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Periodontal parameters and platelet-activating factor levels in serum and gingival crevicular fluid in a Chinese population

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Abstract

Aim: Platelet-activating factor (PAF) is a potent proinflammatory mediator and has been implicated in cardiovascular pathophysiology. The present clinical study assessed the relation between the severity of periodontal disease and PAF levels in gingival crevicular fluid (GCF) and serum.

Methods: A total of 60 non-smoking subjects (21 periodontitis, 19 gingivitis patients and 20 healthy individuals) were included. Probing depth, attachment level, bleeding on probing, plaque index and sulphide levels were recorded at six sites of each tooth. GCF and blood samples were collected from all individuals, and PAF levels were investigated by enzyme-linked immunoabsorbent assay.

Results: The periodontitis group showed significantly higher PAF levels in the serum (329.3 ± 287.3 pg/ml) and GCF (21.8 ± 7.0 pg/sample) compared with the gingivitis group (138.0 ± 77.9 pg/ml, 13.8 ± 3.6 pg/sample) and with healthy controls (68.9 ± 42.8 pg/ml, 2.4 ± 2.7 pg/sample). The differences between patients and controls were statistically significant ($p \leqslant 0.05$). Positive correlations were observed between PAF levels in GCF and serum and for PAF levels and clinical parameters.

Conclusion: The present findings suggest a role of PAF in the pathogenesis of periodontitis. Based on the observed close correlation of GCF and serum PAF levels, future studies are warranted to test the hypothesis of a possible link between periodontitis and adverse systemic events mediated by PAF.

Key words: gingival crevicular fluid; periodontitis; platelet-activating factor; serum

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Platelet-activating factor (PAF) is one of the most potent and versatile proinflammatory mediators found in mammals (Prescott et al. 2000). It can be produced and released from a variety of cells, especially activated inflammatory cells like macrophages and lymphocytes (Snyder 1990). PAF promotes aggregation, chemotaxis, granule secretion and oxygen radical generation by leucocytes and their adherence to the endothelium (Behrens & Goodwin 1990, Denizot et al. 1994, Ishii & Shimizu 2000). PAF increases the permeability of endothelial cells and stimulates the contraction of smooth muscle (Stafforini et al. 2003).

The presence of PAF in human mixed saliva was first reported in 1981 (Cox et al. 1981). Pure parotid saliva apparently has no detectable PAF activity, suggesting that PAF in mixed saliva originated from a source other than this salivary gland (Cox et al. 1981). Healthy edentulous patients had almost undetectable levels of salivary PAF levels, suggesting that PAF in mixed saliva may be derived from periodontal tissues (McManus et al. 1990). Consistent with this concept, PAF has been detected in periodontally inflamed gingival tissues (Noguchi et al. 1989) and in the gingival fluid of teeth affected by periodontitis (Rasheed & McManus 1990). A significant correlation has been observed between salivary and gingival fluid PAF levels and periodontal disease progression, demonstrating a role of this mediator for the pathogenesis of inflammatory diseases (Garito et al. 1995, Emingil et al. 2001).

There has been considerable attention directed towards the interaction between oral and systemic conditions, and several observations support the idea that orally derived inflammatory mediators could participate in the development of

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adverse systemic outcomes (Gemmell et al. 1997, Loos et al. 2000, Loos 2005). PAF has been implicated in cardiovascular pathophysiology (Prescott et al. 1996).

The aim of the present study was to examine the presence of PAF in gingival crevicular fluid (GCF) and serum in patients with periodontal disease, gingivitis and healthy controls.

Materials and Methods

Study population

Sixty Chinese non-smoking subjects from the Department of Periodontology, Zhejiang University, were recruited for the study. The Ethics Committee of the Zhejiang University approved the study and informed consent was obtained from each subject. All participants were in good general health and had no history of systemic diseases or had received any medication within the past 4 weeks. Subjects with more than 20 teeth were classified into three groups: Untreated periodontitis group (Periodontitis): 21 Chinese subjects (12 females and nine males, aged from 23 to 51 years) with a mean probing depth $\geqslant$4 mm and bleeding on probing (BOP). The patients exhibited a clinical and radiographic attachment loss in four or more teeth of the upper and lower jaw. Gingivitis group (Gingivitis): 19 Chinese subjects (10 females and nine males, aged from 22 to 48 years) with varying degrees of gingival inflammation, but no signs of attachment loss observed by clinical and radiographic examination. Healthy control group (Healthy controls): 20 Chinese subjects (11 females and nine males, aged from 22 to 53 years) with no clinical or radiographic evidence of gingival or periodontal disease.

