J Clin Periodontol 2005; 32: 1219–1225 doi: 10.1111/j.1600-051X.2005.00855.x

Journal of Clinical Periodontology

Controlled clinical and psychometric studies on the relation between periodontitis and depressive mood

Alexander Saletu[1], Helene Pirker-Frühauf[1], Franziska Saletu[2], Leopold Linzmayer[3], Peter Anderer[3] and Michael Matejka[1]

[1]Clinic of Dentistry, Department of Periodontology; [2]Clinic of Dentistry, Department of Oral Surgery; [3]Department of Psychiatry, Medical University of Vienna

Saletu A, Pirker-Frühauf H, Saletu F, Linzmayer L, Anderer P, Matejka M. Controlled clinical and psychometric studies on the relation between periodontitis and depressive mood. J Clin Periodontol 2005; 32: 1219–1225. doi: 10.1111/j.1600-051X.2005.00855.x.

Abstract

Background: Depressive mood is considered a risk factor for the development of periodontitis.

Objectives: Investigation of the relationship between periodontitis and psychopathology utilizing psychometry (both observer- and self-rating scales).

Methods: Forty periodontitis patients were compared with 41 age- and sex-matched controls. The percentage of smokers was similar in both groups (30% *versus* 24.4%). Dental variables included probing depth, clinical attachment loss (CAL), radiographic loss of attachment, papillary bleeding index (PBI) and approximal plaque index (API). Psychometry comprised the Hamilton Depression Scale, the Zung Self-Rating Depression and Anxiety Scales, the von Zerssen Well-being and Complaint Scales, the Epworth Sleepiness Scale, the Pittsburgh Sleep Quality Index, the Quality-of-Life Index, crystallized intelligence and the Freiburg Personality Inventory (FPI).

Results: Multifactorial analysis of variance demonstrated increased depression and anxiety scores, reduced well-being, increased somatic complaints, deteriorated quality of life and introversion in periodontitis. Partial correlation analyses between psychometric measures and dental variables revealed positive correlations of periodontal disease severity/CAL with the depression/anxiety, subjective well-being and complaints scores, and a negative correlation with quality of life. The API was negatively correlated with social orientation, and the CAL was positively correlated with somatic complaints and introversion in the FPI.

Conclusion: Our clinical-psychometric studies confirm depressive mood as a relevant pathogenetic factor for periodontitis.

Key words: anxiety; approximal plaque index; clinical attachment loss; depressive mood; Freiburg Personality Inventory; observer rating; papillary bleeding index; periodontal disease severity; quality of life; self-rating; sleep; somatic complaints; well-being

Accepted for publication 30 August 2005

Because of specific pathogenic bacteria colonizing the subgingival area, periodontitis can be considered an infectious disease, with its onset and progression modified by risk factors affecting the host (Genco et al. 1998).

Systemic risk factors include age and gender (Oliver et al. 1991), cigarette smoking and diabetes mellitus (Grossi et al. 1994, 1995, Genco 1996, Persson et al. 2005), acquired immunodeficiency syndrome (Robinson 1992, Robinson et al. 1996), osteopenia (Wactawski-Wende et al. 1996), neutrophil disorders (Daniel & Van Dyke 1996), genetic polymorphisms (Wilson & Kalmar 1996, Kornman et al. 1997), as well as psychosocial stress, distress and coping behaviour (Genco et al. 1998, Hugoson et al. 2002, Vettore et al. 2003).

Gupta et al. (1993) and Monteiro da Silva et al. (1996) considered depressive mood another important risk factor for the development, severity and course of periodontitis, while other authors did not find an association between depression and periodontitis (Persson et al. 2003, Solis et al. 2004). Anyhow, the relation between periodontitis and depressive mood, depressive syndrome and depression/major depressive disorder remains largely unknown, although there are a variety of hypotheses. An explanation on the behavioural level might be that depressed patients neglect oral hygiene and regular dental

check-ups as a result of reduced drive, mood, affectivity and interest (Monteiro da Silva & Newman 1995, Monteiro da Silva et al. 1996). On the neurophysiological level, depressed patients have been hypothesized to show reduced vigilance, resulting in increased fatigability and inactivity. On the neuroendocrinological level, the relation between depressive mood and periodontitis has been attributed to an impaired immune response caused by a disturbance in the hypothalamo–pituitary–adrenocortical (HPA) system (Schleifer et al. 1989, 1996, Herbert & Cohen 1993, Maes et al. 1993, 1994, Maes 1995). Studies on depressed patients revealed significant alterations in both the cellular (Herbert & Cohen 1993, Maes et al. 1994) and the humoral immune response (Maes 1995). This impairment of immunological defence mechanisms might result in an accumulation of periodontopathogens and thus exacerbate periodontitis. In a study by Schleifer et al. (1996), depressed patients showed increased leucocyte and granulocyte counts, decreased numbers of CD56+ cells and a reduced activity of natural killer cells. Other studies obtained different results and did not find any differences in blood parameters between periodontitis patients and controls (Schleifer et al. 1989).

