

Approximal plaque and gingival sulcus bleeding in routine dental care patients: relations to life stress, somatization and depression

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Abstract

Objectives: Previous research on relations between life stress and periodontal conditions was often based on indicators of periodontal destruction history and stimulus-specific measures of life stress. The present study was undertaken to compare patients showing different degrees of gingival sulcus bleeding with patients without signs of bleeding, using an instrument measuring cognitive impacts of events and assessing reported symptoms of depression and somatization. Additionally the patient groups were compared with regard to dental status and dental visiting behaviour. Analog comparisons were conducted in patients with different degrees of approximal plaque.

Materials and Methods: 140 routine dental care patients attending a private dental practice were examined. Measurement devices were the sulcus bleeding index (SBI), the approximal plaque index (API), the Dental Avoidance Scale, the Life Experience Survey (LES), the Impact of Event Scale with the subtests cognitive intrusion and cognitive avoidance, and the SCL-90-R subscales somatization and depression.

Results: Patients with high API scores differed from their zero-score counterparts in dental avoidance and time since last visit only. By contrast, subjects scoring high in the SBI not only had more missing teeth and reported more dental avoidance than their zero-score counterparts but also had elevated scores in intrusive and avoidant thoughts related to a stressful event as well as in symptoms of somatization and depression. No difference was found for the measure of stimulus specific recent life events (LES).

Conclusions: The results suggest that cognitive preoccupation with adverse events and the presence of somatization and depression symptoms might play a role in gingival inflammation.

Key words: dental plaque; depression; gingival bleeding; life stress; somatization

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Various studies published since the 1990s have reported a relationship between patient characteristics and indices of periodontal disease. Various extensive reviews suggested that associations of life stress and depression with gingival inflammation might be mediated by hypothalamic–pituitary–adrenal (HPA) axis reactivity modulating immune responses, resulting in a

lowered host resistance to periodontitis-related bacteria (Clarke & Hirsch 1995, Monteiro da Silva et al. 1995, Breivik et al. 1996, Genco et al. 1998). However, the empirical evidence reported to date for a perceived stress-periodontal health association is not unequivocal.

Marcenes & Sheiham (1992) found that work-related demand was higher in

subjects showing signs of gingival inflammation and recession. According to Horning & Cohen (1995), patients with necrotizing gingival stomatitis gave their present life stress a higher rating than control subjects. In a study by Croucher et al. (1997), subjects with a clinically significant pocket probing depth reported more life change on the

Social Readjustment Rating Scale than healthy persons. Mengel et al. (2002) found a correlation between family-induced stress and gingival bleeding.

On the other hand, negative results were reported as well. In a community-based study by Locker & Leake (1993) involving 624 respondents aged 50 years or more, no differences in attachment loss were found between subjects reporting high and low levels of life stress. According to Monteiro da Silva et al. (1996), patients with rapidly progressive periodontitis and with chronic adult periodontitis did not differ from controls in their perceived stress using a scale by Linn (1986). In 77 periodontal cases identified from the collective of a large epidemiological study, Moss et al. (1999) found no difference in daily strain from subjects with no signs of periodontitis. An analysis of the data of all 1426 respondents in the Eric County Risk Factor Study by Genco et al. (1999) revealed no associations between level of attachment loss and recent life events, daily hassles and uplifts, or most aspects of daily strain. As a marginal finding, only financial strain was elevated in respondents with moderate attachment loss. When comparing subjects with three different levels of attachment loss, Vettore et al. (2003) detected no differences on the Social Readjustment Rating Scale or in a stress symptoms inventory.

Whereas the above studies were cross-sectional in nature, three prospectively designed studies supporting the hypothesis of an association between subjective stress and periodontal health are outlined below. In a 5.5-year follow-up of 23 regular attenders, job satisfaction was found to be associated with less attachment loss (Linden et al. 1996). A study by Kamma & Baehni (2003) of 25 early onset periodontitis patients followed over 5 years demonstrated that perceived stress according to the measure by Linn (1986) was related to periodontal progression. Deinzer et al. (1998) reported that medical dental students undergoing a stressful examination deteriorated in their gingival bleeding compared to controls.