Clinical examination

All subjects underwent a comprehensive periodontal examination. Full-mouth probing pocket depth (PPD), clinical attachment levels (CAL) and BOP was measured with a Michigan-O style periodontal probe at six sites per tooth. CAL were measured from the cemento-enamel junction to the most apical penetration of the periodontal probe. Dental plaque was recorded at six sites per teeth using the Silness–Löe Plaque Index (Silness & Löe 1964). Sulphur levels (SUL) within the gingival sulcus were measured at six sites using the Diamond Probe/Perio 2000 system (Diamond General Development Corp., Ann Arbor, MI, USA) as described by Zhou et al. (2004). The system combines a conventional Michigan-O style dental probe with a sulphide sensor for the simultaneous measurement of PPD and SUL.

Sampling of GCF and serum

GCF was collected as described previously by Lamster et al. (1991). Briefly, before GCF sampling, the tooth surfaces were dried gently by an air syringe and were isolated by cotton rolls. Supragingival plaque was gently removed. Paper strips were carefully inserted into the crevice until mild resistance was felt and left there for 30 s. Care was taken to avoid mechanical injury. Strips contaminated with blood were discarded. For the periodontitis group, GCF samples were collected from one site per quadrant with the deepest PPD. For the gingivitis and the healthy control group, GCF samples were collected from the mesio-buccal site of the first molar per quadrant. Papers were weighed before and after sampling. The strips were separately placed into 1.5 ml Eppendorf tubes and maintained at -20°C until further analysis. During the same appointment, 3 ml vein blood was sampled from the cubital vein of each subject. The whole blood samples were centrifuged at 2000 rpm for 2 min. The serum was separated carefully and stored at -70°C.

Laboratory assays

PAF concentrations in GCF and serum were measured by an enzyme-linked immunoabsorbent assay (Human Serum PAF Assay Kit, TPI Inc., Lynnwood, WA, USA). All procedures were performed according to the manufacturer's instructions. All samples were assayed in duplicate. For serum samples, the concentration was calculated in picogram per millilitre. For GCF samples, the total amount of PAF was specified in pg and the PAF concentration was calculated in picogram per microlitre.

Statistical analysis

For all periodontal markers, full-mouth data were calculated and means and standard deviations were computed. For the comparison of PAF levels between different groups, means and standard deviations were calculated and differences were tested for statistical significance using the Kruskal–Wallis *H*-test, followed by the Nemenyi test. The significance level was set at $p<0.05$. For correlation analysis, the Spearman rank correlation analysis was used. All statistical procedures were performed using the SAS statistical software program (SAS Institute Inc., Cary, NC, USA).

Results

Periodontal parameters

The mean values and standard deviations for the clinical parameters in each group are presented in Table 1. Statistically significant differences between the three groups were observed for PPD ($p\leqslant0.001$). BOP and plaque scores in the periodontitis and the gingivitis group were significantly higher than in the control group ($p\leqslant0.001$). The mean scores for CAL were significantly higher in the periodontitis than in the gingivitis group and the healthy control group ($p\leqslant0.001$). No significant differences were observed between the periodontitis and the gingivitis group for the parameter BOP ($p=0.183$) and for the plaque index ($p=0.269$). SUL levels for the periodontitis group were significantly higher than for the gingivitis and the control group ($p\leqslant0.001$), and SUL levels of the gingivitis group were significantly higher than for the control group ($p\leqslant0.001$).