Bruxism and heavy smoking in depressed patients as well as xerostomia and alterations in saliva composition caused by antidepressive medication might also result in an exacerbation of periodontitis (Rees 1998, Quattrocki et al. 2000).

All the above-described factors play a role in the multifactorial pathogenesis of periodontitis and might be influenced by depression (Monteiro da Silva & Newman 1995).

The aim of the present study was to investigate the relationship between periodontitis and the psychopathology of depression evaluated by means of both observer-rating scales and self-rating scales. The role of sleep and awakening disorders, crystallized intelligence, quality of life and personality dimensions in the pathogenesis of periodontal disease was studied as well, controlling for age, smoking and the API as confounding risk factors.

Material and Methods

Forty patients of both sexes (16 women, 24 men), aged between 32 and 64 years, diagnosed as suffering from periodontitis (K05) were enrolled in the study. Inclusion criteria were based on AAP as well as ICD-10 classification criteria (Weltgesundheitsorganisation 1992, Armitage 1999). The results of dental and psychopathological investigations were compared with those of a control group of 41 patients (18 women, 23 men), aged between 23 and 70 years, not suffering from periodontitis. The study was performed in accordance with the relevant guidelines of the Declaration of Helsinki, as amended by the World Medical Assembly in Somerset West. The study protocol was approved by the institutional review committee. Informed consent was obtained.

From both patients and controls, a medical and dental history, as well as information pertaining to smoking habits were obtained.

Subjects were identified as non-smokers if they had never smoked, current smokers if they had a current smoking habit and former smokers if they reported that they had quit smoking. Smoking was quantified by the number of cigarettes smoked per day.

Only one periodontitis patient suffered from diabetes mellitus. A detailed clinical examination was performed and an orthopantomogram was taken. Periodontal variables studied included probing depth (PD) and clinical attachment loss (CAL) at six probing sites per tooth, measured by a CP 12 periodontal probe. The diagnosis of periodontitis was established on the basis of clinically and radiographically evident loss of attachment. Moreover, at all probing sites, the papillary bleeding index (PBI) according to Saxer & Muhlemann(1975) and the Lange approximal plaque index (API) (Lange 1986) were determined.

On the basis of dental radiography and the measured CAL, three degrees of periodontal disease severity were distinguished: slight periodontitis with an attachment loss of 1–2 mm and/or a bone loss of 10–30%, moderate periodontitis with an attachment loss of up to 4 mm and/or a bone loss of 30–50% and severe periodontitis with an attachment loss of $\geqslant 5$ mm and/or a bone loss of $> 50\%$ (Lang 2003).

The patients of the control group were required to fulfil the following criteria: no radiographically evident bone loss, a maximal probing depth of 4 mm and no clinical attachment loss caused by periodontal disease anywhere in the dentition. Patients suffering from gingivitis were thus included in the control group. Psychopathological assessment was based on observer- and self-rating scales including the Hamilton Depression Scale (HAMD) (Hamilton 1967), the Zung Self-Rating Depression Scale (SDS) (Zung 1965), the Zung Self-Rating Anxiety Scale (SAS) (Zung 1971), the Zerssen Bf-S Scale for evaluation of subjective well-being (Bf-S) (Zerssen et al. 1970), the Zerssen Complaint List (B-L) (Zerssen 1971), the Epworth Sleepiness Scale (ESS) (Johns 1991, 1992), the Quality-of-Life-Index (QLI) according to Mezzich et al. (2000) and the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al. 1989). Personality dimensions were determined by means of the Freiburg Personality Inventory (FPI) (Fahrenberg et al. 1985), and the general level of intelligence by means of a multiple-choice vocabulary test (MWT) (Lehrl 1977). The observer-rating scale (HAMD) was evaluated by a physician.

Statistics

Statistical analysis was performed by means of SPSS software (SPSS Inc., Chicago, IL, USA; version 11.0 under Windows 2000) on the basis of the concept of descriptive data analysis (DDA) (Abt 1987), with one confirmatory statement on the SDS score (Zung 1965). The predetermined null hypothesis was: there is no significant difference in the SDS score between periodontitis patients and normal controls (maximal error probability $p = 0.05$). All other variables were tested descriptively.

Differences in psychometric variables and personality dimensions between periodontitis patients and controls were based on multifactorial analysis of variance, with the psychometric variables as dependent variables, group (patients, controls) as fixed factors and age, smoking and the API as covariates.

Partial correlations between periodontal disease severity, on the one hand, and psychometric variables and personality dimensions, on the other, were carried out controlling for the effects of age, smoking and API.

Partial correlations between psychometric variables and personality dimensions, on the one hand, and API and PBI, on the other, were carried out controlling for the effects of age and smoking.

