Decision-Making In The Periodontal Practice Regarding Periodontal Risk Factors

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Citation

A Dannan. *Decision-Making In The Periodontal Practice Regarding Periodontal Risk Factors*. The Internet Journal of Dental Science. 2013 Volume 12 Number 1.

Abstract

The identification of groups and individuals at risk for disease progression still represents one of the greatest challenges in the management of periodontal patients.
Tobacco smoking, poor-controlled diabetes mellitus (both type 1 and type 2), specific pathogenic bacteria, microbial tooth deposits, genetic factors, age, gender, socioeconomic status, stress, infection with Human Immunodeficiency Virus (HIV), and osteoporosis are all considered to be risk "elements" for periodontal disease.
In this paper, we tried to introduce a simple method for systematic decision making in the periodontal practice regarding the most accepted periodontal risk factors. A fundamental review of risk factors in Periodontology has also been conducted.

INTRODUCTION

The role of risk factors and risk assessment in the prediction of clinical periodontal outcomes has been a subject of much interest. To date, it is accepted that specific pathogenic bacteria (A.a, P.g, B.f), cigarette smoking, and diabetes mellitus are the major established risk factors for periodontitis. Although several approaches have been developed to assess the factors which may interfere with periodontal disease's onset and/or progression, some contradictions regarding the classification, the definition, and the assumed implemented factors do exist among all these methods.
Risk assessment can be defined by numerous components (1, 2).
Risk is the probability that an individual will develop a specific disease in a given period. The risk of developing the disease will vary from individual to individual.
A risk factor can be defined as any environmental, behavioral, or biologic factor that, when present, increases the likelihood that an individual will develop the disease (3).
It is important to make the distinction that risk factors are associated with a disease but do not necessarily cause the disease. Evidence used to identify risk factors is usually derived from case reports, case series, case-control study, cross-sectional studies, longitudinal cohort studies, and controlled clinical trials, also known as interventional studies. All of these studies can identify factors associated with a disease though they are not equal in strength. The longitudinal study may be capable of identifying a causal relationship. The interventional study gives the strongest evidence of a causal relationship and furthermore can provide evidence of the benefit of eliminating the risk factor (4).
However, to be identified as a risk factor, the exposure must occur before disease onset.
The term risk determinant is reserved to those risk factors that cannot be modified.
Risk indicators are probable risk factors that have been identified in cross-sectional studies but not confirmed through longitudinal studies.
Risk markers, although associated with increased risk for disease, do not cause the disease.
In a recent paper (5), we initiated the term "Risk Elements" due to the contradiction found in the literature regarding how to define and classify risk factors, risk determinants, risk indicators, and risk markers for periodontal disease.

RISK

While the current understanding of risk elements associated with periodontitis has expanded, the identification of groups and individuals at risk for disease progression still represents one of the greatest challenges in the management of periodontal patients.
Most accepted risk elements for periodontal disease include tobacco smoking, poor-controlled diabetes mellitus (both type 1 and type 2), specific pathogenic bacteria, microbial

tooth deposits, genetic factors, age, gender, socioeconomic status, stress, infection with Human Immunodeficiency Virus (HIV), and osteoporosis.

Smoking

Cigarette smoking is recognized as a major risk factor in the incidence and progression of periodontitis (6-12). A dose-effect relationship between cigarette smoking and the severity of periodontitis has also been demonstrated (12-16). Odds ratios for developing periodontal disease as a result of smoking range from 2.5 (17), 3.97 for current smokers and 1.68 for former smokers (12) and 3.25 for light smokers to 7.28 for heavy smokers (15). Clinical studies have indicated that smokers respond less favourably to periodontal treatment compared with non-smokers (18-21).

Moreover, a significant effect of smoking on bone height reduction was observed. It was suggested that there is an accelerated height reduction rate for smokers compared with non-smokers as found by Paulander et al. (2004) (22) in a 10-year prospective study of a randomized sample of 50-year-old individuals, where the incidence of periodontal bone loss and potential risk factors for periodontal bone loss were analyzed. Smoking was found to be the strongest risk predictor for alveolar bone loss during the 10-year period. The relative risk for bone loss was 3.2 for smokers compared with never smokers. Subjects who had quit smoking before the baseline examination did not demonstrate an increased risk for disease progression.

While non-smokers and former smokers (more than 5 years since cessation) have a relatively low risk for recurrence of periodontitis, the heavy smokers (as defined by smoking more than one pack per day) are definitely at high risk. Occasional smokers (< 10 cigarettes a day) and moderate smokers (10-19 cigarettes a day) may be considered at moderate risk for disease progression (23).

In conclusion, cigarette smoking represents a risk factor for progression of periodontitis, the effect of which may be dose related. Heavy smokers should be considered as high-risk individuals for disease progression. The clinical implications for this are that smokers should be identified during patient examination and efforts should be made to modify this behavioural risk factor.