Table 1. Mean scores of PD, AL, BOP, PLI and SUL in different groups (mean ± SD)

Group	*n*	PPD (mm)	CAL (mm)	BOP (%)	Plaque index	SUL
Periodontitis	21	4.81 ± 0.74	5.84 ± 1.53	58.82 ± 21.66	2.76 ± 0.19	29.44 ± 8.91
Gingivitis	19	2.88 ± 0.17	0.00 ± 0.00	46.30 ± 15.26	2.56 ± 0.41	18.17 ± 4.21
Control	20	2.14 ± 0.30	0.00 ± 0.00	6.30 ± 5.50	0.93 ± 0.57	5.73 ± 74.53

PPD, probing pocket depth; CAL, clinical attachment levels; BOP, bleeding on probing; SUL, sulphur levels.

Table 2. PAF level in serum and GCF from different groups (mean ± SD)

	n	PAF levels					
		serum (pg/ml)		GCF (pg/sample)		GCF (pg/μl)	
		mean	SD	mean	SD	mean	SD
Periodontitis	21	329.31	287.28	21.78	7.01	26.65	9.04
Gingivitis	19	138.03	77.86	13.84	3.58	21.73	7.77
Healthy control	20	68.94	42.75	2.44	2.72	6.66	4.05

PAF, platelet-activating factor; GCF, gingival crevicular fluid.

PAF levels in serum and GCF

PAF levels in serum and GCF samples are displayed in Table 2 and showed significant differences for the serum PAF concentrations between the three different groups. The periodontitis group exhibited significantly higher serum PAF levels compared with the gingivitis group ($p = 0.047$) and the healthy control group ($p = 0.005$). The concentration of PAF in the serum was significantly higher for the gingivitis group than for the control group ($p = 0.019$). The results for the total amount of PAF in GCF were as follows: the periodontitis group exhibited significantly higher amounts of PAF compared with the gingivitis group ($p \leqslant 0.001$) and the gingivitis group showed significantly higher amounts PAF than the control group ($p \leqslant 0.001$). The PAF concentrations in picogram per microlitre for the periodontitis and the gingivitis group were significantly higher than for the healthy control group ($p \leqslant 0.001$), whereas no significant differences between the periodontitis and the gingivitis group were found ($p > 0.05$).

Correlation analysis

PAF concentrations in the serum (picogram per mililitre) and PAF levels in GCF (picogram per sample) demonstrated a positive correlation with clinical markers of periodontitis (Fig. 1). PAF concentrations in the serum were positively correlated with PPD ($r = 0.832$), CAL ($r = 0.636$), PLI ($r = 0.871$), SUL ($r = 0.803$) and BOP ($r = 0.647$). PAF levels in GCF were positively correlated with PPD ($r = 0.921$), CAL ($r = 0.740$), PLI ($r = 0.869$), SUL ($r = 0.904$) and BOP ($r = 0.929$). The significance level for all correlations was $p \leqslant 0.001$. PAF levels in serum showed a significantly positive correlation to PAF levels (picogram per sample) in GCF as well as to PAF concentration (picogram per microlitre) in GCF ($r = 0.896$ and $r = 0.899$, respectively; Fig. 2). The significance level was $p \leqslant 0.0001$.

Discussion

The present study demonstrated that Chinese patients having periodontitis and gingivitis exhibited elevated levels of the inflammatory mediator platelet-aggregating factor in the serum and gingival fluid compared with healthy controls. PAF levels both in the serum and in GCF had significant positive correlations with all clinical periodontal parameters including sulphide levels.

It is generally accepted that analysis of GCF constituents can provide information on specific metabolic changes and periodontal disease status (Lamster & Novak 1992, Ozmeric 2004). However, in the present study the total amount of PAF in GCF was significantly higher in periodontitis than in gingivitis patients, but the concentration of PAF in the sulcular fluid failed to show significant differences between both groups. It has been demonstrated that the rate of fluid increases in inflammation (Attström 1970) but the increase in the amounts of individual components may not be proportional to that of the fluid, as it has been demonstrated for example for alkaline phosphatase (Binder et al. 1987). The expression of PAF levels as concentration may introduce an additional source of error due to collection of variables volumes of fluid and therefore, it has been suggested to replace concentrations by total amounts (Lamster et al. 1986).