Table 1. Differences in psychometric variables between periodontitis patients and controls (based on multifactorial analysis of variance with the psychometric variables as dependent variables, group [patients, controls] as fixed factors and age, smoking and the API as covariates); ($n = 81$)

Psychometric variables	Patients ($N = 40$)	Controls ($N = 41$)	Main effect group	
			F	*p*
Hamilton Depression Scale (HAMD)	6.0 ± 6.7	2.3 ± 2.6	10.17	0.002
Zung Self-Rating Depression Scale (SDS)	34.7 ± 10.4	27.6 ± 5.0	10.68	0.002
Zung Self-Rating Anxiety Scale (SAS)	31.1 ± 10.1	25.3 ± 4.0	5.82	0.018
Von Zerssen Scale for Evaluation of Subjective Well-Being (Bf-S)	17.0 ± 16.2	7.2 ± 6.0	11.05	0.001
Von Zerssen Complaint List (B-L)	19.6 ± 14.5	10.0 ± 7.0	5.84	0.018
Epworth Sleepiness Scale (ESS)	7.5 ± 3	8.3 ± 2.8	1.16	0.286
Pittsburgh Sleep Quality Index (PSQI)	5.2 ± 4.2	3.3 ± 1.9	3.67	0.060
Multiple-Choice Vocabulary Test (MWT)	30.6 ± 5.4	31.3 ± 3.7	1.41	0.239
Quality-of-Life Index (QLI)	7.4 ± 1.5	8.5 ± 1.0	10.09	0.002

Table 2. Differences in personality dimensions (FPI) between periodontitis patients and controls (based on multifactorial analysis of variance with the personality dimensions as dependent variables, group [patients, controls] as fixed factors and age, smoking and the API as covariates); ($n = 81$)

FPI dimensions	Patients ($N = 40$)	Controls ($N = 41$)	Main effect group	
			F	*p*
FPI 1 Life satisfaction	7.2 ± 3.3	7.9 ± 2.6	1.93	0.170
FPI 2 Social orientation	6.3 ± 2.6	9.2 ± 16.5	0.00	0.979
FPI 3 Achievement orientation	6.2 ± 2.3	7.1 ± 2.7	3.07	0.084
FPI 4 Inhibition	4.9 ± 2.6	4.1 ± 2.4	2.43	0.123
FPI 5 Excitability	5.6 ± 3.1	5.1 ± 2.9	0.20	0.653
FPI 6 Aggressiveness	3.8 ± 2.2	3.6 ± 1.9	0.10	0.753
FPI 7 Stress	6.0 ± 3.7	4.7 ± 3.2	1.56	0.216
FPI 8 Somatic complaints	3.9 ± 2.7	2.2 ± 1.1	7.22	0.010
FPI 9 Health problems	6.1 ± 3.0	7.8 ± 17.0	0.05	0.819
FP1 10 Openness	5.9 ± 2.8	6.1 ± 2.6	0.02	0.904
FPI E Extraversion	5.6 ± 2.7	7.1 ± 3.0	5.93	0.017
FPI N Emotional lability	5.3 ± 3.2	4.5 ± 3.2	0.13	0.717

FPI, Freiburg Personality Inventory.

Results

Observer rating of depression

Observer rating of depression by means of the German version of the HAMD (Hamilton 1967), in which 21 symptoms of depression are assessed, yielded a significantly higher total depression score in periodontitis patients than in normal controls (Table 1), although mean values of both groups were within normal limits. Only 25% of the patients had a score of $\geqslant 9$, which is considered clinically relevant.

Self-rating of depression, anxiety, well-being and somatic complaints

The SDS, the SAS, the Zerssen Bf-S Scale for evaluation of subjective well-being (Bf-S) and the Zerssen Complaint List (B-L) yielded significantly higher scores in periodontitis patients than in normal controls (Table 1), with the mean values of periodontitis patients also being slightly higher than the normative data reported in the literature [SDS: 26 ± 4 (Zung 1965); SAS: 26 ± 5 (Zung 1971); Bf-S: 12 ± 9 (Zerssen et al. 1970); B-L: 14 ± 10 (Zerssen 1971)].

Subjective sleep quality and daytime sleepiness

Subjective sleep quality over the past 4 weeks, determined by means of the PSQI, showed a trend towards a decrease in periodontitis patients as compared with controls (Table 1). The patients' scores were also higher than the normative values (2.7 ± 1.7) of the PSQI (Buysse et al. 1989), which indicated reduced sleep quality.

Concerning daytime sleepiness, determined by means of the ESS, no differences between periodontitis patients and controls were observed (Table 1). The patients' scores did not differ from the normative values of 5.9 ± 2.2 described by Johns (1991, 1992).

Intelligence

The level of crystallized intelligence, evaluated by means of a MWT (Lehrl 1977), did not differ between periodontitis patients and normal controls.

Quality of life

Quality of life, assessed by means of the German version (Saletu et al. 2003) of the QLI according to Mezzich et al. (2000), was slightly but significantly reduced in periodontitis patients as compared with controls (Table 1).

Personality dimensions

The FPI (Fahrenberg et al. 1985), which assesses 12 largely independent personality dimensions, yielded significant differences between periodontitis patients and controls in three variables: The patients reported decreased achievement orientation, increased somatic complaints and less extraversion (Table 2).