It has been suggested that various methodological aspects should be borne in mind when investigating the relationship between stress and periodontal health (Locker & Leake 1993, Monteiro da Silva et al. 1995, Vettore et al. 2003). First, indicators such as attachment loss and pocket probing depth represent a

historical record of periodontal destruction (Griffiths et al. 1988). Therefore, an association with experienced recent life stress is not to be expected. Second, when using the diagnosis of chronic periodontal disease for defining study subjects, this assessment is a result of a foregoing disease process (Armitage 1999), and it is not to be assumed that it bears any relation to acute stress. Finally, the prediction of outcome by stress perceived long ago does not take into account changes in stressful conditions which are common within a longer time span, e.g. of 5 years. Locker & Leake (1993) proposed using clinical measures of acute inflammation for studying relations between stress and gingival health.

Another issue is related to the measurement of perceived stress. A stressful life event (the external stimulus condition) may vary in its impact on subjective well-being, depending on whether it is perceived as threat or as a challenge. It has been suggested that the cognitive preoccupation with an event, manifested in intrusive thoughts and efforts to abandon them, determines physical and psychological health (Horowitz 1993). The Impact of Event Scale (IES, Horowitz et al. 1979) measuring cognitive intrusion and avoidance has been successfully used in field research as well as in clinical investigations (Spurrell & McFarlane 1995, Klages 2003). One topic of this research was a comparison of routine dental care patients showing different degrees of gingival bleeding with respect to their reported recent life events and their cognitive impact of event according to the questionnaire by Horowitz et al. (1979).

Depression is a psychological symptomatology assumed to modulate HPA reactivity and gingival immune response (Breivik et al. 2000). Various studies provide evidence of an association between depression and periodontal health. Monteiro da Silva et al. (1996) found that depression and loneliness were the only variables in which their rapidly progressive periodontitis patients differed from controls. In a study by Mengel et al. (2002), patients with untreated aggressive generalized periodontitis were characterized by a pessimistic attitude to life. According to Axtelius et al. (1998) non-responsive periodontally treated patients had a more pronounced passive dependent personality than their successful counterparts. In the Eric County Risk Factor Study, depress-

ion was a predictor of severe periodontal destruction in a regression model (Genco et al. 1999).

The tendency to experience multiple physical symptoms (somatization) might also interact with HPA reactivity (Rief & Auer 2001). Earlier studies reported associations between somatization and periodontal health status (Moulton et al. 1952, Baker et al. 1961, Green et al. 1986), whereas recent research found no support for this assumption (Monteiro da Silva et al. 1996, Moss et al. 1999). An issue of interest for this research was the relationship between depression or somatization and gingival inflammation.

Neglect of oral hygiene is an additional factor assumed to contribute to the development of gingival inflammation (Mariotti 1999). In a regression model, plaque level was a predictor of periodontal disease status (Croucher et al. 1997). Kurer et al. (1995) and Mengel et al. (2002) both reported strong correlations between dental plaque and gingival bleeding, whereas in the studies by Moss et al. (1999) and Vettore et al. (2003) periodontal cases did not differ from controls in their dental plaque level.

Oral hygiene assessed by dental plaque accumulation is hypothesized to be influenced by perceived recent stress and a depressive condition of the patient (Genco et al. 1998). However, evidence for this assumption is sparse. Kurer et al. (1995) reported a correlation between depression and plaque. In a quasi-experimental design by Deinzer et al. (2001) students experiencing academic stress showed fewer plaque-free sites than the controls, whereas Monteiro da Silva et al. (1998) found no relationships between life events, perceived stress or depression and dental plaque in periodontal patients. The relation of subjective stress and depression to different levels of plaque accumulation was another point assumed to be of interest for investigation in this research.

Dental visiting behavior including anxiety-related avoidance of dental care is postulated to be a variable contributing to oral hygiene adherence and consequently to periodontal tissue condition (Tedesco et al. 1991, Galgut 1992, McCaul et al. 1992). Locker & Leake (1993) found in their community-based study that regular dental attendance as well as a short interval since the last visit were associated with less attachment loss. According to various authors, dental avoidance was associated

with deteriorated oral health (e.g. Wisloff et al. 1995, Skaret et al. 2004).

