

## Chapter 9

# Periodontal Risk Assessment & Prognosis: Current Status & Future Development - A Perspective From Hong Kong

E.F. Corbet, L.J. Jin

The University of Hong Kong, Faculty of Dentistry, Hong Kong

### Introduction

Global risk factors and risk indicators for periodontal diseases have recently been overviewed (Albandar 2002). The case for risk, the probability that an event will occur in the future, versus association, found in large scale epidemiological studies, is explored. Risk factors and risk indicators discussed as acting globally include: geographic region, oral hygiene level, smoking, diabetes mellitus, age, gender, race-ethnicity, genetic factors, bacterial specificity, viruses, host response factors, socio-economic status, osteopenia and osteoporosis, psychological factors and local factors. This review concludes that periodontal disease is clearly a multi-factorial disorder. Periodontitis is thus a multi-factorial disease with microbial dental plaque as its initiator and perpetuator. Dental plaque is a necessary factor for periodontitis.

### Periodontal Risk in Asians

The first convincing demonstration that not everybody is at equal risk to periodontal destruction from periodontitis, despite inadequate oral hygiene and hence exposure to microbial dental plaque, came from an Asian study. In 1978, Löe and co-workers

reported on the rate of periodontal destruction before the age of 40 years in Sri Lankan male Tamil tea plantation workers (Löe *et al* 1978 a&b). On the basis of the mean data this report showed fairly even progression of destruction across the Sri Lankan subjects and destruction greater in the Sri Lankan males than in Norwegian male students and academics. However, in 1986 a recalculation of the rates of progression based on mesial attachment loss and tooth loss in these Sri Lankan males aged 16 – 46 years allowed for the identification of three subgroups within the studied subjects on the basis of periodontal destruction, which were labeled 'no progression, moderate progression and rapid progression' subgroups (Löe *et al* 1986). A subsequent analysis, on the basis of data collected in that study, which tried to identify what was associated with risk for periodontal destruction in these Sri Lankan tea plantation workers, found that age, gingival index and calculus index were all associated with destruction but that plaque index, tobacco smoking and betel-quid chewing were not (Neely *et al* 2001). It may well be that this study did not capture data about each subject which would have allowed for a comprehensive assessment of risk associated for the periodontal destruction encountered.

Risk for periodontal destruction in Asians has recently been reviewed as part of an overview of periodontal conditions in Asia and Oceania (Corbet *et al* 2002). Longitudinal studies into periodontal disease behaviour have been conducted in many Asian countries besides the well-known study in Sri Lanka (Löe *et al* 1978a), in Indonesia (Timmerman *et al* 1998, Timmerman *et al* 2000), in Japan (Lindhe *et al* 1989) and in China (Baelum *et al* 1997, Suda *et al* 2000). In Indonesia, the longitudinal study being conducted found age, amount of subgingival calculus and subgingival presence of *Actinobacillus actinomycetemcomitans* to be associated with attachment loss in adolescents. In Japan, the longitudinal study associated calculus, age and previous disease experience with attachment loss (Haffajee *et al* 1991). In China, age, gender (with males being worse than females), pre-existing periodontitis and percentage of teeth involved, and certain periodontopathogenic bacteria exceeding thresholds have all been associated with periodontal destruction (Baelum *et al* 1997, Papapanou *et al* 1997, Suda *et al* 2000). The overview concluded that not much particular to Asians with respect to risk has been uncovered, save an association with dental calculus.

Dental calculus, in terms of its risk association for periodontal destruction poses some interesting considerations, particularly among Asians in whom its high prevalence in large amounts has led to easy study. Calculus in Asians is not always associated with periodontal inflammation or pockets (Takahashi *et al* 1988, Holmgren and Corbet 1990, Peng *et al* 1990). There is evidence that tooth brushing alone will improve periodontal conditions despite the persistence of dental calculus (Gaare *et al* 1990). The removal of calculus alone has no effect on periodontal conditions (Lembariti *et al* 1998). Hence its

role as a true risk factor for periodontal destruction is difficult to comprehend and it should be considered to be associated with periodontitis perhaps as a sequel, when there is large amount of subgingival calculus.