Periodontal variables

Periodontal disease severity was found to be slight in 22.5%, moderate in 32.5% and severe in 45% of the patients.

In detail, CAL was 3.7 ± 1 mm for the total patient group as compared with 0.2 ± 0.4 mm for the control group. Table 3 depicts the data for the three severity subgroups.

PD was 3.3 ± 0.9 mm for all periodontitis patients as compared with 2.0 ± 0.4 mm for the controls, with the data of the three periodontitis subgroups shown in Table 3.

The API of the total patient group was 58 ± 23% as compared with 41 ± 18% of the control group, with the values of both main groups (58 and 41%), but also of the three periodontitis subgroups (Table 3) lying over the normative values reported in the literature.

The PBI also yielded significantly increased values in periodontitis patients as compared with normal controls (49% *versus* 13%), with the percentage

Table 3. Periodontal characteristics (mean ± SD) of periodontitis patients and controls

Variable	Controls ($n = 41$)	Periodontitis patients ($n = 40$)		
		slight ($n = 9$)	moderate ($n = 13$)	severe ($n = 18$)
CAL (mm)	0.2 ± 0.4	2.0 ± 0.3***	3.6 ± 0.6***	4.4 ± 0.7***
PD (mm)	2.0 ± 0.4	2.0 ± 0.4	3.2 ± 0.5***	3.9 ± 0.5***
API (%)	41 ± 18	56 ± 15*	59% ± 23*	57 ± 26*
PBI (%)	13 ± 11	37 ± 16***	50% ± 34***	55 ± 29***

CAL, clinical attachment loss; PD, probing depth; API, approximal plaque index; PBI, papillary bleeding index.
*$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$ (Mann–Whitney test).

Table 4. Partial correlations between periodontal disease severity, CAL and psychometric variables controlling for the effects of age, smoking and the API, as well as partial correlations between API, PBI and psychometric variables controlling for the effects of age and smoking

Psychometric variables	Periodontal disease severity	CAL	API	PBI
Hamilton Depression Scale (HAMD)	0.310**	0.330**	− 0.035	0.111
Zung Self-Rating Depression Scale (SDS)	0.271*	0.297**	0.056	− 0.033
Zung Self-Rating Anxiety Scale (SAS)	0.1 92+	0.243*	0.141	0.051
Von Zerssen Scale for Evaluation of Subjective Well-Being (Bf-S)	0.305**	0.313**	0.073	0.039
Von Zerssen Complaint List (B-L)	0.239*	0.243*	− 0.001	0.059
Epworth Sleepiness Scale (ESS)	− 0.116	− 0.136	− 0.033	− 0.161
Pittsburgh Sleep Quality Index (PSQI)	0.154	0.150	0.026	0.034
Multiple-Choice Vocabulary Test (MWT)	0.064	− 0.031	− 0.064	− 0.025
Quality-of-Life Index (QLI)	− 0.339**	− 0.292*	− 0.170	− 0.123

CAL, clinical attachment loss; API, approximal plaque index; PBI, papillary bleeding index.
+$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$ ($n = 81$).

in the three subgroups increasing with the severity of the disease (Table 3).

Smoking

There were 12 smokers in the periodontitis group (30%) and 10 smokers in the control group (24.4%), which is in line with the expected 25–28% of smokers in the adult population (Andreasen & Black 2001, Thamm & Burckhard 2003).

The mean daily cigarette consumption of the smokers in the periodontitis group amounted to 19.4 ± 11.8 cigarettes, with a mean smoking duration of 21.6 ± 9.2 years, and that of the smoking controls amounted to 14.7 ± 8.2 cigarettes over a period of 23.3 ± 7.6 years.

In the larger non-smoking subgroups (28 periodontitis patients *versus* 31 controls), 50 out of 59 persons had never smoked and only nine were ex-smokers. Out of the 31 non-smoking controls, 26 (83.9%) were non-smokers and five (16.1%) were ex-smokers who had been smoking for an average of 17.4 ± 9.4 years. Out of the 28 non-smoking periodontitis patients, 24 (85.7%) were non-smokers and four were ex-smokers who had been smoking for an average of 18.3 ± 11.2 years.

All six patients with slight periodontitis were non-smokers. Seven patients with moderate periodontitis were non-smokers and one was an ex-smoker. Eleven out of 14 patients with severe periodontitis were non-smokers and three were ex-smokers.

Correlation analyses

Partial correlation analyses revealed the following significant relationships between psychometric variables and periodontal measures (controlling for the effects of age, smoking and the API):

The higher the observer-rated Hamilton Depression Score, the SDS and the SAS, the von Zerssen Well-Being and Complaint Score and the lower the QLI, the more pronounced the periodontal disease severity and the CAL (Table 4).

The API and the PBI showed no significant correlations with psychometric variables (Table 4).

Partial correlation analyses between the Freiburg personality dimensions and dental measures (controlling for the effects of age, smoking and the API) as well as partial correlations between API, PBI and personality dimensions controlling for the effects of age and smoking revealed a significant negative correlation between social orientation and the API, a positive correlation between somatic complaints and CAL and a negative correlation between extraversion and CAL (Table 5).