Finally, dental status is hypothesized to be a risk factor for plaque accumulation and periodontal health. Local factors such as margins of fillings or abutment teeth in partial dentures are susceptible to the development of plaque and gingivitis unless meticulous cleaning procedures are consistently followed (Clarke & Hirsch 1995, Petridis & Hempton 2001). According to Locker & Leake (1993) the number of remaining teeth was related to attachment loss. The aspects of patients' visiting behavior and dental status and their relations to gingival inflammation and plaque accumulation seemed to us to be important factors in the present study.

To summarize, the following questions were addressed in this study investigating patients in routine dental care:

1. Do patients presenting different levels of approximal plaque differ in their dental status (filled and missing teeth) and in their visiting behavior compared to those with no signs of plaque?
2. Do patients presenting different levels of gingival sulcus bleeding differ in their dental status (filled and missing teeth), in their visiting behavior, and in dental plaque compared to those with no signs of bleeding?
3. Do patients presenting different levels of approximal plaque differ in their reported recent life events, cognitive impact of event, depression and somatization compared to those with no signs of plaque?
4. Do patients presenting different levels of gingival sulcus bleeding differ in their reported recent life events, cognitive impact of event, depression and somatization compared to those with no signs of bleeding?

Material and Methods

Subjects

One hundred and forty regular dental care patients attending a private practice participated in this study. They had been asked to undergo a gingival and plaque examination and to fill in a questionnaire, and had given their informed consent. The examiner was a male dentist with two years of clinical experience. 16 of the originally addressed 156 patients were unwilling to participate. Forty-eight subjects of the study sample were male, and 92 females. The mean

age was 40.73 years (SD = 15.93). Seventy-five patients had completed elementary school, 37 junior high school and 28 senior high school.

Measures

Approximal plaque index (API)

After being stained with erythrosine, a periodontal probe was guided through the approximal spaces of the first and third quadrants from the oral aspect and of the second and fourth quadrant from the buccal aspect. The presence of plaque remnants on the probe was registered. A maximum of 28 measuring points were examined. The number of positive findings was divided by the number of measurements to yield a percent plaque index (Lange 1975). In 20 patients, the inter-rater agreement between the examiner and a senior dentist was assessed. The reliability was $r = 0.92$.

Sulcus bleeding index (SBI)

A periodontal probe was gently guided through the gingival sulcus. Bleeding on contact was noted at the same assessment points as in the API procedure. Positive findings were divided by assessments and a per cent SBI was obtained (Mühlemann & Son 1971). Inter-rater agreement was $r = 0.90$.

Dental visiting behavior

The dental avoidance scale by Kleinkecht et al. (1973) consists of two items asking patients about the postponement and cancellation of appointments because of fear of dental procedures with reference to a 7-point scale ranging from 1 = never to 7 = most of the time. The reliability has been reported to be $\alpha = 0.90$ (Milgrom et al. 1997). The time since the last visit was recorded in months.

Life Event Scale

A short form of 15 negative life changes from the Life Experience Survey (LES) by Sarason et al. (1978) was presented. Familial, financial and work changes were included, while items relating to health were excluded. The patients were asked to indicate whether they had experienced each of the 15 events during the last six months and how distressing it had been, perceived on a 5-point Likert scale ranging from 0 = indifferent or positive to 4 = extremely nega-

tive. A Guttman split half reliability of 0.88 has been reported (Klages 2002).

Impact of event scale

The patients were requested to indicate the frequency of thoughts referring to the most stressful event during the last 6 months on a 4-point scale format from 1 = never to 4 = often (Horowitz et al. 1979). The Intrusion Scale refers to uncontrollable cognitive preoccupation with the event (e.g. 'I thought about the event when I didn't mean to'). The Cognitive Avoidance Scale comprises items referring to efforts to banish intrusive thoughts (e.g. 'I didn't let myself have thoughts related to it'). The reliability for the German form according to Cronbach's α was 0.92 for Intrusion and 0.82 for Cognitive Avoidance (Klages 2003).