### Periodontal Risk: A Perspective

An overview of periodontal risk factors has recently been published (Nunn 2003). This overview noted that distinctions between terms used in descriptions of risk associations are not always clear, nor is it clear how a clinician makes use of such information. This overview defines a risk factor as ‘any characteristic, behaviour or exposure with an association to a particular disease’, noting that the relationship is not necessarily causal in nature (Brownson and Pettiti 1998). Yet the global review of periodontitis and risk (Albandar 2002) in a different issue of the same journal had defined a risk factor as a distinctive characteristic or exposure that increases the possibility of developing periodontitis or leads to measurable periodontal attachment loss. The overview of Nunn (2003) allows that a risk factor that cannot be modified is often referred to as a (risk) determinant (Genco 1996). To differentiate clearly between those risk associations for which it is possible to intervene, to reduce the risk, and those which are immutable to change, e.g. age, race, genetics, gender, is very useful in practice and for many medical conditions is the basis of the medical model. For instance, those males with a risk determinant for cardio-vascular disease due to their fathers having had cardio-vascular disease are generally encouraged to modify those modifiable risk factors for cardio-vascular disease such as diet and exercise, whereas they can do nothing about the cardio-vascular history of their fathers.

Having a known risk determinant shapes

the preventive and perhaps therapeutic approaches in more stringently controlling those modifiable risk factors, while the risk determinant is immutable. In the same way, levels of plaque control can be improved in those with genetically determined risk to periodontal disease, so as to reduce the risk of periodontal destruction. A risk indicator was defined by Nunn (2003) as 'a potential risk factor identified to be associated with disease from case-control or cross sectional studies'. A risk marker was defined by Nunn (2003) 'as a risk factor that can be used to predict the future course of disease'. Whereas Albandar (2002) drew the distinction between factors which have a true risk-modifying effect and those which are associated with periodontitis, which he considered to be risk indicators.

The overview of Nunn (2003) considers a range of risk factors which have been studied, and grouped these as follows: subject determinants such as age and race, social and behavioural factors such as tobacco smoking, socio-economic status, nutrition and psychological factors, systemic factors such as diabetes mellitus, drugs, HIV, genetic factors considering twins and genotype polymorphisms, tooth factors such as anomalies, crowding, restorations, fractures etc, microbial risk factors, featuring the holy triumvirate of *Actinobacillus actinomycetemcomitans*, *Tannerella forsythensis* (formerly *Bacteroides forsythus*) and *Porphyromonas gingivalis* (Zambon 1996) and concludes with an introduction to emerging risk factors to do with systemic disease periodontal disease interrelationships.

### Periodontal Risk Levels Combined in Clinical Risk Assessment

It is apparent therefore from the overview of Nunn (2003) that periodontal risk factors can act at multiple levels: at the subject level,

at the tooth level and even at the specific site level. Risk factors acting these different levels can be grouped to give subject risk assessments and examples of this approach have been recently reported for prediction of future periodontal status (Page *et al* 2002, Page *et al* 2003) and in the management of supportive periodontal therapy for periodontitis patients (Lang & Tonetti 2003). It has been suggested that a systematized approach to subject risk assessment is more consistent than subjective expert opinion in clinical and periodontal decision-making (Persson *et al* 2003). The periodontal risk calculator (PRC) has been developed and tested in the United States of America and the Periodontal Risk Assessment (PRA) in Europe. If an Asian country has data on risk associations for periodontal destruction in its own citizens, it would probably be prudent for periodontal researchers in that country to construct and test the validity of a risk assessment model for clinical use in that country. Such an approach has been adopted in Hong Kong on the basis of data from epidemiological studies conducted in Hong Kong and Southern China and on longitudinal studies of periodontitis patients in Hong Kong.

### Future Directions

Developments in the understanding of the pathogenesis of periodontitis have shed light on possible future directions in research and clinical applications (Page *et al* 1997). In contrast to a unidirectional approach to the study of risk factors, e.g. studies of subgingival periodontopathogens in dental plaque biofilms, the emerging trend of studying both periodontopathogens and the host response they evoke heralds the future trends. We first looked at granulocyte elastase activity in gingival crevicular fluid (GCF), a marker of intracrevicular PMN activity (Lamster 1997),

in relation to the presence of subgingival periodontopathogens in subjects with untreated chronic periodontitis as an attempt to improve risk evaluation through studying dynamic bacteria-host relations (Jin *et al* 1999). This study showed that low elastase activity in GCF was coincident with low prevalence of the target species, while a wide variation of elastase activity existed among the untreated periodontitis sites with similar co-infections of *B. forsythus*, *P. gingivalis*, *P. intermedia* and *T. denticola*, suggesting the local host inflammatory response to the bacterial challenge in untreated periodontal pockets is diverse based on both subject level and site level within the subjects. This study was then expanded to investigate multiple interrelated markers of host response evoked by the presence of various periodontopathogens, which suggested that shifts in host-bacteria interactions may reflect different phases of the inflammatory response and therefore indicate a range of periodontal disease activity levels, despite the presence of the periodontopathogens (Jin *et al* 2000). This investigative approach is being applied not only in untreated chronic periodontitis but also in relation to the response to treatment efforts. We found that IL-8-related granulocyte elastase activity in GCF was related to the change in infection patterns of subgingival periodontopathogens following scaling and root planing. Varying initial IL-8 levels in GCF and a corresponding shifting change of granulocyte elastase activity in GCF may characterize the different short-term treatment responses (Jin *et al* 2002). In a recent study, we evaluated the dynamics of host response marker in gingival crevicular fluid under various periodontal conditions in subjects with healthy periodontium and those with gingivitis and chronic periodontitis (Jin *et al* 2003). This study showed that patterns of dynamic changes in GCF flow and elastase activity