Discussion

Our clinical investigations on the psychometric differences between periodontitis patients and controls showed that the patients had significantly higher scores in the self-rated depression and anxiety scales, even after controlling for confounding risk factors such as age, smoking and the API. Also, the observer-rated HAMD scale yielded significantly higher total scores in periodontitis patients than in controls. In contrast to the self-rating, however, in the observer-rating mean values of both patients and controls were within normal limits. This suggests that patients consider their depressive mood more pronounced than the doctor does, in whose rating only 25% of the patients ended up with a score of $\geqslant 9$, which is considered clinically relevant.

Patients' suffering is also reflected by the reduced well-being and increased somatic complaints determined by means of the von Zerssen scales as well as by their deteriorated quality of life.

Subjective sleep quality, evaluated by means of the PSQI, showed only a trend towards deterioration in periodontitis patients as compared with controls, whereas daytime sleepiness was not significantly increased at all. In the FPI, periodontitis patients reported decreased achievement orientation, increased somatic complaints and less extraversion.

Partial correlation analyses (controlling for the effects of age, smoking and the API) revealed significant positive correlations between periodontal disease severity, CAL and depression determined by means of observer and self-ratings.

Also, self-rated anxiety, subjective well-being and complaint scores were positively correlated with periodontal disease severity and CAL, and moreover, the lower quality of life, the higher periodontal disease severity and CAL. Finally, it seems that personality dimensions like social orientation, somatic complaints and introversion also contribute to the pathogenesis of periodontitis.

Table 5. Partial correlations between periodontal disease severity, CAL and personality dimensions (FPI) controlling for the effects of age, smoking and the API, as well as partial, correlations between API, PBI and personality dimensions controlling for the effects of age and smoking

FPI dimensions	Periodontal disease severity	CAL	API	PBI
FPI 1 Life satisfaction	− 0.174	− 0.143	− 0.028	− 0.004
FPI 2 Social orientation	− 0.026	− 0.012	− 0.250*	0.088
FPI 3 Achievement orientation	− 0.174	− 0.185	0.013	− 0.057
FPI 4 Inhibition	0.157	0.179	0.015	0.087
FPI 5 Excitability	0.076	0.098	− 0.107	− 0.120
FPI 6 Aggressiveness	− 0.069	− 0.074	− 0.072	− 0.084
FPI 7 Stress	0.163	0.120	− 0.046	− 0.002
FPI 8 Somatic complaints	0.209	0.262*	0.123	0.216
FPI 9 Health problems	0.007	0.049	0.029	− 0.009
FPI 10 Openness	− 0.051	− 0.031	− 0.097	0.015
FPI E Extraversion	− 0.158	− 0.197+	0.033	− 0.094
FPI N Emotional lability	0.133	0.115	− 0.048	− 0.126

FPI, Freiburg Personality Inventory; CAL, clinical attachment loss; API, approximal plaque index; PBI, papillary bleeding index.
+$p \leqslant 0.10$; *$p \leqslant 0.05$; **$p \leqslant 0.01$; ***$p \leqslant 0.001$ ($n = 81$).

We were able to replicate the statistically significant differences observed between the patient and control group in the larger non-smoking subgroups, but not in the smaller smoking subgroups. The lack of statistically significant findings in smokers may not only be because of the small sample size but also the psychotropic effects of smoking itself.

Our findings are in agreement with the majority of the literature. Moss et al. (1996) and Monteiro da Silva et al. (1996) showed that depression was associated with a more severe course of periodontitis, with continuous periodontal bone loss and different serum antibody titres against periodontopathogens.

As early as in 1961, Baker et al. described significant correlations between periodontal status and psychopathology of psychiatric patients. This was in agreement with the findings of Belting & Gupta (1961), who reported a deteriorated periodontal status in psychiatric patients as compared with controls, independent of variables such as brushing frequency, calculus, bruxism and teeth clenching. This study also revealed that periodontal disease severity was associated with increased anxiety, which is in agreement with our own findings. Recently, Johannsen et al. (2005) described that self-reported anxiety was associated with an adverse effect on the gingiva and seems to increase periodontal disease severity in smokers.

Because of the positive correlation between anxiety and the periodontal disease index, Davis and Jenkins concluded as early as in 1962 that anxiety increases blood levels of adrenocorticotropic hormones such as cortisol, which has a negative effect on periodontal immune mechanisms.

Recent neuroendocrinological studies mainly suggest that in depression there is a disturbance in the hypothalamo–pituitary–adrenocortical (HPA) system and the hypothalamo–pituitary–thyroid system (Holsboer-Trachsler 1994, Steiger 2002, 2004). Alterations in the limbic system might result in an increased release of corticotropin-releasing hormone (CRH) and thus a hypersecretion of ACTH and cortisol. In approximately 50% of depressed patients, the dexamethasone suppression test yields pathological values (Kasper et al. 2002).