SCL-90-R – depression

The depression scale of the Symptom Check List-90-R (Derogatis 1983) was applied in its German form by Franke (1995). It comprises 13 depressive symptoms including self-blame, loneliness, hopelessness, and worthlessness. Patients indicated how distressed they had felt by these symptoms during the last 6 months on a 5-point scale (0 = not at all, 4 = very strongly). Patients' ratings were added and divided by the number of items. Thus the depression scale had a range from 0 to 4. According to the test manual, α was found to be 0.92 (Franke 1995).

SCL-90-R – somatization

Patients were asked to indicate the distress experienced from 12 psychosomatic symptoms, such as headache, low back pain, hot and cold chills or dizziness. A reliability of $\alpha = 0.82$ was reported.

Statistical analyses

The statistical software SPSS for Windows Release 12.0 (SPSS Inc., Chicago, IL, USA) was applied in all analyses. One-way analyses of variance were performed to compare patients showing different levels of dental plaque and of sulcus bleeding. Simple contrasts were calculated to compare patients with no signs of plaque or bleeding with those presenting higher degrees. Levene tests

investigating homogeneity of variances had been previously performed. In variables with significant deviations from homogeneity, *t*-tests for non-equal variances were calculated. A conventional significance criterion of $p < 0.05$ was applied in the analyses.

Results

With regard to the first research question, levels of approximal plaque sites were to be defined. In 59 patients, no signs of plaque were detected. In 49 patients, plaque was noted in up to 20% of measurement sites. According to Lange (1975) oral hygiene in this group is to be regarded as good. Thirty-two patients were identified as presenting with plaque in >20% to 75% of examined interdental spaces. This group comprised a range of oral hygiene estimated as adequate in 19 subjects, as moderate in nine persons, and as inadequate in one patient. Patients showing these three oral hygiene levels did not differ significantly with regard to sex (chi-squared = 1.09, $p = 0.58$), education (chi-squared = 8.10, $p = 0.09$) and age ($F = 1.68$, $p = 0.19$).

The results of one-way analyses of variance including simple contrasts comparing patients with no sign of plaque to those with approximal plaque in 1–20% and to those showing plaque in >20% to 75% of examined sites with regard to dental status and dental visiting behaviour are shown in Table 1. As decayed teeth were found in only seven patients, this variable was omitted from the analysis.

Levene tests had yielded non-homogeneity of variances in all four variables. Therefore *t*-tests for non-equal variances were calculated. Simple contrasts revealed that patients showing

plaque in more than 20% of examined approximal sites had more missing teeth than those with no sign of plaque ($t = 2.03$, $p < 0.05$). They reported more avoidance behavior ($t = 3.00$, $p < 0.01$), and their last dental visit had been longer ago ($t = 2.80$, $p < 0.01$) compared to patients in the non-plaque group.

Using the non-parametric Mann-Whitney test, the result of a significant difference was not confirmed for missing teeth ($Z = 1.70$, $p = 0.09$). However, it was substantiated for dental avoidance ($Z = 2.93$, $p = 0.003$) and for last dental visit ($Z = 2.07$, $p = 0.04$).

According to the second research question, four degrees of the SBI were defined. Twenty-six patients exhibited no signs of sulcus bleeding. In 32 subjects, bleeding was noted in up to 10% of examined sites. According to Mühlemann & Son (1971) the extent is to be regarded as within the normal range without clinical significance. 42 patients showed bleeding in 11–20% of measured sites. Their SBI values are to be regarded as signs of low inflammation. Forty patients attained SBI scores of >20% to 75%, which is to be regarded as a sign of moderate inflammation in 36 patients and of severe inflammation

(>50%) in four subjects all showing a periodontal treatment need.

The results of the one-way analyses of variance comparing dental status and visiting behavior in patients demonstrating four levels of sulcus bleeding are shown in Table 2.

Foregoing Levene tests yielded a non-homogeneity of variances for the variables missing teeth, dental avoidance, last dental visit, and approximal plaque. In these variables *t*-tests for non-equal variances were performed. Compared to patients with no sulcus bleeding, subjects with an SBI >20% had more missing teeth ($t = 3.10$, $p < 0.01$), reported more dental avoidance ($t = 2.79$, $p < 0.01$), and presented more approximal plaque ($t = 4.04$, $p < 0.001$). The results were substantiated by non-parametric Mann-Whitney tests for missing teeth ($Z = 2.52$, $p < 0.05$), dental avoidance ($Z = 2.31$, $p < 0.05$), and dental plaque ($Z = 2.86$, $p < 0.01$).