Poor-controlled diabetes mellitus

Although studies that have examined the relationship between diabetes and periodontitis are heterogenous in design and aim, current studies support a higher incidence and severity of periodontitis in patients with diabetes mellitus (24, 25).

A review of the literature by Kinane and Chestnutt (1997) found considerable evidence to suggest that diabetes and periodontitis have a direct relationship (26). Studies have shown a relationship between poor glycemic control and periodontal disease parameters (27-30). Taylor (2001) has suggested a bi-directional relationship between periodontal disease and glycemic control (31) with each disease having a potential impact on the other.

Cross sectional studies on Pima Indians, a group displaying the highest prevalence of type 2 diabetes in the world, show an odds ratio of 2.8 to 3.4 for developing periodontal disease in type 2 diabetics compared to non-diabetics (32).

Similarly, longitudinal studies have shown increased risk of ongoing periodontal destruction in diabetics as compared to non-diabetics with an odds ratio of 4.2. Finally, studies have been done which suggest that poorly controlled diabetics respond less successfully to periodontal therapy relative to well-controlled and non-diabetics (33, 34).

Although no difference in impact has been determined between type 1 and type 2 diabetes mellitus in general (35), it has been recently shown that type 2 could be more connected to periodontitis, as a risk factor, and that more studies are still needed to confirm the harmful effects of type 1 diabetes mellitus on periodontal disease (36).

In conclusion, studies indicate that diabetics with poor glycemic control have an increased risk for periodontitis and disease progression. Preventive periodontal regimens for diabetic patients should be sufficiently intense and sustained to eliminate periodontal inflammation and should be closely coordinated with the patient's overall clinical diabetic management (37).

Pathogenic bacteria and microbial tooth deposits

Although there are over 500 different intra-oral species and others that have not yet been identified, the majority of studies have focused on a subset of microorganisms including Aggregatibacter actinomycetemcomitans (A.a) (formerly Actinobacillus actinomycetemcomitans), P. gingivalis (P.g), Tanerella forsythensis (T.f) (formerly Bacteroides forsythus (B.f), Prevotella intermedia (P.i), and Treponema denticola (T.d).

However, of all of the various microorganisms that colonize the mouth, there are three; Porphyromonas gingivalis, Tannerella forsythia, and Aggregatibacter actinomycetemcomitans have been implicated as etiologic agents in periodontitis. The presence of periodontal

pathogens, though necessary to cause disease, is not sufficient. Indeed the odds ratio of developing periodontal disease in an individual who harbors one of the putative periodontal pathogens is not high enough to consider them a risk factor (38).

Papapanou et al. (1997) (39) studied subgingival microbiota in an untreated Chinese population and found an association between subjects with progressing tooth sites and certain bacteria (P.g, T.f, T.d). Albandar et al. (1997) (40) found an association between individuals with rapid disease progression and specific bacterial species (P.g, T.d, P.i). In both these studies (39, 40), the microbiological sampling was performed at the end of the time period over which the clinical disease progression was assessed.

A number of longitudinal studies have shown that the presence and elevated levels of one or more of these species at baseline are a prognostic indicator for disease progression (increased attachment loss or bone loss) (11, 41-44). Other studies do not support the detection of specific bacterial species for the identification of individuals at risk for periodontitis progression (45-47). While the majority of the periodontal microbiota is commensally, a subset of likely opportunistic pathogens fulfills the epidemiologic requirements needed in order to be ascribed as risk/causative factors. Given the large proportion of the periodontal microbial habitat that is currently insufficiently explored, and assuming that the hitherto uncultivated segment of the bacterial community will include similar levels of pathogenic species, the list of periodontal pathogens should be expected to expand (48).

On an individual level, longitudinal studies have shown that plaque scores are a poor predictor of periodontitis progression (41, 49). However, Nyman et al. (1977) (50) showed that patients with high plaque scores had greater periodontitis progression following periodontal surgery than untreated periodontal patients. A number of longitudinal studies have demonstrated that patients who do not comply with regular periodontal maintenance experience greater progression of disease (51-53).

Stress and socioeconomic status

Studies have demonstrated that individuals under psychological stress are more likely to develop clinical attachment loss and loss of alveolar bone (54-58). One possible link in this regard may be increases in production of Interleukin (IL)-6 in response to increased psychological stress. Another study suggests that host response to P. gingivalis infection may be compromised in psychologically stressed individuals (59).

Gingivitis and poor oral hygiene have been shown to be related to lower socioeconomic status (1). This can most likely be attributed to decreased dental awareness and decreased frequency of dental visits. After adjusting for other risk factors, lower socioeconomic status alone does not result in increased risk for periodontitis. Similarly, evidence for the role of stress and depression in modifying an individual's susceptibility to periodontitis progression is limited and inconclusive (3, 60). It is difficult to distinguish between the roles that stress plays on host resistance factors and altered behavioural responses that stress may induce, such as negligence in oral hygiene and increased smoking. The significance of stress and coping behaviours on periodontitis progression requires further investigation.