Steiger (2002, 2004) postulates the hyperactivity of the HPA system to be an important factor in the pathophysiology of sleep in depression. Indeed, the present investigation also revealed a trend towards an increase in sleep disorders (evaluated by the PSQI) in periodontitis patients.

The negative effects of cortisol on immune defence mechanisms also negatively influence the development and course of periodontitis. This was demonstrated very clearly by Genco et al. (1998), who found that salivary cortisol levels were higher in a test group exhibiting severe periodontitis, a high level of financial strain and high emotion-focused coping than in a control group with little or no periodontal disease, low financial strain and low levels of emotion-focused coping (11.0 ± 4.4 *versus* 8.6 ± 4.1 nmol/l salivary cortisol).

Psychosocial stress factors such as negative life events, financial strain, unemployment or family problems also play a major role in the pathogenesis of periodontitis (Croucher et al. 1997, Genco et al. 1998). This is confirmed by our findings of a negative correlation between periodontitis and quality of life determined by means of the QLI according to Mezzich et al. (2000), which covers different dimensions such as occupational functioning, interpersonal functioning, social emotional support, community and services support and personal fulfilment.

Last but not the least, it seems of interest that in our study significant inter-group differences and correlations were found in the target variable, the self-rated depressive syndrome, which comprises a variety of symptoms in different organ systems. This indicates that it is not depressive mood itself that favours the development of periodontitis but rather a combination of different axial symptoms such as reduced drive, affectivity or well-being or imbalances in biorhythm. The latter do not only manifest themselves as sleep disorders but also as diurnal fluctuations with a morning pessimum in thymopsychic variables, which might be the reason why depressed patients neglect oral hygiene in the morning. Indeed, Elter et al. (2002) suggested that clinically relevant depression might affect the success of periodontal therapy, which has to be proven by future studies involving clinical, neurophysiological, neuroendocrinological and psychopharmacological investigations. Such studies could elucidate the question regarding the extent to which the obviously related biochemical and behavioural factors are responsible for the pathogenesis of periodontitis. Decreased cerebral monoamine and increased cortisol levels lead to depression, which in turn, at the behavioural level, is responsible for a lack of dental hygiene, which is supported by in increased plaque index in our periodontal patients.

References

Abt, K. (1987) Descriptive data analysis: a concept between confirmatory and exploratory data analysis. *Methods of Information in Medicine* **26**, 77–88.

Andreasen, N. C. & Black, D. W. (2001) *Introductory Textbook of Psychiatry*, 3rd

edition. Washington DC: American Psychiatric Publishing Inc.

Armitage, G. C. (1999) Development of a classification system for periodontal diseases and conditions. *Annals of Periodontology* **4**, 1–6.

Baku, E. G., Crook, G. H. & Schwacher, E. D. (1961) Personality correlates of periodontal diseases. *Journal of Dental Research* **40**, 396–403.

Belting, C. M. & Gupta, O. P. (1961) The influence of psychiatric disturbances on the severity of periodontal disease. *Journal of Periodontology* **32**, 219–226.

Buysse, D. J., Reynolds, C. F. III, Monk, T. H., Berman, S. R. & Kupfer, D. J. (1989) The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Research* **28**, 193–213.

Croucher, R., Marcenes, W. S., Torres, M. C., Hughes, F. & Sheiham, A. (1997) The relationship between life-events and periodontitis. A case–control study. *Journal of Clinical Periodontology* **24**, 39–43.

Daniel, M. A. & Van Dyke, T. E. (1996) Alterations in phagocyte function and periodontal infection. *Journal of Periodontology* **67**, 1070–1075.

Davis, C. H. & Jenkins, C. D. (1962) Mental Stress and oral disease. *Journal of Dental Research* **41**, 1045–1049.

Elter, J. R., White, B. A., Gaynes, B. N. & Bader, J. D. (2002) Relationship of clinical depression to periodontal treatment outcome. *Journal of Periodontology* **73**, 441–449.

Fahrenberg, J., Hampel, R. & Selg, H. (1985) Die revidierte Form des Freiburger Persönlichkeitsinventar FPI-R. *Diagnostica* **31**, 1–21.

Genco, R. J. (1996) Current view of risk factors for periodontal diseases. *Journal of Periodontology* **67**, 1041–1049.

Genco, R. J., Ho, A. W., Kopman, J., Grossi, S. G., Dunford, R. G. & Tedesco, L. A. (1998) Models to evaluate the role of stress in periodontal disease. *Annals of Periodontology* **3**, 288–302.

Grossi, S. G., Genco, R. J., Machtei, E. E., Ho, A. W., Koch, G., Dunford, R., Zambon, J. J. & Hausmann, E. (1995) Assessment of risk for periodontal disease. II. Risk indicators for alveolar bone loss. *Journal of Periodontology* **66**, 23–29.

Grossi, S. G., Zambon, J. J., Ho, A. W., Koch, G., Dunford, R. G., Machtei, E. E., Norderyd, O. M. & Genco, R. J. (1994) Assessment of risk for periodontal disease I. Risk indicators for attachment loss. *Journal of Periodontology* **65**, 260–267.