varied under different periodontal conditions. Assessment of both static GCF and flow GCF may allow better insight into the dynamic change of the target components in GCF. The markers of host response studied have recently been expanded to others which are strongly linked to bacteria-host interactions with promising results, such as soluble CD14 (Jin and Darveau 2001) and membrane-bound CD14 (a lipopolysaccharide receptor) (Jin *et al* 2004).

The simultaneous study of a battery of host response markers and subgingival periodontopathogens evoking these responses signals future approaches for combined risk profile assessment beyond what is offered from the history taking, clinical and radiographic examination. Our ongoing research efforts focus on testing for bacteria, intrinsic GCF components and messenger RNA/protein expression in adjacent healthy and diseased periodontal tissues, which may lead to the development of new diagnostic strategies for identification of high-risk individuals and sites particularly susceptible to periodontal destruction thus enabling targeted prevention and better control of periodontitis. Also the future seems to hold the possibility of screening, diagnostic and monitoring tests which are based on co-biomarkers and genetic markers for periodontal diseases utilizing both oral fluid (e.g. GCF and saliva) and serum as testing samples. In addition to models for risk assessment being constructed and tested, 'Bio-assessment' models are being constructed based on our data for later testing and validation.

## Conclusion

On the basis of what is already known about risk for periodontal destruction as a component of the multi-factorial disease like

periodontitis for which microbial dental plaque is a necessary factor for its initiation and perpetuation, it is possible to construct clinically useful risk assessment models. The future holds the hope that by testing for inflammatory mediators and their antagonists; matrix metalloproteinase and their tissue inhibitors; genotypes and phenotypic expression; lipopolysaccharides and host pattern recognition receptors including lipopolysaccharide-binding protein, CD14, IL-1 receptor/toll-like receptor superfamily; along with further studying the microbial biofilm, bio-assessment can be combined with clinical risk assessment for better prevention and treatment of and supportive care for periodontitis in its various forms.

## References

- Albandar JM. Global risk factors and risk indicators for periodontal diseases. *Periodontol 2000* 2002;29:177-206.
- Baelum V, Luan WM, Chen X and Fejerskov O. A 10-year study of the progression of destructive periodontal disease in adult and elderly Chinese. *J Periodontol* 1997;68:1033-1042.
- Brownson RC and Pettit DB. *Applied epidemiology: theory to practice*. New York: Oxford University Press. 1998.
- Corbet EF, Zee KY and Lo ECM. Periodontal diseases in Asia and Oceania. *Periodontol 2000* 2002;29:122-152.
- Gaare D, Rolla G, Aryadi FJ and van der Ouderaa F. Improvement of gingival health by toothbrushing in individuals with large amounts of calculus. *J Clin Periodontol* 1990;17:38-41.
- Genco RJ. Current view of risk factors for periodontal disease. *J Periodontol* 1996;67:1041-1049.
- Haffajee AD, Socransky SS, Lindhe J, Kent RL, Okamoto H and Yoneyama T. Clinical risk indicators for periodontal attachment loss. *J Clin Periodontol* 1991;18:117-125.
- Holmgren CJ and Corbet EF. Relationship between periodontal parameters and CPITN scores. *Community Dent and Oral Epidemiol* 1990;18:322-323.
- Jin LJ and Darveau RP. Soluble CD14 levels in gingival crevicular fluid of subjects with untreated adult periodontitis. *J Periodontol* 2001;72:634-640.
- Jin LJ, Leung WK, Corbet EF and Söder B. Relationship of changes in interleukin-8 levels and granulocyte elastase activity in gingival crevicular fluid to subgingival periodontopathogens following non-surgical periodontal therapy in subjects with chronic periodontitis. *J Clin Periodontol* 2002;29:604-614.
- Jin LJ, Ren L, Leung WK and Darveau RP. The *in vivo* expression of membrane-bound CD14 in periodontal health and disease. *J Periodontol* 2004;75:578-585.
- Jin LJ, Söder B and Corbet EF. Interleukin-8 and granulocyte elastase in gingival crevicular fluid in relation to periodontopathogens in untreated adult periodontitis. *J Periodontol* 2000;71:929-939.
- Jin LJ, Soder PÖ, Leung WK, Corbet EF, Samaranayake LP, Söder B and Davies WIR. Granulocyte elastase activity and PGE<sub>2</sub> levels in gingival crevicular fluid in relation to the presence of subgingival periodontopathogens in subjects with untreated adult periodontitis. *J Clin Periodontol* 1999;26:531-540.
- Jin LJ, Yu C and Corbet EF. Granulocyte elastase activity in static and flow gingival crevicular fluid. *J Periodont Res* 2003;38:303-310.
- Lamster IB. Evaluation of components of gingival crevicular fluid as diagnostic tests. *Ann Periodontol* 1997;2:123-137.
- Lang NP and Tonetti MS. Periodontal risk assessment (PRA) for patients in supportive periodontal therapy (SPT). *Oral Health Prevent Dent* 2003;1:7-16.
- Lembariti BS, van der Weijden GA and van Palenstein Helder WH. The effect of a single scaling with or without oral hygiene instruction on gingival bleeding and calculus formation. *J Clin Periodontol* 1998;25:30-33.
- Lindhe J, Okamoto H, Yoneyama T, Haffajee A and Socransky SS. Longitudinal changes in periodontal disease in untreated subjects. *J Clin*