Genetic factors and host response

Evidence indicates that genetic differences between individuals may explain why some patients develop periodontal disease and others do not. Studies of identical twins suggest 50% of susceptibility to periodontal disease is due to host factors (61).

It has been also indicated through evidence that the destruction observed in periodontal disease is the result of an improperly regulated immune response to bacterial infection rather than the directly destructive effect of the bacterial pathogens themselves (62). In the case of localized aggressive periodontitis, it has been suggested that overly active or "primed" neutrophils may be responsible for mediating much the tissue destruction that is observe in that disease (62).

IL-1 gene polymorphisms have been linked to periodontal disease. Thus specific IL-1 genotypes have been linked to the presence of pathogenic microorganisms (63), and to an increased risk of periodontal diseases in non-smokers (64) and smokers (65, 66). In a population studied by Kornman et al. (1997) (64), an odds ration of 18.9 was associated with a specific IL-1 genotype.

Meisel et al. (2002) (66) have shown results that demonstrate no effect of IL-1 genotype in non-smokers. Guzman et al. (2003) (28) have shown a possible relationship between IL-1 genotype and periodontal status in diabetics, while, more recently, Lopez et al. found that although periodontitis was significantly associated with some IL-1 gene polymorphisms, no association between diabetes and IL-1A and -1B gene polymorphisms was found (67).

According to a recent meta-analysis study (68), a statistically significant association of IL-1A C[-889]T and IL-1B

C[3953/4]T polymorphisms was found with chronic periodontal disease. A weak positive association was also found concerning IL-1B T[-511]C and chronic periodontal disease, and no association was found for all the cytokines examined as far as the aggressive form of the disease is concerned.
It seems to be that no definitive IL-1 genotype exists that puts individuals in any given population at risk for periodontal disease. Furthermore, the evidence suggesting possible interactions between IL-1 and smoking and diabetes suggest that there is interplay between genetic an environmental factors that results in periodontal disease.

Age
Ageing is associated with an increased incidence of periodontal disease (9, 15). However it has been suggested that the increased level of periodontal destruction observed with aging is the result of cumulative destruction rather than a result of increased rates of destruction. A recent review (69) has shown that aging alone does not lead to critical loss of periodontal attachment in healthy elderly persons and that the effects of aging on periodontal tissues are based on molecular changes in the periodontal cells, which intensify bone loss in elderly patients with periodontitis. These effects may be associated with alterations in differentiation and proliferation of osteoblasts and osteoclasts, an increase in periodontal cell response to the oral microbiota and mechanical stress leading to the secretion of cytokines involved in osseous resorption, and systemic endocrine alterations in the elderly people.
Thus aging is not a risk factor per se (70).

Gender
Epidemiological surveys show a higher prevalence and extent of attachment loss in males than females (71). Hyman and Reid (2003) (10), in a study of epidemiological risk factors for periodontal attachment loss among adults, found, after adjustment for confounding variables, that males were at increased risk of attachment loss. Attachment loss thresholds of ≥3, ≥4, ≥5mm were noted in 23%, 44% and 55% more males than females, respectively. It has been suggested that hormonal and behavioural differences including differences in oral hygiene between the two gender groups may contribute to the higher risk for periodontitis in males than females (71).

Osteoporosis
Osteoporosis, characterized by a decrease in bone mineral density (BMD), is a common metabolic bone disease among the elderly. The association between systemic osteoporosis and periodontitis has been investigated in cross-sectional studies with conflicting results. Some studies indicate osteoporosis as a risk indicator for periodontitis (72, 73), while others do not find a significant association (74, 75). As both periodontitis and osteoporosis result in bone loss and share common risk factors, it has been suggested that postmenopausal women with osteoporosis (low skeletal BMD) may be at risk for progression of periodontitis (76, 77).
There are only a limited number of longitudinal studies evaluating the association of osteoporosis and periodontitis progression. In a 2-year longitudinal clinical study, Payne et al. (1999) (78) found greater alveolar bone loss in osteoporotic and estrogen-deficient women. All subjects were non-smokers.
Another longitudinal study including 179 subjects (non-smokers) found, after adjustment for confounding variables, a weak but significant relationship between additional attachment loss (≥3 mm) and systemic BMD over a 3-year period in an older (70 years) Japanese population (79).
Another study found also little evidence of an association between periodontitis and skeletal BMD among older men (80).
The relationship between osteoporosis and periodontitis remains unclear. Larger prospective longitudinal studies are needed to further evaluate osteoporosis as a risk factor for progressive periodontitis.