Gupta, O. P., Tiwarri, O. S., Salimeno, T. Jr. & Allen, D. R. (1993) Neuropsychiatric disorders and periodontal disease. *Annals of Dentistry* **52**, 28–33.

Hamilton, M. (1967) Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology* **6**, 278–296.

Herbert, T. B. & Cohen, S. (1993) Depression and immunity: a meta-analytic review. *Psychological Bulletin* **113**, 472–486.

Holsboer-Trachsler, E. (1994) *Neurobiologische und psychopathologische Verlaufsmessungen bei Depressionstherapie, Trimipramin,Schlafentzug und Licht*, **Vol. 167**. Basel: Karger.

Hugoson, A., Ljungquist, B. & Breivik, T. (2002) The relationship of some negative events and psychological factors to periodontal disease in an adult Swedish population 50 to 80 years of age. *Journal of Clinical Periodontology* **29**, 247–253.

Johannsen, A., Asberg, M., Soder, P. O. & Soder, B. (2005) Anxiety, gingival inflammation and periodontal disease in non-smokers and smokers – an epidemiological study. *Journal of Clinical Periodontology* **32**, 488–491.

Johns, M. W. (1991) A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* **14**, 540–545.

Johns, M. W. (1992) Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep* **15**, 376–381.

Kasper, S., Möller, H. J. & Müller-Spahn, F. (2002) *Depression Diagnose und Pharmakotherapie*. Stuttgart: Georg Thieme Verlag.

Kornman, K. S., Crane, A., Wang, H. Y., di Giovine, F. S., Newman, M. G., Pirk, F. W., Wilson, T. G. Jr., Higginbottom, F. L. & Duff, G. W. (1997) The interleukin-1 genotype as a severity factor in adult periodontal disease. *Journal of Clinical Periodontology* **24**, 72–77.

Lang, N. (2003) *Parodontalerkrankungen Klassifikation und Charakterisierung*. Berlin: Quintessenz.

Lange, D. E. (1986) New aspects of diagnosis and therapy of periodontal diseases for dental practitioners. *Quintessenz* **37**, 521–532.

Lehrl, S. (1977) *Mehrfachwahl-Wortschatz-Intelligenztest. Manual zum MWT-B*. Erlangen.

Maes, M. (1995) Evidence for an immune response in major depression: a review and hypothesis. *Progress in Neuro-psychopharmacology and Biological Psychiatry* **19**, 11–38.

Maes, M., Meltzer, H. Y., Scharpe, S., Bosmans, E., Suy, E., De Meester, I., Calabrese, J. & Cosyns, P. (1993) Relationships between lower plasma L-tryptophan levels and immune-inflammatory variables in depression. *Psychiatry Research* **49**, 151–165.

Maes, M., Meltzer, H. Y., Stevens, W., Calabrese, J. & Cosyns, P. (1994) Natural killer cell activity in major depression: relation to circulating natural killer cells, cellular indices of the immune response, and depressive phenomenology. *Progress in Neuro-psychopharmacology and Biological Psychiatry* **18**, 717–730.

Mezzich, J. E., Ruiperez, M. A., Perez, C., Yoon, G., Liu, J. & Mahmud, S. (2000) The Spanish version of the quality of life index: presentation and validation. *Journal of Nervous and Mental Disease* **188**, 301–305.

Monteiro da Silva, A. M. & Newman, H. N. O. (1995) Psychosocial factors in inflammatory periodontal diseases. A review. *Journal of Clinical Periodontology* **22**, 516–526.

Monteiro da Silva, A. M., Oakley, D. A., Newman, H. N., Nohl, F. S. & Lloyd, H. M. (1996) Psychosocial factors and adult onset rapidly progressive periodontitis. *Journal of Clinical Periodontology* **23**, 789–794.

Moss, M. E., Beck, J. D., Kaplan, B. H., Offenbacher, S., Weintraub, J. A., Koch, G. G., Genco, R. J., Machtei, E. E. & Tedesco, L. A. (1996) Exploratory case–control analysis of psychosocial factors and adult periodontitis. *Journal of Periodontology* **67**, 1060–1069.

Oliver, R. C., Brown, L. J. & Loe, H. (1991) Variations in the prevalence and extent of periodontitis. *Journal of the American Dental Association* **122**, 43–48.

Persson, G. R., Persson, R. E., MacEntee, C. I., Wyatt, C. C., Hollender, L. G. & Kiyak, H. A. (2003) Periodontitis and perceived risk for periodontitis in elders with evidence of depression. *Journal of Clinical Periodontology* **30**, 691–696.

Persson, R. E., Kiyak, A. H., Wyatt, C. C., Macentee, M. & Persson, G. R. (2005) Smoking, a weak predictor of periodontitis in older adults. *Journal of Clinical Periodontology* **32**, 512–517.

Quattrocki, E., Baird, A. & Yurgelun-Todd, D. (2000) Biological aspects of the link between smoking and depression. *Harvard Review of Psychiatry* **8**, 99–110.