- Periodontol* 1989; 16:662-670.
- Löe H, Anerud A, Boysen H and Morrison E. Natural history of periodontal disease in man. Rapid, moderate and no loss of attachment in Sri Lankan laborers 14 – 46 years of age. *J Clin Periodontol* 1986;13:431-445.
- Löe H, Anerud A, Boysen H and Smith M. The natural history of periodontal disease in man. Study design and baseline data. *J Periodont Res* 1978a;13:550-562.
- Löe H, Anerud A, Boysen H and Smith. The natural history of periodontal disease in man. The rate of periodontal destruction before 40 years of age. *J Periodontol* 1978b;49:607-620.
- Neely AL, Holford TR, Löe H, Anerud A and Boysen H. The natural history of periodontal disease in man. Risk factor for progression of attachment loss in individuals receiving no oral health care. *J Periodontol* 2001;72:1006-1015.
- Nunn ME. Understanding the etiology of periodontitis: an overview of periodontal risk factors. *Periodontol 2000* 2003;32:11-23.
- Page RC, Krall EA, Martin J, Mancl L and Garcia RI. Validity and accuracy of a risk calculator in predicting periodontal disease. *J Am Dent Assoc* 2002;133:569-576.
- Page RC, Martin J, Krall EA, Mancl L and Garcia R. Longitudinal validation of a risk calculator for periodontal disease. *J Clin Periodontol* 2003;30:819-827.
- Page RC, Offenbacher S, Schroeder HE, Seymour GJ and Kornman KK. Advances in the pathogenesis of periodontitis: summary of developments, clinical implications and future directions. *Periodontol 2000* 1997;14:216-248.
- Persson GR, Mancl L, Martin J and Page RC. Assessment of risk for periodontal disease by expert clinicians relative to assessment using a computerized risk assessment tool. *J Am Dent Assoc* 2003;134:575-582.
- Papapanou PN, Baelum V, Luan WM, Madianos PN, Chen X and Fejerskov O. Subgingival microbiota in adult Chinese: prevalence and relation to periodontal disease progression. *J Periodontol* 1997;68:651-666.
- Peng TK, Yao JH, Shih KS, Dong YJ, Chen CK and Pai L. Assessment of periodontal disease in an adult population survey in Taipei city using CPITN and GPM/T indices. *Chung-Hua-Ya-I-Hsueh-Hui-Tsa-Chih* 1990;9:64-74.
- Suda R, Cao C, Hasegawa K, Yang S, Sasa R and Suzuki M. 2-year observation of attachment loss in a rural Chinese population. *J Periodontol* 2000;71:1067-1072.
- Takahashi Y, Kamijyo H, Kawanishi S and Takaesu Y. Presence and absence of bleeding in association with calculus in segments given Code 2 in the Community Periodontal Index of Treatment Needs (CPITN). *Community Dent and Oral Epidemiol* 1988;16:109-111.
- Timmerman MF, van der Weijden GA, Abbas F, Armand S, Winkel EG, van Winkelhoff AJ and van der Velden U. Untreated periodontal disease in Indonesian adolescents. Longitudinal clinical data and prospective clinical and microbiological risk assessment. *J Clin Periodontol* 2000;27:932-942.
- Timmerman MF, van der Weijden GA, Armand S, Abbas F, Winkel EG, van Winkelhoff AJ and van der Velden U. Untreated periodontal disease in Indonesian adolescents. Clinical and microbiological baseline data. *J Clin Periodontol* 1998;25:215-224.
- Zambon JJ. Periodontal disease: Microbial factors. *Ann Periodontol* 1996;1:879-925.