Human immunodeficiency virus infection
Two longitudinal cohort studies have documented an accelerated rate of attachment loss in HIV seropositive patients (81, 82). A recent longitudinal evaluation of prostaglandin E2 (PGE2) and periodontal status in HIV+ patients indicated that sites with high gingival crevicular fluid levels of PGE2 in HIV+ patients are at significantly greater risk for progression of periodontitis (83).
More recently, a hypothetic model about the potential role of periodontitis as a global oral infection that potentially contributes to HIV recrudescence has been presented (84).
However, other studies that attempted to eliminate selection bias (85, 86) showed no differences in baseline attachment loss between HIV-seropositive and -seronegative controls. Indeed, rates of disease progression were recorded at only 1% over the observation period. Similar data have emerged from Robinson et al. (2000) (87), who found no difference in

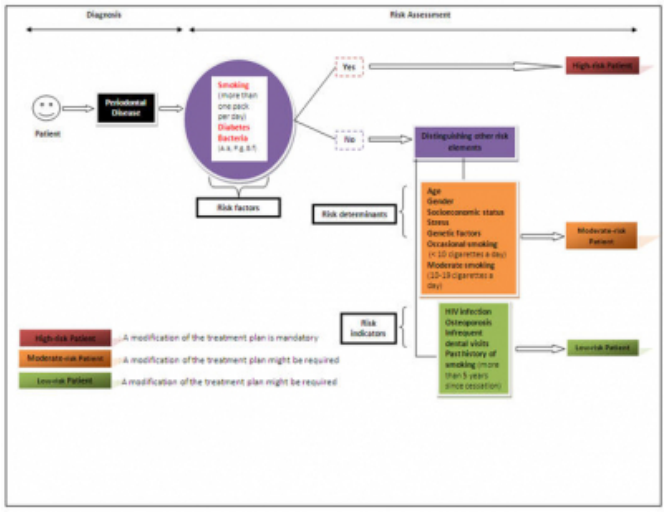
disease progression, as measured by relative attachment loss on six index teeth, between 19 HIV-positive and 17 HIV-negative individuals over a 12-month period.
To conclude, current evidence suggests that HIV seropositivity is not a predictor for progressive periodontitis.

A SYSTEMATIC DECISION MAKING IN THE PERIODONTAL PRACTICE

Depending on the recent agreement of accepting specific bacteria (A.a, P.g, B.f), cigarette smoking, and diabetes mellitus as the major established risk factors for periodontitis (88), we tried to develop a simple scheme for systematic decision making in the periodontal practice (Fig. 1).

Figure 1

Systematic decision making in the periodontal practice



As usual, the first step would be a fundamental examination of the periodontal status and finally making an appropriate diagnosis of the periodontal disease. The next step would be the assessment of current risk elements for periodontal disease. Here, if one or more of the major risk factors (i.e. detection of perio-pathogenic bacteria, heavy cigarette smoking, or diabetes) is proved to be available, the patient would be directly considered as “high-risk patient”, and a modification of the whole treatment plan is obligatory. If this is not the case, other possible risk elements should be distinguished. In this contest, a distinction between risk determinants and risk indicators is made according to Novak and Novak (3). If one or more of risk determinants does exist, the patient would be considered as “moderate-risk patient”, and a modification of the whole treatment plan might be necessary according to every individual case.
If one or more of risk indicators does exist, the patient would be considered as “low-risk patient”. In this case, a modification of the whole treatment plan might be necessary.
For instance, a diabetic heavy smoker male patient who suffers from chronic periodontitis with a history of stress and poor oral hygiene would be considered as “high-risk patient”, and the treatment plan would probably concentrate on non-surgical method with adjunctive antibiotics rather than surgical methods and regenerative applications (e.g. using enamel matrix derivatives). Moreover, in such cases, the patient should be carefully educated about the importance of later supportive periodontal therapy with restricted recall visits (i.e. minimum 4 times/ year).
Another female patient who is a former smoker (more than 5 years since cessation) and suffers from chronic periodontitis with a current history of osteoporosis and very good oral hygiene would be considered as “low-risk patient” at the dental clinic. In such a case, almost all periodontal treatment methods are applicable, and normal recall visits are required (i.e. up to 2 times/ year).

SUMMARY

To date, most accepted risk elements for periodontal disease include tobacco smoking, poor-controlled diabetes mellitus (both type 1 and type 2), specific pathogenic bacteria, microbial tooth deposits, genetic factors, age, gender, socioeconomic status, stress, infection with Human Immunodeficiency Virus, and osteoporosis.
Taking such risk elements in the daily periodontal practice should be mandatory, since this may change or modify the treatment plan.
The scheme of systematic decision making in the periodontal treatment which has been introduced in this paper could be appointed at the dental office, at the periodontal disease treatment centers, and at dental schools. However, this may require careful following to assure the certainty of application.

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