Rees, T. D. (1998) Drugs and oral disorders. *Periodontol 2000* **18**, 21–36.

Robinson, P. (1992) Periodontal diseases and HIV infection. A review of the literature. *Journal of Clinical Periodontology* **19**, 609–614.

Robinson, P. G., Sheiham, A., Challacombe, S. J. & Zakrzewska, J. M. (1996) The periodontal health of homosexual men with HIV infection: a controlled study. *Oral Diseases* **2**, 45–52.

Saletu, B., Prause, W., Loffler-Stastka, H., Anderer, P., Brandstatter, N., Zoghlami, A., Saletu-Zyhlarz, G. & Katschnig, H. (2003) Quality of life in nonorganic and organic sleep disorders: I. Comparison with normative data. *Wiener Klinische Wochenschrift* **115**, 246–254.

Saxer, U. P. & Muhlemann, H. R. (1975) Motivation and education. *SSO Schweiz Monatsschr Zahnheilkd* **85**, 905–919.

Schleifer, S. J., Keller, S. E., Bartlett, J. A., Eckholdt, H. M. & Delaney, B. R. (1996) Immunity in young adults with major depressive disorder. *American Journal of Psychiatry* **153**, 477–482.

Schleifer, S. J., Keller, S. E., Bond, R. N., Cohen, J. & Stein, M. (1989) Major depressive disorder and immunity. Role of age, sex, severity, and hospitalization. *Archives of General Psychiatry* **46**, 81–87.

Solis, A. C., Lotufo, R. F., Pannuti, C. M., Brunheiro, E. C., Marques, A. H. & Lotufo-Neto, F. (2004) Association of periodontal disease to anxiety and depression symptoms, and psychosocial stress factors. *Journal of Clinical Periodontology* **31**, 633–638.

Steiger, A. (2002) Sleep and the hypothalamo-pituitary-adrenocortical system. *Sleep Medicine Review* **6**, 125–138.

Steiger, A. E. A. (2004) *The interaction of sleep and the HPA system in pathophysology and pharmacotherapy of affective disorders*. Paper presented at the International Congress of Biological Psychiatry, Sydney.

Thamm, M. & Burckhard, J. (2003) *Tabak-Zahlen und Fakten zum Konsum*. Geesthacht: Neuland Verlagsgesellschaft mbH.

Vettore, M. V., Leao, A. T., Monteiro Da Silva, A. M., Quintanilha, R. S. & Lamarca, G. A. (2003) The relationship of stress and anxiety with chronic periodontitis. *Journal of Clinical Periodontology* **30**, 394–402.

Wactawski-Wende, J., Grossi, S. G., Trevisan, M., Genco, R. J., Tezal, M., Dunford, R. G., Ho, A. W., Hausmann, E. & Hreshchyshyn, M. M. (1996) The role of osteopenia in oral bone loss and periodontal disease. *Journal of Periodontology* **67**, 1076–1084.

Weltgesundheitsorganisation (1992) *International Classification of Diseases and Related Health Problems*, **Vol. 1**. Geneva: WHO.

Wilson, M. E. & Kalmar, J. R. (1996) FcyRIIa (CD32): a potential marker defining susceptibility to localized juvenile periodontitis. *Journal of Periodontology* **67**, 323–331.

Zerssen, D. V. (1971) Die Beschwerden Liste als Test. *Therapiewoche* **21**, 1908–1914.

Zerssen, D. V., Koeller, D. M. & Rey, E. R. (1970) Die Befindlichkeits-Skala (Bf-S) – ein einfaches Instrument zur Objektivierung von Befindlichkeits-Störungen, insbesondere im Rahmen von Lägsschnitt-Untersuchungen. *Arzneimittel-Forsch* 915–918.

Zung, W. (1965) A self rating depression scale. *Archives of General Psychiatry* **12**, 63–70.

Zung, W. (1971) A rating instrument for anxiety disorders. *Psychosomatics* **12**, 371–379.

Address:
Alexander Saletu
Vienna University Clinic of Dentistry
Department of Periodontology
Währinger Strasse 25a
A-1090 Vienna
Austria
E-mail: alexander.saletu@meduniwien.ac.at

Clinical relevance

Scientific rationale for the study: In the multifactorial pathogenesis of periodontitis, depressive mood was suggested as a risk factor. This study aimed at identifying psychometric measures correlated to periodontitis.

Principal findings: As compared with controls, periodontitis patients exhibited deteriorated scores in various observer- and self-rating scales on depression, anxiety, well-being, somatic complaints, quality of life and introversion.

Correlation analyses demonstrated that particularly the depression, well-being and quality-of-life score was linked to periodontitis.

Practical implications: Dental practioners should give consideration to the fact that some patients with periodontal disease may be experiencing depressive symptoms, which may be measured by rating scales, and should consider referral where appropriate.

However, in addition to cross-sectional investigations, longitudinal studies are necessary to elucidate causation between depression and periodontitis.