Previous studies reported that PAF levels in saliva and gingival fluid of patients having gingival and periodontal diseases are elevated compared with healthy controls (Garito et al. 1995, Emingil et al. 2001), which is in agreement with the present results. The elevated levels of PAF in GCF in patients having periodontitis and gingivitis suggested an important role of this lipid mediator in the pathogenesis of gingivitis, periodontitis and a potential involvement of this mediator in the development of systemic diseases. PAF is synthesized by a variety of cells (Snyder 1990), activates neutrophils and regulates the induction of chemotaxis, superoxide generation and degranulation (Ishii & Shimizu 2000). Upon activation, it can stimulate the release of a variety of lysosomal enzymes, arachidonic acid metabolites and cytokines, which can further induce PAF synthesis (Ishihara et al. 2000, Stafforini et al. 2003). The importance of this mediator in the course of periodontitis was underlined by the reduction of PAF levels in saliva after initial periodontal therapy (Rasch et al. 1995). In a recently published paper, it has been shown that the plasma levels of lipoprotein-associated phospholipase A(2), also known as PAF acetylhydrolase (PAF–AH), which participates in the degradation of PAF, was also reduced after periodontal therapy (Lösche et al. 2005). A specific mutation that inactivates PAF–AH increased the risk for myocardial infarction (Yamada et al. 1998). In addition, altered serum lipoprotein profiles and decreased PAF–AH activity were observed in cases of generalized aggressive periodontitis compared with healthy controls (Rufail et al. 2005). The molecular mechanism linking elevated PAF levels in GCF and serum with PAF–AH activity and the risk for myocardial infarction should be evaluated in future studies.

In the present paper, it was demonstrated that clinical measures of periodontitis such as bleeding scores, probing depth or attachment loss were positively correlated with serum and gingival fluid levels of PAF. In contrast, no correlation was found for PAF levels in gingival tissues and GCF compared with clinical measurements in a study published by Emingil et al. (2001). This discrepancy could be attributed to the different number of patients and singularities of the ethnic groups participating in the two studies that has been addressed earlier (Persson et al. 2004).

In the present study, sulphide levels increased from periodontal health, to gingivitis and to periodontitis and were significantly correlated with all periodontal parameters. These sulphide compounds originate from bacterial metabolism and accumulate in periodontal pockets, causing cellular des-

