the relationship between vitamin C and periodontal disease (chapter 3). However, it may be questioned whether under all conditions fasting blood samples result in lower plasma vitamin C than those of non-fasting blood. In recent studies, investigating plasma vitamin C on the basis of fasting blood, mean plasma vitamin C levels of healthy (control) subjects were found of 8.45mg/l (Carr et al. 2013), 9.1mg/l (Suarez & Schramm-Sapyta 2014), 10.4-10.7mg/l (Vandevijvere et al. 2013) and 11.3mg/l (Kuzmanova et al. 2012). The latter study from the periodontal field included also periodontitis patients with plasma vitamin C values of 8.5mg/l. This value is still much higher than the 5.2mg/l as found in the Indonesian population of 2011, in which also fasting blood was used. Even, in subjects selected on the

basis of habitually low intake of fruit and vegetables for a vitamin C supplementation study, a plasma vitamin C level of 6.7mg/l was found in fasting blood (Khan et al. 2014). These data suggest that the 5.2mg/l of the Indonesian population as found in the fasting blood samples of the 2011 study is extremely low. This may imply that the results of the non-fasting blood samples of the same subjects in 2005 reflect to some extent their capacity to absorb vitamin C. This phenomenon of intra-individual differences in absorbing capacity could be confirmed in the capacity of vitamin C absorption experiment described in chapter 4. A possible explanation for this phenomenon may be that genetic variations in vitamin C transporter protein SVCT1 can influence plasma vitamin C concentrations (Cahill & El-Sohemy 2009, De Jong et al. 2014). Other factors that may have contributed to the extreme low plasma vitamin C levels in our study population could be related to their low dietary vitamin C intake and cooking habits. In the present study population, it is common to cook vegetables until they are tender (personal observation of the author). The carrot, cabbage and potato are mixed in a soup dishes and boiled for more than half an hour. This is also applicable to the wok procedure of kangkung and cassava leaves. Vitamin C is easily degraded by excessive heat and water, and 30 minutes heating time will result in 49.91-64.71% loss of vitamin C in vegetables (Igwemmar, 2013).

The question can be raised what mechanism could be responsible for the observed inverse relationship between plasma vitamin C levels and the periodontal condition. In periodontitis, a key feature of the disease is the hyperactivity and reactivity of peripheral blood neutrophils and it is supposed that the production of reactive oxygen species (ROS) by neutrophils is a significant factor in the local tissue damage (Chapple & Metthews 2007). When ROS are excreted by the neutrophil into the extracellular tissue these molecules will be reduced by, amongst others, vitamin C. This molecule will be oxidized into dehydroascorbic acid which will be transported into the neutrophil by glucose transporters GLUT 1 and GLUT 2. In the cell it will be reduced to ascorbic acid by glutathione (Padayatty & Levine 2001). It has been shown that the vitamin C content of the peripheral blood neutrophils of periodontitis patients and matched healthy controls is not different (Kuzmanova et al.2012). However, the locally present vitamin C in the extracellular periodontal tissues may be lower since this may be dependent on the vitamin C plasma concentration. This phenomenon has for example been shown in skeletal muscle tissue. The vitamin C concentration of this tissue appears to be highly responsive to changes in plasma vitamin C concentrations (Carr et al. 2013). Therefore, the locally lower availability of vitamin C in the extracellular periodontal tissues,

due to lower plasma levels of vitamin C, may explain partly the observed inverse relationship between periodontal disease and vitamin C.

In general, basic treatment of periodontitis consists of oral hygiene instructions in conjunction with supra- and subgingival scaling and rootplaning. Both the removal of supragingival and subgingival deposits/biofilms are essential for improving the periodontal condition (Sbordone et al. 1990, Kaldahl et al. 1996). However, the vitamin C/citrus flavonoid supplementation study (chapter 4) did not include any periodontal treatment. Supplementation of vitamin C/citrus flavonoids only in further untreated periodontitis patients would likely to have very little effect on the periodontal condition. Possibly, gingival bleeding may decrease (Leggott et al. 1986, Jacob et al. 1987, Staudte et al. 2005) but it does not result in a reduction of the periodontal lesion (Leggott et al. 1991, Staudte et al. 2005) or tooth mobility (O'Leary et al. 1969). Also, since the Ethics Committee did not grant a placebo controlled clinical trial, it implicated that a control group would not be available. Hence, the chances for assessing a possible effect of vitamin C/flavonoids supplementation on the clinical periodontal condition were considered negligible. Consequently, periodontal measures for the evaluation of the clinical periodontal condition were not included in the supplementation study protocol. However, results showed that at baseline almost 50% of this population had fasting plasma vitamin C levels <4.0 mg/l. However, supplementation resulted in plasma vitamin C levels >4.0 of all subjects and in major improvement of the HbA1c and CRP levels as well as a substantial decrease in subgingival quantity of all studied micro-organisms. Hence, we may have been too pessimistic with the assumption that improvement of the clinical periodontal condition due to supplementation of vitamin C/citrus flavonoids would be negligible. Therefore, it is suggested that future studies should include evaluation of the clinical periodontal condition as well.

References

Amarasena N, Ogawa H, Yoshihara A, Hanada N, Miyazaki H. Serum vitamin C-periodontal relationship in community-dwelling elderly Japanese. J Clin Periodontol. 2005;32:93-97.