The results of one-way analyses of variance comparing patients with different API degrees in life stress and psychological symptoms are shown in Table 3.

On the basis of foregoing Levene tests, *t*-tests for non-equal variances

Table 1. Results of one-way analyses of variance with the factor plaque level and the dependent variables filled and missing teeth, dental avoidance and months since last visit: means (*M*), standard deviations (SD) and simple contrasts (*t*) comparing API levels 2 and 3 against level 1

	Approximal plaque level			Simple contrasts	
	(0%) <i>M</i> (SD)	(1%–20%) <i>M</i> (SD)	(21–75%) <i>M</i> (SD)	1 versus 2 <i>t</i>	1 versus 3 <i>t</i>
Filled teeth	4.39 (4.10)	6.22 (6.05)	6.13 (4.64)	1.80	1.77
Missing teeth	3.71 (5.16)	4.16 (5.21)	6.69 (7.32)	0.45	2.03*
Dental avoidance	3.01 (2.30)	2.69 (1.80)	5.28 (3.89)	0.81	3.01**
Last visit	6.69 (4.66)	8.29 (7.85)	12.76 (1.77)	1.19	2.80**

* $p < 0.05$.

** $p < 0.01$.

API, approximal plaque index.

Table 2. Results of one-way analyses of variance with the factor sulcus bleeding level and the dependent variables filled and missing teeth, dental avoidance and months since last visit: means (*M*), standard deviations (SD) and simple contrasts (*t*) comparing SBI levels 2, 3 and 4 against level 1

	Sulcus bleeding level				Simple contrasts		
	(0%) <i>M</i> (SD)	(1–10%) <i>M</i> (SD)	(11–20%) <i>M</i> (SD)	(21–75%) <i>M</i> (SD)	1 versus 2 <i>t</i>	1 versus 3 <i>t</i>	1 versus 4 <i>t</i>
Filled teeth	4.46 (4.23)	5.41 (4.96)	5.33 (6.19)	6.05 (4.22)	0.57	0.54	1.09
Missing teeth	3.19 (4.61)	2.94 (4.16)	3.48 (4.39)	7.85 (7.56)	0.22	0.25	3.10*
Dental avoidance	3.07 (2.39)	2.71 (2.18)	2.76 (4.90)	4.90 (3.74)	0.59	0.58	2.72*
API – plaque	6.46 (9.86)	8.53 (9.30)	6.69 (9.03)	22.70 (22.24)	0.81	0.09	4.04**

* $p < 0.01$.

** $p < 0.001$.

API, approximal plaque index.

Table 3. Results of one-way analyses of variance with the factor plaque level and the dependent variables life events, cognitive intrusion and avoidance, somatization and depression: means (*M*), standard deviations (*SD*) and simple contrasts (*t*) comparing API levels 2 and 3 against level 1

	Approximal plaque level			Simple contrasts	
	(0%) <i>M</i> (<i>SD</i>)	(1–20%) <i>M</i> (<i>SD</i>)	(21–75%) <i>M</i> (<i>SD</i>)	1 versus 2 <i>t</i>	1 versus 3 <i>t</i>
LES – life events	5.06 (5.26)	5.42 (8.01)	7.53 (7.51)	0.27	1.63
IES – cognitive intrusion	15.66 (6.85)	14.93 (7.22)	17.09 (6.67)	0.53	0.94
IES – cognitive avoidance	13.83 (5.29)	14.38 (6.10)	16.06 (5.71)	0.51	1.78
SCL-90-R – somatization	7.36 (5.40)	8.36 (6.26)	11.09 (10.23)	0.87	1.89
SCL-90-R – depression	8.00 (7.95)	7.63 (9.16)	11.58 (11.04)	0.20	1.59

LES, Life Experience Survey; IES, Impact of Event Scale.