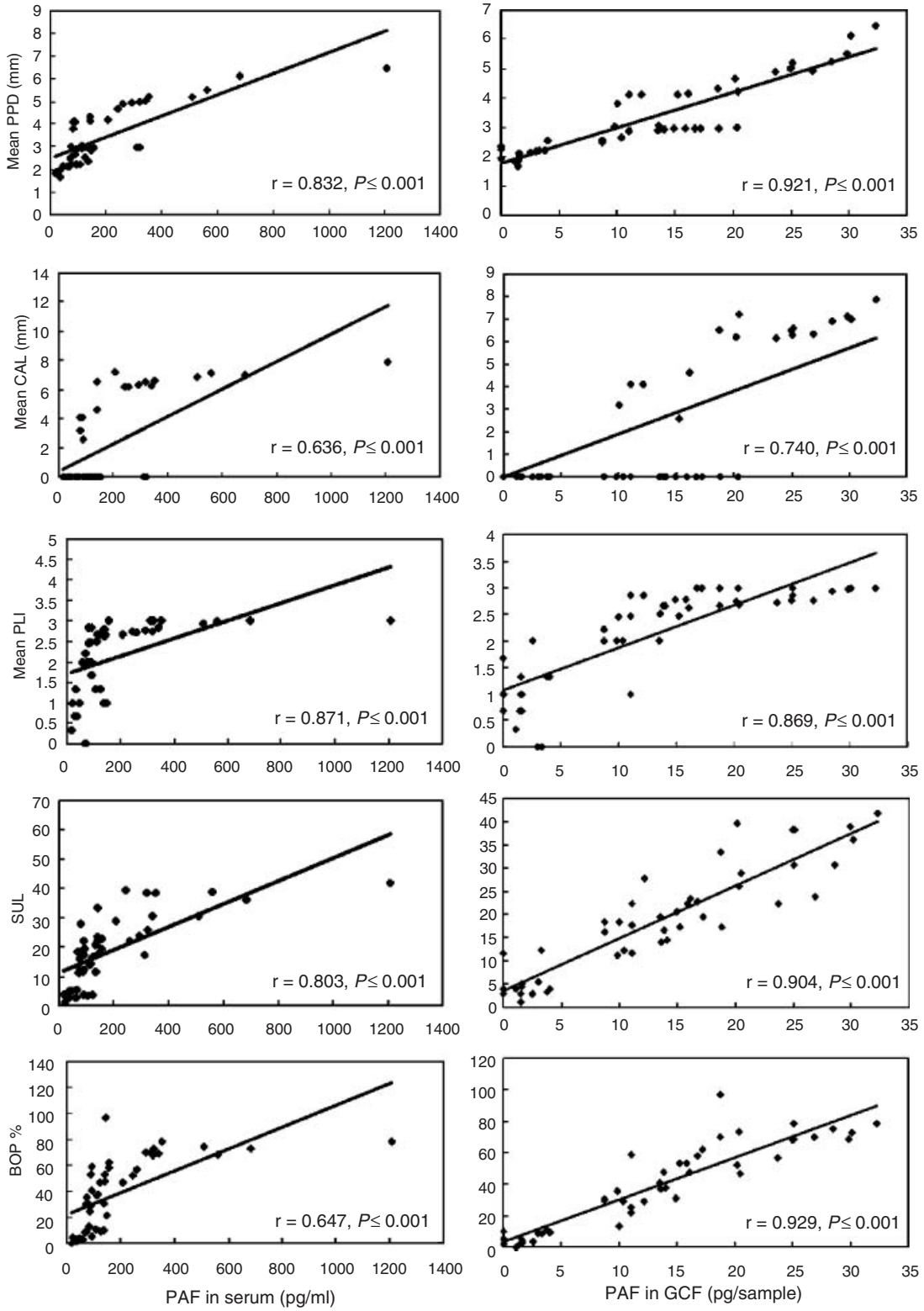

Fig. 1. Correlation between clinical periodontal markers and platelet-activating factor (PAF) levels in serum (left) and gingingival crevicular fluid (right).

truction (Torresyap et al. 2003). As traditional diagnoses of periodontal infections are retrospective in nature and routine detection of bacteria in periodontal pockets is very time consuming, the detection of sulphide levels in the early stage of bacterial activity may represent a new focus.

PAF has direct and potent effects upon cardiac function and has been implicated in cardiovascular pathophysiology (Prescott et al. 1996, Tselepis &