Cahill LE, El-Sohemy A. Vitamin C transporter gene polymorphisms, dietary vitamin C and serum ascorbic acid. J Nutrigenet Nutrigenomics. 2009;2:292-301.

Carr AC, Bozonet SM, Pullar JM, Simcock JW, Vissers MC. A randomized steady-state bioavailability study of synthetic versus natural (kiwifruit-derived) vitamin C. Nutrients. 2013;5:3684-3695.

Carr AC, Bozonet SM, Pullar JM, Simcock JW, Vissers MC. Human skeletal muscle ascorbate is highly responsive to changes in vitamin C intake and plasma concentrations. Am J Clin Nutr. 2013;97:800-807.

Chapple IL, Matthews JB. The role of reactive oxygen and antioxidant species in periodontal tissue destruction. Periodontol 2000. 2007;43:160-232.

De Jong TM, Jochens A, Jockel-Schneider Y, Harks I, Dommisch H, Graetz C,Flachsbart F, Staufenbiel I, Eberhard J, Folwaczny M, Noack B, Meyle J, Eickholz P, Gieger C, Grallert H, Lieb W, Franke A, Nebel A, Schreiber S, Doerfer C, Jepsen S, Bruckmann C, van der Velden U, Loos BG, Schaefer AS. SLC23A1 polymorphism rs6596473 in the vitamin C transporter SVCT1 is associated with aggressive periodontitis. J Clin Periodontol. 2014;41:531-540.

Igwemmar NC, Kolawole SA, Imran IA. Effect of heating on vitamin C content of some selected vegetables. Int J Scient Technol Res. 2013;2:209-212.

Jacob RA, Omaye ST, Skala JH, Leggott PJ, Rothman DL, Murray PA. Experimental vitamin C depletion and supplementation in young men. Nutrient interactions and dental health effects. Ann N Y Acad Sci. 1987;498:333-346.

Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. J Periodontol. 1996;67:93-102.

Khan F, Ray S, Craigie AM, Kennedy G, Hill A, Barton KL, Broughton J, Belch JJ. Lowering of oxidative stress improves endothelial function in healthy subjects with habitually low intake of fruit and vegetables: a randomized controlled trial of antioxidant- and polyphenol-rich blackcurrant juice. Free Radic Biol Med. 2014;72:232-237.

Kuzmanova D, Jansen ID, Schoenmaker T, Nazmi K, Teeuw WJ, Bizzarro S, Loos BG, Van der Velden U. Vitamin C in plasma and leucocytes in relation to periodontitis. J Clin Periodontol. 2012;39:905-912.

Leggott PJ, Robertson PB, Jacob RA, Zambon JJ, Walsh M, Armitage GC. Effects of ascorbic acid depletion and supplementation on periodontal health and subgingival microflora in humans. J Dent Res. 1991;70:1531-1536.

Leggott PJ, Robertson PB, Rothman DL, Murray PA, Jacob RA. The effect of controlled ascorbic acid depletion and supplementation on periodontal health. J Periodontol. 1986;57:480-485.

O'Leary TJ, Rudd KD, Crump PP, Krause RE. The effect of ascorbic acid supplementation on tooth mobility. J Periodontol. 1969;40:284-286.

Padayatty SJ, Levine M. New insights into the physiology and pharmacology of vitamin C. CMAJ. 2001;164:353-355.

Panjamurthy K, Manoharan S, Ramachandran CR. Lipid peroxidation and antioxidant status in patients with periodontitis. Cell Mol Biol Lett. 2005;10:255-264.

Sbordone L, Ramaglia L, Gulletta E, Iacono V. Recolonization of the subgingival microflora after scaling and root planing in human periodontitis. J Periodontol. 1990;61:579-584.

Staudte H, Sigusch BW, Glockmann E. Grapefruit consumption improves vitamin C status in periodontitis patients. Br Dent J. 2005;199:213-217

Suarez EC, Schramm-Sapyta NL. Race differences in the relation of vitamins A, C, E, and β-carotene to metabolic and inflammatory biomarkers. Nutr Res. 2014;34:1-10.

Väänänen MK, Markkanen HA, Tuovinen VJ, Kullaa AM, Karinpää AM, Kumpusalo EA. Periodontal health related to plasma ascorbic acid. Proc Finn Dent Soc. 1993;89:51-59.

Van der Velden U, Abbas F, Armand S, Loos BG, Timmerman MF, Van der Weijden GA, Van Winkelhoff AJ, Winkel EG. Java project on periodontal diseases. The natural development of periodontitis: risk factors, risk predictors and risk determinants. J Clin Periodontol. 2006;33:540-548.

Vandevijvere S, Geelen A, Gonzalez-Gross M, van't Veer P, Dallongeville J, Mouratidou T, Dekkers A, Börnhorst C, Breidenassel C, Crispim SP, Moreno LA, Cuenca-García M, Vyncke K, Beghin L, Grammatikaki E, De Henauw S, Catasta G, Hallström L, Sjöström M, Wärnberg J, Esperanza L, Slimani N, Manios Y, Molnár D, Gilbert CC, Kafatos A, Stehle P, Huybrechts I. Evaluation of food and nutrient intake assessment using concentration biomarkers in European adolescents from the Healthy Lifestyle in Europe by Nutrition in Adolescence study. Br J Nutr. 2013;109:736-747.