Table 4. Results of one-way analyses of variance with the factor plaque level and the dependent variables life events, cognitive intrusion and avoidance, somatization and depression: means (*M*), standard deviations (*SD*) and simple contrasts (*t*) comparing SBI levels 2–4 against level 1

	Sulcus bleeding level				Simple contrasts		
	(0%) <i>M</i> (<i>SD</i>)	(1%–10%) <i>M</i> (<i>SD</i>)	(11%–20%) <i>M</i> (<i>SD</i>)	(21%–75%) <i>M</i> (<i>SD</i>)	1 versus 2 <i>t</i>	1 versus 3 <i>t</i>	1 versus 4 <i>t</i>
LES – life events	4.26 (7.47)	7.03 (9.53)	5.28 (5.46)	5.55 (4.83)	1.51	0.59	0.72
IES – cognitive intrusion	11.73 (6.25)	14.81 (6.76)	15.54 (6.79)	18.80 (6.09)	1.79	2.35*	4.22***
IES – cognitive avoidance	12.50 (5.99)	14.59 (5.59)	13.54 (5.15)	16.75 (5.50)	1.43	0.76	2.99**
SCL-90-R – somatization	6.36 (5.41)	7.65 (5.98)	7.87 (5.72)	10.57 (9.04)	0.85	1.08	2.24*
SCL-90-R – depression	4.12 (6.07)	7.68 (6.95)	8.94 (9.96)	12.34 (9.36)	2.06*	2.03*	4.12***

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

LES, Life Experience Survey; IES, Impact of Event Scale.

were calculated for the SCL-90-R scales somatization and depression. No significant elevations of life events, cognitive avoidance and depression were found when comparing patients showing two levels of approximal plaque with the reference no-plaque group. Cognitive avoidance and somatization were slightly elevated in patients with API scores $> 20\%$ compared to the reference group demonstrating statistical tendencies ($t = 1.78$, $p = 0.08$ and $t = 1.88$, $p = 0.07$).

Table 4 shows the comparisons of patients with different sulcus bleeding levels in terms of life stress and SCL-90-R variables.

As variances were different (Levene test) in somatization and depression, the relevant *t*-tests for non-equal variances were applied to these variables. No differences between groups were found for the life-event scale. However, compared to the reference group showing no sulcus bleeding, patients with low and with moderate to severe inflammation scored higher in cognitive intrusion ($t = 2.35$, $p < 0.05$ and $t = 4.61$, $p < 0.001$). Cognitive avoidance was elevated only in the SBI-high score groups ($t = 3.11$, $p < 0.01$), as was somatization ($t = 0.276$, $p < 0.01$). Finally, compared

with the reference group, depression scores were elevated in patients showing sulcus bleeding within the normal range ($t = 2.06$, $p < 0.05$), indicating low inflammation ($t = 2.03$, $p < 0.05$) and with moderate to severe inflammation ($t = 4.36$, $p < 0.001$).

When using the API as a control variable in a covariance analysis design, the significance of differences between SBI-high score patients and the reference group was confirmed for cognitive intrusion ($t = 4.33$, $p < 0.001$), cognitive avoidance ($t = 2.64$, $p < 0.01$), somatization ($t = 2.29$, $p < 0.05$) and depression ($t = 3.76$, $p < 0.001$). In the low inflammation group the elevation of cognitive intrusion remained significant ($t = 2.34$, $p < 0.05$).

Discussion

The aim of this study was to investigate whether life stress, depression and somatization, which are assumed to influence HPA reactivity (Breivik et al. 2000, Rief & Auer 2001), were related to signs of periodontal disease activity. To avoid confounding with history of periodontal destruction, a reported problem in measures of probing depth and attachment loss (Griffiths et al. 1988),

gingival sulcus bleeding was assessed as a clinical indicator of acute inflammation (Mühlemann & Son 1971). Considering the postulate of cognitive theory that not life stress alone but the processing of information relating to the event causes psycho-physical dysfunction (Horowitz 1993), a measure assessing intrusive thoughts and cognitive avoidance (Horowitz et al. 1979) was included in this study.