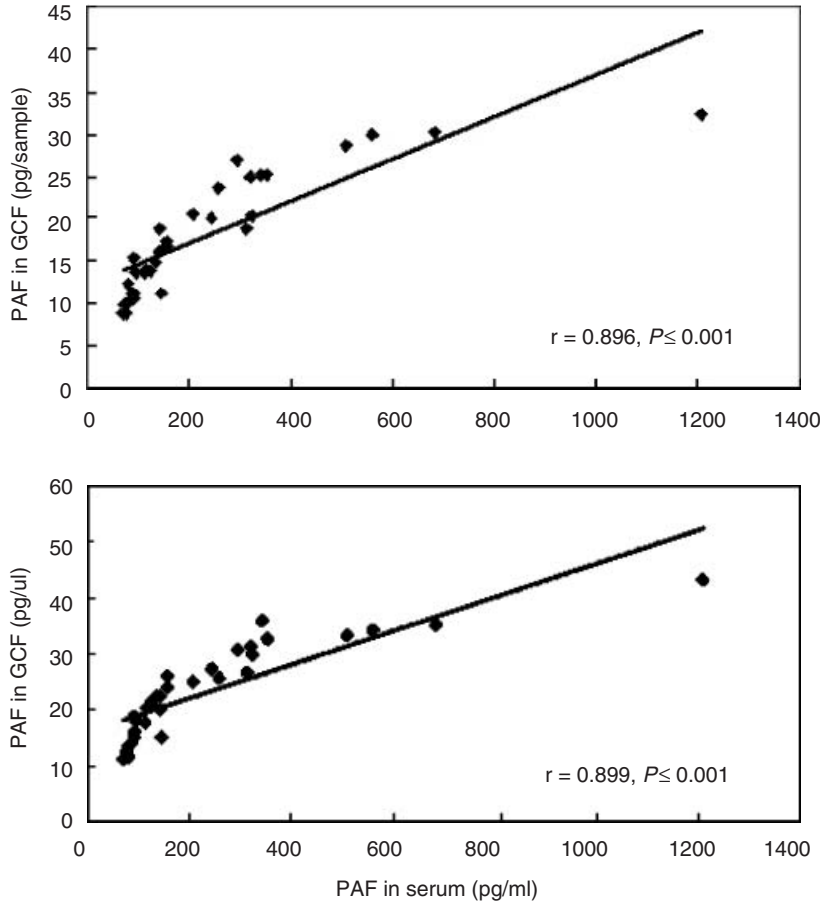

Fig. 2. Correlation between serum and gingival crevicular fluid levels of platelet-activating factor (PAF) (top: gingival crevicular fluid (GCF) amounts, bottom: GCF concentration).

Chapman 2002). Interestingly, salivary PAF levels are transiently increased in subjects presenting with myocardial infarction (Jones et al. 1994). In addition, PAF appears to have a role in reproductive pathophysiology including labour in normal and pre-term pregnancy (Narahara et al. 1996). Other mediators derived from periodontal tissues like C-reactive protein and IL-6 were detected in higher concentrations in the serum of periodontally diseased patients compared with healthy controls and may also promote adverse systemic effects (Loos et al. 2000, Buhlin et al. 2003). In agreement with these studies, other researchers found a significant reduction of the mediators IL-6 and C-reactive protein after periodontal therapy (D'Aiuto et al. 2004). Based on these observations, it is conceivable that the proinflammatory mediator PAF synthesized within the oral cavity – among others – may play a significant role in the initiation or progression of non-oral inflammatory processes to promote the manifestation of systemic diseases. These orally derived mediators may increase the inflammatory reaction in atherosclerotic lesions and potentially the risk for cardiac events, as several studies have shown that periodontitis is a significant risk factor for coronary heart diseases (Jansson et al. 2001, Haynes & Stanford 2003, Geerts et al. 2004).

In conclusion, elevated PAF levels in both the serum and GCF samples from patients with periodontal disease support the role of this lipid mediator as a marker in human destructive periodontal diseases and the potential contribution of PAF from periodontal lesions for the development of coronary heart diseases. Future studies are warranted to investigate whether periodontal treatment will lead not only to a reduction of PAF levels in GCF but also in the serum.

References

Attström, R. (1970) Presence of leukocytes in crevices of healthy and chronically inflamed gingivae. *Journal of Periodontal Research* **5**, 42–47.

Behrens, T. W. & Goodwin, J. S. (1990) Control of human T cell proliferation by platelet-activating factor. *International Journal of Immunopharmacology* **12**, 175–184.

Binder, T. A., Goodson, J. M. & Socransky, S. S. (1987) Gingival fluid levels of acid and alkaline phosphatase. *Journal of Periodontal Research* **22**, 14–19.

Buhlin, K., Gustafsson, A., Pockley, A. G., Frostegard, J. & Klinge, B. (2003) Risk factors for cardiovascular disease in patients with periodontitis. *European Heart Journal* **24**, 2099–2107.

Cox, C. P., Wardlow, M. L., Jorgensen, R. & Farr, R. S. (1981) The presence of platelet-activation factor (PAF) in normal human mixed saliva. *Journal of Immunology* **127**, 46–50.

D'Aiuto, F., Parkar, M., Andreou, G., Suvan, J., Brett, P. M., Ready, D. & Tonetti, M. S. (2004) Periodontitis and systemic inflammation: control of the local infection is associated with a reduction in serum inflammatory markers. *Journal of Dental Research* **83**, 156–160.

Denizot, Y., Dupuis, F. & Praloran, V. (1994) Effects of platelet-activating factor on human T and B cells – an overview. *Research in Immunology* **145**, 109–116.

Emingil, G., Cinarcik, S., Baylas, H. & Huseyinov, A. (2001) Levels of platelet-activating factor in gingival crevicular fluid and gingival tissue in specific periodontal diseases. *Journal of Periodontology* **72**, 1032–1037.

Garito, M. L., Prihoda, T. J. & McManus, L. M. (1995) Salivary PAF levels correlate with the severity of periodontal inflammation. *Journal of Dental Research* **74**, 1048–1056.

Geerts, S. O., Legrand, V., Charpentier, J., Albert, A. & Rompen, E. H. (2004) Further evidence of the association between periodontal conditions and coronary artery disease. *Journal of Periodontology* **75**, 1274–1280.

Gemmell, E., Marshall, R. I. & Seymour, G. J. (1997) Cytokines and prostaglandins in immune homeostasis and tissue destruction in periodontal disease. *Periodontology 2000* **14**, 112–143.

Haynes, W. G. & Stanford, C. (2003) Periodontal disease and atherosclerosis: from dental to arterial plaque. *Arteriosclerosis, Thrombosis and Vascular Biology* **23**, 1309–1311.

Ishihara, Y., Zhang, J. B., Quinn, S. M., Schenkein, H. A., Best, A. M., Barbour, S. E. & Tew, J. G. (2000) Regulation of immunoglobulin G2 production by prostaglandin E(2) and platelet-activating factor. *Infection and Immunity* **68**, 1563–1568.

Ishii, S. & Shimizu, T. (2000) Platelet-activating factor (PAF) receptor and genetically engineered PAF receptor mutant mice. *Progress in Lipid Research* **39**, 41–82.

Jansson, L., Lavstedt, S., Frithiof, L. & Theobald, H. (2001) Relationship between oral health and mortality in cardiovascular diseases. *Journal of Clinical Periodontology* **28**, 762–768.

Jones, K. P., Reynolds, S. P., Gray, M., Hughes, K. T., Rolf, S. & Davies, B. H. (1994) Salivary PAF in acute myocardial infarction and angina: changes during hospital treatment and relationship to cardiac enzymes. *Thrombosis Research* **75**, 503–511.

Lamster, I. B. & Novak, M. J. (1992) Host mediators in gingival crevicular fluid: implications for the pathogenesis of periodontal disease. *Critical Reviews in Oral Biology and Medicine* **3**, 31–60.

Lamster, I. B., Oshrain, R.L, Celenti, R., Levine, K. & Fine, J. B. (1991) Correlation analysis for clinical and gingival crevicular fluid parameters at anatomically related gingival sites. *Journal of Clinical Periodontology* **18**, 272–277.

Lamster, I. B., Oshrain, R. L. & Gordon, J. M. (1986) Enzyme activity in human gingival crevicular fluid: considerations in data reporting based on analysis of individual crevicular sites. *Journal of Clinical Periodontology* **13**, 799–804.

Loos, B. G. (2005) Systemic markers of inflammation in periodontitis. *Journal of Periodontology* **76**, 2106–2115.

Loos, B. G., Craandijk, J., Hoek, F. J., Wertheim-van Dillen, P. M. & van der Velden, U. (2000) Elevation of systemic markers related to cardiovascular diseases in the peripheral blood of periodontitis patients. *Periodontology 2000* **71**, 1528–1534.

Lösche, W., Marshal, G. J., Apatzidou, D. A., Krause, S., Kocher, T. & Kinane, D. F. (2005) Lipoprotein-associated phospholipase A2 and plasma lipids in patients with destructive periodontal disease. *Journal of Clinical Periodontology* **32**, 640–644.

McManus, L. M., Marze, B. T. & Schiess, A. V. (1990) Deficiency of salivary PAF in edentulous individuals. *Journal of Periodontal Research* **25**, 347–351.

Narahara, H., Toyoshima, K. & Johnston, J. M. (1996) Role of platelet-activating factor in parturition. *Advances in Experimental Medicine and Biology* **416**, 269–275.