As gingival inflammation is often associated with dental plaque (Mariotti 1999), it was considered to be of interest how life stress and the two personality variables of depression and somatization relate to plaque accumulation. Finally, dental status and dental visiting behavior were hypothesized to be of relevance to the presentation of dental plaque and gingival bleeding.

As a first topic this research was concerned with the question of whether patients demonstrating different levels of approximal plaque differed in their dental status and in their visiting behavior. Three levels of plaque accumulation were defined (Lange 1975). The first covered patients showing no signs of plaque at all. The second comprised subjects attaining plaque scores within a normal range. The third consisted of

patients indicating only moderate oral hygiene. Whereas numbers of filled and of missing teeth did not differ, patients of the last group reported more avoidance behavior (postponing and canceling appointments), and the time since their last dental visit was longer. This result underscores the importance of regular dentist supervision in maintaining oral hygiene behavior. Several studies on oral hygiene training demonstrated that the effects were only short term, and compliance declined with fading dental appointments (Tedesco et al. 1991, Galgut 1992, McCaul et al. 1992).

As a second issue we investigated whether different degrees of sulcus bleeding were associated with dental status and with visiting behavior. The first degree was defined as freedom from signs of bleeding. The second level covered sulcus bleeding which was not to be regarded as clinically significant. The third degree covered sulcus bleeding with low inflammation, where improvements were warranted. The fourth level comprised sulcus bleeding indicating moderate to severe inflammation and treatment need (Mühlemann & Son 1971). At the highest level of the SBI, more missing teeth were registered in patients compared to subjects with no bleeding points. This result confirms a finding by Locker & Leake (1993) in their community-based study, where fewer remaining teeth were associated with stronger attachment loss. In the regression model by Croucher et al. (1997) the number of missing teeth predicted periodontal disease status. The number of teeth lost was found to be related to periodontal progression in the longitudinal study by Kamma & Baehni (2003). One reason for these results may be that gingival inflammation is often observed in patients supplied with partial dental prostheses, when the cleaning practice is not optimal (Petridis & Hempton 2001).

Patients demonstrating a periodontal treatment need in our study also reported more canceling and postponing of dental treatment due to anxious apprehension. A similar finding was reported by Axtelius et al. (1997), in that periodontal treatment failure was associated with an unpleasant feeling toward dental procedures. According to Locker & Leake (1993) regular dental attenders exhibited less attachment loss.

In patients with signs of moderate or severe gingival inflammation, more in-

terdental sites with plaque were detected in the present study. This result confirms findings by Kurer et al. (1995) and Mengel et al. (2002) reporting strong correlations between plaque and gingival scores.

As a third issue of this research we investigated relationships of life stress and of the psychological symptoms variables of depression and somatization to approximal plaque levels. Two measures of life stress were applied: the short form of the LES (Sarason et al. 1978) emphasizing the stimulus aspect of perceived life stress, and the IES (Horowitz et al. 1979) pertaining to cognitive intrusion and cognitive avoidance in relation to the most distressing event during the last 6 months. The somatization and depression scale are part of the widely used Symptom Check List-90-R (Derogatis 1983).

The amounts of negative life changes, of cognitive intrusion and of depression did not differ between patients representing the three grades of the API. Cognitive avoidance and somatization were slightly elevated in patients with a high approximal plaque level; this was to be evaluated as a statistical tendency ($p < 0.10$). Thus the hypothesis postulating an association of patient life stress and personality with dental plaque was not supported by present data. Though this assumption has been repeatedly suggested (e.g. Genco et al. 1998), research evidence is sparse. Kurer et al. (1995) found a slight correlation between depression and plaque accumulation ($r = 0.28$). In students undergoing a stressful examination, a higher dental plaque coverage was found compared to controls (Deinzer et al. 2001). In a study by Monteiro da Silva et al. (1998), life events and depression were not correlated with dental plaque. These last authors explain their negative results with the fact that their patients were secondary referrals who may have expected to be examined for plaque. In our study the patients had not been prepared for a plaque examination, but they may have been used to cleaning their teeth thoroughly before a dental visit. A further explanation for our negative findings might be that the variance of the API scores was relatively small, indicating generally sufficient dental hygiene adherence.