Noguchi, K., Morita, I. & Murota, S. (1989) The detection of platelet-activating factor in inflamed human gingival tissue. *Archives of Oral Biology* **34**, 37–41.

Ozmeric, N. (2004) Advances in periodontal disease markers. *Clinica Chimica Acta; International Journal of Clinical Chemistry* **343**, 1–16.

Persson, G. R., Persson, R. E., Hollender, L. G. & Kiyak, H. A. (2004) The impact of ethnicity, gender, and marital status on periodontal and systemic health of older subjects in the Trials to Enhance Elders' Teeth and Oral Health (TEETH). *Journal of Periodontology* **75**, 817–823.

Prescott, S. M., McIntyre, T. M., Zimmerman, G. A. & Stafforini, D. M. (1996) Inflammation as an early component of atherosclerosis and vascular damage – a role for P-selectin and platelet-activating factor. *Japanese Circulation Journal* **60**, 137–141.

Prescott, S. M., Zimmerman, G. A., Stafforini, D. M. & McIntyre, T. M. (2000) Platelet-activating factor and related lipid mediators. *Annual Review of Biochemistry* **69**, 419–445.

Rasch, M. S., Mealey, B. L., Prihoda, T. J., Woodard, D. S. & McManus, L. M. (1995) The effect of initial periodontal therapy on salivary platelet-activating factor levels in chronic adult periodontitis. *Journal of Periodontology* **66**, 613–623.

Rasheed, A. & McManus, L. M. (1990) Crevicular fluid PAF in human periodontitis patients (abstract). *Journal of Dental Research* **69**, 220.

Rufail, M. L., Schenkein, H. A., Barbour, S. E., Tew, J. G. & van Antwerpen, R. (2005) Altered lipoprotein subclass distribution and PAF-AH activity in subjects with generalized aggressive periodontitis. *Journal of Lipid Research* **46**, 2752–2760.

Silness, J. & Löe, H. (1964) Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condtion. *Acta Odontologica Scandinavica* **22**, 121–135.

Snyder, F. (1990) Platelet-activating factor and related acetylated lipids as potent biologically active cellular mediators. *The American Journal of Physiology* **259**, C697–C708.

Stafforini, D. M., McIntyre, T. M., Zimmerman, G. A. & Prescott, S. M. (2003) Platelet-activating factor, a pleiotrophic mediator of physiological and pathological processes. *Critical Reviews in Clinical Laboratory Sciences* **40**, 643–672.

Torresyap, G., Haffajee, A. D., Uzel, N. G. & Socransky, S. S. (2003) Relationship between periodontal pocket sulfide levels and subgingival species. *Journal of Clinical Periodontology* **30**, 1003–1010.

Tselepis, A. D. & Chapman, M. J. (2002) Inflammation, bioactive lipids and atherosclerosis: potential roles of a lipoprotein-associated phospholipase A2, platelet activating factor-acetylhydrolase. *Artherosclerosis Supplements* **3**, 57–68.

Yamada, Y. S., Ichihara, T., Fujimura, T. & Yokota, M. (1998) Identification of the G994 → T missense in exon 9 of the platelet-activating factor acetylhydrolase gene as an independent risk factor for coronary artery disease in Japanese men. *Metabolism* **47**, 177–181.

Zhou, H., McCombs, G. B., Darby, M. L. & Marinak, K. (2004) Sulphur by-product: the relationship between volatile sulphur compounds and dental plaque-induced gingivitis. *The Journal of Contemporary Dental Practice* **5**, 27–39.

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Clinical Relevance

Scientific rationale: Measurements of PAF in GCF and serum in subjects with periodontitis, gingivitis and healthy controls are warranted to determine the impact of this inflammatory mediator in local inflammation and on cardiovascular diseases.

Principal findings: We found significantly elevated levels of PAF in GCF and serum in diseased subjects compared with healthy controls. The PAF levels in the serum and GCF were positively correlated to the clinical parameters of periodontitis.

Practical implications: The elevated levels of PAF in GCF and serum in periodontitis and the implication of this mediator in cardiovascular diseases support the concept of a link between periodontitis and adverse systemic effects.