The fourth topic of this research was concerned with the relationship of patient life stress and personality to sulcus bleeding level. Life change stress

did not differ between SBI degrees. However, patients with a periodontal treatment need reported more intrusive thoughts and avoidant cognitions on the IES by Horowitz et al. (1979) compared to the SBI-zero percent group. Additionally cognitive intrusion was elevated in patients presenting a level of low inflammation.

Cross-sectional research on the relationship between stress and periodontal indices or periodontal disease status found equivocal results showing single weak associations (Marcenes & Sheiham 1992, Horning & Cohen 1995, Croucher et al. 1997, Genco et al. 1999) or no associations between the two constructs (Locker & Leake 1993, Monteiro da Silva et al. 1996, Moss et al. 1999, Vettore et al. 2003). As explained in the Introduction, the assessment of clinical indices of inflammation might be more adequate for testing the hypothesis than periodontal measures or assessment of periodontal disease status reflecting a history of periodontal destruction (Griffiths et al. 1988, Locker & Leake 1993, Vettore et al. 2003). Present results demonstrating that gingival bleeding does not relate to life changes but to cognitive intrusion and avoidance support the notion that instruments assessing the stimulus aspect of life stress might contribute less well to the explanation of gingival inflammation than measures pertaining to information processing of stressing events (Locker & Leake 1993). The intrusion scores of the high sulcus bleeding group may be of clinical relevance. Their scale mean value was one standard deviation above the mean of patients with inflammatory rheumatic diseases and near the mean of sociophobic patients (Klages 2003).

Patients showing sulcus bleeding at the levels of moderate inflammation, low inflammation and clinical insignificance all had elevated depression scores compared to the SBI-zero percent group. Comparable results were reported by Monteiro da Silva et al. (1996), Axtelius et al. (1998) and Mengel et al. (2002). The depression mean value of the SBI-high scorers may be of clinical significance. According to the test manual (Franke 1995) it was one standard deviation above the mean of a representative normative sample.

Patients presenting a high percentage of bleeding sites indicating treatment need also reported more psychosomatic symptoms on the somatization scale of the SCL-90-R. This finding confirms

results of earlier studies (Moulton et al. 1952, Baker et al. 1961, Green et al. 1986), whereas recent research has not found support for a somatization–periodontitis relationship (Monteiro da Silva et al. 1996, Moss et al. 1999, Genco et al. 1999). The somatization scores of patients with a high SBI level seem to be of clinical importance. Their mean was one standard deviation above the mean of the normative sample and higher than that of psychiatric patients (Franke 1995).

Different life stress and personality scores in patients with high *versus* no sulcus bleeding are not to be explained by oral hygiene. Though the two groups differed in their plaque scores, controlling for its influence using analyses of covariance did not change the significance of differences in intrusive thoughts, cognitive avoidance, depression, and somatization.

Several limitations are to be considered in the generalization and interpretation of the present results. First, with regard to positive findings the cross-sectional design of this study has to be borne in mind. On principle, intrusive thinking, depression and somatization tendencies could be a consequence of gingival symptoms. However, this interpretation seems not to be very convincing, as the impacts of oral health on psychological functioning are of less significance in most cases than diseases such as inflammatory rheumatism or low back pain. Nonetheless, prognostic studies are warranted to test the hypothesis of a causal path leading from psychological condition to gingival health. They should be relatively short term, as a stressor or psychological state is not guaranteed to endure in the long term. A possible strategy may be to investigate the impact of naturally occurring stress episodes on gingival parameters compared to controls (Deinzer et al. 1998). Secondly, in this study gingival condition was assessed by sulcus bleeding only. Additional indicators of inflammation such as crevicular interleukin may be included in further studies (Deinzer et al. 1999, Mengel et al. 2002). Thirdly, dental plaque scores had a relatively small range in the present patient sample, which might have influenced negative findings when investigating relations to patient characteristics. Further studies should use samples showing a wider variation to examine the role of stress and patient personality on the presentation of dental plaque.

With regard to clinical applications it might be helpful to instruct patients with gingival inflammation presenting themselves in a state of stressful cognitive preoccupation, depression or somatic concerns about the role of stress regulation, oral hygiene, and regular appointments in preventing periodontal disease.

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